



A CASE STUDY OF THE DAMODAR VALLEY CORPORATION AND ITS PROJECTS

FLOOD CONTROL SERIES

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UNITED NATIONS

ECONOMIC COMMISSION FOR
ASIA AND THE FAR EAST

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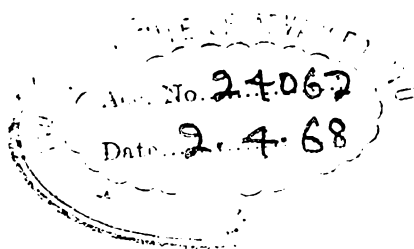
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EXPLANATORY NOTE

The following symbols have been used in the tables and figures throughout the report:

Three dots (. . .) indicate that data are not available or are not separately reported.

A dash (—) indicates that the amount is nil or negligible.

A blank in a table indicates that the item is not applicable.

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

A slash (/) indicates a crop year or fiscal year, e.g. 1957/1958.

Use of hyphen (-) between dates representing years, e.g. 1950-1955, signifies the full period involved, including the beginning and end years.

The following terms have been used throughout the report:

Acreft	—	1,233.5 cubic metres.
Aman	—	Crops harvested in the cold weather.
Aus	—	Early variety of rice.
Crone	—	Ten millions (10,000,000).
Cusec	—	Cubic feet per second.
Ghat	—	A passage across a channel.
Hathia	—	A rain commencing between 24 September and 7 October.
Hectare	—	2.46 acres.
Isohytel	—	Line connecting points of equal rainfall depth.
Kar	—	A variety of short rice crop.
Kharif paddy	—	Aman paddy (rice).
Lakh or lac	—	One hundred thousand (100,000).
Leaching	—	The washing out of salts from the upper zone of the soil by flooding.
Monsoon period	—	June to September.
Maunds	—	82 pounds.
M. S. L.	—	Mean sea level.
Rabi	—	Winter season (October to March) or the winter crop harvested in spring.
Runoff	—	Portion of total precipitation or snow melt over an area, that finds its way into streams as surface flow; remaining portion of precipitation of snow melt is absorbed by deep strata until utilized by vegetation or lost by evaporation.
Water duty	—	The relation between the area of land served and the quantity of irrigation water used.
Waterlogged	—	State of land when water-table is located at or above ground level or when water-table is so near the surface that crops cannot grow.
Watershed	—	Line which follows ridges or summits forming exterior boundary of a drainage area or basin, separating one drainage basin for another.

References to "tons" indicate metric tons, and "dollars" means United States dollars, unless otherwise stated. Details and percentages in tables do not necessarily add up to totals, because of rounding.

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

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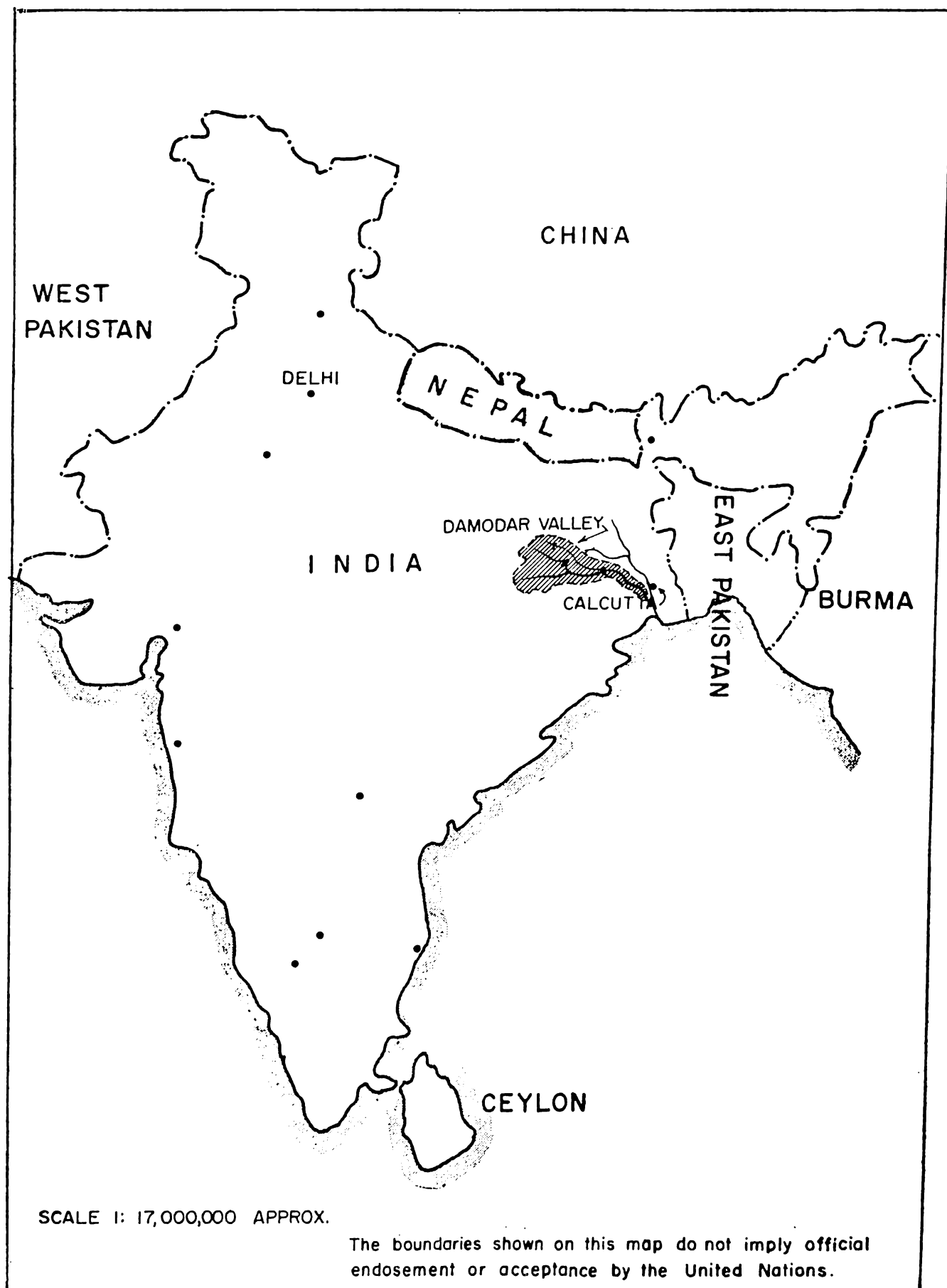
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LOCATION MAP SHOWING DAMODAR VALLEY AREA

Chapter I

INTRODUCTION

General

India, less than half the size of the United States, has more than twice the population. It became an independent nation on 15 August 1947.

India's poverty is difficult for outsiders to comprehend as are the conditions under which millions exist. The country is predominantly rural. Because of the large illiteracy percentage, lack of medical personnel, hospitals, communications and utilities, the Government is confronted with the superhuman task of rehabilitating the unfortunate masses. *The United Nations Statistical Yearbook for 1953* recorded the Indian level of nutrition at 1950 calories per person, as the lowest in the world.

Although India is a country of poor people, it is not a poor country. The natural resources exist for the highest of modern economic development. Few countries in the world can be said to possess agricultural prospects as bright as those of India. Even more striking are its potential mineral resources for industrial development. India possesses abundant reserves of iron, coal, oil, mica, bauxite, copper, manganese, gold, silver, lead and last, but by no means the least, tremendous potentialities for the development of water power and other multiple-purpose features. India ranks second only to the United States in water resources, yet in 1958 used only 3.4 per cent of its total potential.

Within the operating boundaries of the Damodar Valley Corporation all the ingredients necessary for embarking on a stupendous industrial development exist. With huge reserves of iron and coal it is reasonable to liken the area to that of the Ruhr sector in the Federal Republic of Germany.

Climate and geography of the Damodar valley

The Damodar river basin straddles the states of Bihar and West Bengal and originates in west of Calcutta, some 200 miles away. (See frontispiece map of area).

The Damodar valley, though small in area, is rich in natural resources. Nature has endowed the valley with everything needed to make the area prosperous: soil, water, minerals and manpower. But much of the land particularly in the upper valley is deteriorating rapidly unless it is reconditioned; erosion will spread to its lower reaches and ultimately the whole valley will be destined to become a desert.

The topography of the valley varies from the rugged bare hills of Chota Nagpur to the lush plains of West

Bengal. The highest peak in the upper valley, known as Parasnath Hill, rises to a height of 4,480 ft. Here the plateau is intersected by deep ravines and extensive valleys. It is from this area that the Damodar springs. During the monsoon season it strips away vegetation and drains away the wealth of the soil.

The lower valley lies in West Bengal, and is the recipient of the rich deposits of alluvial soil from the Damodar during the flood stages. Much of the land has been protected from floods by the construction of a levee (bund) on the left bank, and is partially irrigated by the Damodar canal, which in turn feeds the Eden canal below Burdwan. The water is diverted into the canal by the Anderson weir across the river at Rhondia. The system was constructed before the establishment of the Damodar Valley Corporation (DVC), and crops often failed for lack of an adequate water supply during the dry months.

The flooding of large expanses in the lower valley, involving heavy losses of life and property has been a common feature of the region for centuries.

The climatic conditions of the valley vary from the temperate months of November through March, to the hot and humid months of April, May, and June, followed by monsoon rains, increasing at times to cyclonic proportions, until October. These storms usually form in the Bay of Bengal and travel in a generally northwesterly direction on reaching the Damodar valley. Storms are usually of greater intensity in the first half of the monsoon season than in the latter half. Except for the years 1958-59, the upper portion of the Damodar basin received the greater rainfall; usually more than 80% of the average annual rainfall occurs from June to October.

Table 1 shows, in order of magnitude, the average storm rainfall occurrences in the upper Damodar basin in excess of 0.5 in for periods of 24 hours for the first and last half of the monsoon season from 1932 through 1958.

The largest recorded rainfall in the Damodar valley in the catchment area above Raniganj averaged 11.8 in between 6 and 14 August 1913. The runoff coefficient amounted to 70%. The largest known rainfall above Raniganj occurring in the last half of the monsoon period took place between 30 September and 7 October 1917, amounting to 9.8 in; the runoff coefficient was 84%. The rainfall in the Damodar valley averages about 46.5 in annually, and ranged from a maximum

of 64.27 in 1917 to a minimum in 1915 of 30.65 in over a 47 year period. Table 2 shows the annual average rainfall from 1912 through 1959.

Rainfall data in the Barakar and Damodar basins have been consistently collected for nearly 100 years, although the results have often not been too reliable.

TABLE 1. AVERAGE STORM RAINFALL (IN INCHES) OCCURRING DURING THE MONSOON MONTHS (1930-1958) IN THE CATCHMENT AREA ABOVE RHONDIA
(Tabulated in order of magnitude)

Order of magnitude	First half of monsoon up to 15 August	Second half of monsoon up to 15 October
1	11.64	7.03
2	10.37	6.60
3	9.61	6.08
4	9.56	5.89
5	7.71	5.80
6	7.52	5.56
7	6.34	5.43
8	6.14	5.13
9	6.05	5.07
10	5.56	4.95
11	5.47	4.90
12	5.31	4.78
13	5.25	4.77
14	5.10	4.41
15	5.03	4.33
16	4.90	4.17
17	4.82	4.16
18	4.79	4.15
19	4.76	3.96
20	4.74	3.96
21	4.73	3.94
22	4.68	3.83
23	4.56	3.66
24	4.23	3.62
25	4.07	3.57
26	4.07	3.44
27	4.05	3.43
28	3.93	3.34
29	3.90	3.26
30	3.88	3.20
31	3.76	3.13
32	3.68	2.94
33	3.62	2.94
34	3.48	2.87
35	3.39	2.73
36	3.36	2.56
37	3.24	2.38
38	3.19	2.10
39	2.95	2.05
40	2.87	1.84
41	2.61	1.71
42	2.55	1.56
43	2.37	1.40
44	2.35	1.23
45	2.32	1.22
46	2.26	1.10
47	2.16	1.09
48	2.07	1.06
49	2.03	
50	2.01	
51	1.96	
52	1.96	
53	1.95	
54	1.95	
55	1.82	

TABLE 1. (contd.)

Order of magnitude	First half of monsoon up to 15 August	Second half of monsoon up to 15 October
56	1.74	
57	1.69	
58	1.67	
59	1.54	
60	1.32	
61	1.24	
62	1.16	
63	1.11	
64		
65		

Source: Preliminary memorandum on the unified development of the Damodar river, August 1945, including records of subsequent years.

Explanation: 1. Storms which last a day or more, with rainfall more than one inch, have been taken into consideration.

2. Rainfall occurrences exceeding 0.5 in in 24 hours have been taken into consideration for the above figures, to find out the total storm rainfall. The figures shown are not the monthly averages but totals of particular storm occurrences.

TABLE 2. AVERAGE ANNUAL RAINFALL IN THE DAMODAR VALLEY (1912-1959)

Year	Average rainfall (in inches)
1912	32.02
1913	51.97
1914	34.94
1915	30.65
1916	49.53
1917	64.27
1918	39.54
1919	58.63
1920	47.46
1921	42.35
1922	55.24
1923	48.74
1924	50.58
1925	42.77
1926	46.87
1927	38.74
1928	46.63
1929	52.93
1930	52.03
1931	42.31
1932	38.97
1933	46.34
1934	42.54
1935	34.39
1936	56.30
1937	46.95
1938	38.13
1939	52.81
1940	38.29
1941	53.29
1942	56.15
1943	53.20
1944	47.87
1945	43.10
1946	49.10
1947	42.70
1948	43.00
1949	46.80
1950	48.60
1951	39.30
1952	44.70
1953	56.90
1954	40.20

TABLE 2. (contd.)

Year	(in inches) Average rainfall
1955	34.10
1956	46.90
1957	38.90
1958	40.60
1959	60.00

Source: Preliminary memorandum on the unified development of the Damodar river, August 1945, including subsequent years.

The land, people and economic conditions prior to DVC

The Damodar valley area is composed of two distinct land forms, depending on the variations of climate and soil characteristics. The upper valley, with its dry climate and sloping land, has abundant mineral resources. The lower valley, which impinges into the lower deltaic region of West Bengal, is predominantly agricultural. The entire valley has an area of nearly 9,400 sq mi. According to the 1951 census, the population was 5 million, of whom 4.5 million resided in rural areas and the remainder in urban areas, i.e. 25 towns. There were more than 10,000 villages. The population density varied from 121 to 1,635 per sq mi.

As in other parts of India, agriculture in the valley was a seasonal industry. Table 3 indicates the pattern of land utilization for the area comprising areas falling partly within the valley in 1947-48.

TABLE 3. CLASSIFICATION OF AREA WITHIN DAMODAR AND ADJOINING AREAS IN 1947-1948
(In thousands of acres)

Classification	Lower valley and adjoining areas	Upper valley and adjoining areas
Forest area	—	5,950
Area not available for cultivation	879.7	2,251
Other uncultivable land, excluding current fallow	509.1	2,274
Current fallow	393.7	2,422
Net area sown	2,774.4	5,381
Total	4,556.9	18,278

The upper valley and the adjoining areas includes the entire area of the districts of Hazaribagh, Ranchi, Palamau, Santhal Parganas and Manbhum. The lower valley comprises the districts of Bankura, Burdwan, Hooghly and Howrah. These combined districts represent an area of approximately 35,750 sq mi. In the lower area, only 6.7% of the net area sown was used for cultivating more than one crop. The principal crops grown in the lower valley and the adjoining areas were paddy, jute and some varieties of pulses. The net area sown in the upper valley and the adjoining area was 29.5% of the total, while in the whole two areas 2.8 million acres of land remained uncultivated. The staple food of the people of the valley was rice. Other crops were not grown in the valley in any abundance. In the lower valley and

its adjoining lands, the area under paddy was 2.5 million acres; production totalled 265 lakh maunds (1 million metric tons).

In 1948-49, the acreage under paddy in the upper valley, including the adjoining areas, was nearly 3.4 million acres. Other crops grown in the upper valley were maize and gram, and some varieties of oil seeds.

The agricultural economy of the lower region was based on subsistence farming. Holdings were uneconomic and the cultivators lacked any incentive to increase productivity. Since the area was situated on the fringes of the Calcutta industrial region, the cultivators in this part of the valley were less inactive. With the growth of townships within the region, the productivity consciousness of the cultivators grew in view of ready markets for surplus agricultural commodities.

By comparison, the land of the upper valley was more susceptible to soil erosion; the nature and extent of damage depended on the slope, intensity of rainfall, soil character and vegetation cover. Variations in the productivity of land in the upper valley was principally due to differences in soil characteristics.

In the absence of any subsidiary means of livelihood during the slack season, dependence on land became increasingly pronounced. The absence of any organized marketing facilities also deprived cultivators of favourable prices for their products. The capital equipment of farms in general consisted of not more than one pair of bullocks and some iron ploughs.

The existence of irrigation facilities, so necessary to boost agricultural production, was very limited. In lower valley and the adjoining areas, out of a total farming area of about 3 million acres, the area under irrigation was only 800,000 acres. In the upper valley and the adjoining areas, roughly 15% of the net area sown was irrigated. The need to extend irrigation facilities was keenly felt, as there were vast stretches of land which could be brought under cultivation with some effort. The problem of water supply for agricultural development demanded particular attention, for which all resources were to be tapped. The choice of methods to be used, from among irrigation canals, multiple-purpose reservoirs, tube wells, river pumping, open wells and rainwater conservation by "bundling", according to their economic suitability for the area in question, required careful study.

The scanty supply of suitable manure, lack of knowledge of modern practices, characterised by cropping pattern, use of artificial manure and of improved varieties of seed, etc., were also causes of the low productivity of the land. Control of weeds, provision for adequate storage facilities and for protection against pests and diseases were not practised on a large scale or along modern lines.

Compared to the potential resources of the region, industrial development was not impressive. A measure of the assessed mineral resources of the Damodar valley and the adjoining region as compared to the whole of India in 1949 is given in table 4.

TABLE 4. OUTPUT OF SOME IMPORTANT MINERALS IN THE DAMODAR VALLEY AND ADJOINING AREAS EXPRESSED AS A PERCENTAGE OF THE TOTAL PRODUCTION OF INDIA IN 1949

<i>Mineral</i>	<i>Percentage</i>
Coal	80
Iron ore	98
Copper	100
Manganese	10
Mica	70

Some further enlightenment as to the mineral activity of the area may be seen from a summary of the mining production occurring in the state of Bihar during 1947 as reflected in table 5.

TABLE 5. OUTPUT OF SOME IMPORTANT MINERALS IN STATE OF BIHAR IN 1947

<i>Mineral</i>	<i>Output</i>	<i>Value of output (in lakhs of rupees)</i>
Coal	17,318 thousand tons	2,572
Iron ore	1,106 " "	6,655
Manganese	18 " "	1
Copper	353 " "	60
Mica	87 " cwt	109

Prior to the incorporation of DVC, the coal-mining industry in the area was beset by difficulties. It depended, for instance, on meeting the requirements of the Calcutta industrial region and the railways. Despite an abundance of cheap labour and easily mined rich deposits, development was far short of the economic need. The best quality of coal came from the Jharia coalfields. Good quality coal was also found in the Raniganj-Barakar area in West Bengal in the heart of the valley. The production of coal in West Bengal in 1947 was reported to be 7.6 million tons.

Of the three steel plants in India, one was located near Asansol, another and the largest at Jamshedpur, a town adjacent to the valley. The production of finished steel goods came largely from these two plants.

In Bihar in 1946, the public electricity undertakings marketed almost 90 million kWh of electricity to 21,875 end consumers. In West Bengal, excluding the Calcutta area, nearly 116 million kWh of electricity were consumed in 1946. At that time, the supply of electricity in the Damodar valley region was mainly confined to the coal-mining areas and industrial townships. The Damodar valley area, notwithstanding its hydroelectric potential and coal resources, remained economically dormant.

In the lower Damodar valley and the adjoining areas, 555 factories in organized sectors employed more than 12,000 workers in 1947. Of this number, 376 factories were in the district of Howrah, part of which falls within the Calcutta industrial region. In 1947, the state of Bihar had 281 factories in organized sectors, of which 64 were seasonal. The seasonal industries, such as sugar, were the cause of considerable labour migration. However, during the agricultural slack season employment by these industries, to some extent, eased-out the appalling rural underemployment in the state.

Transport facilities in the Damodar valley area were

most inadequate. The Grand Trunk Road which linked Calcutta with upper India was the only important all-weather long-distance road in the valley. The village roads were seasonal and almost impassable during the rainy season using any modern conveyance. In the upper valley, the soil was sufficiently hard for the easy development of a road system, but no appreciable progress was made. The rivers in the upper valley were navigable to some extent during the rainy season, but the situation was better in the lower reaches. This transport bottleneck was one of the prime causes of the economic imbalance within the valley, and one of the reasons for constructing a railway system within the valley for the transport of minerals such as coal, mica, etc. to the industries of the Calcutta region. Towards the end of 1947, in the Burdwan, Bankura, Howrah and Hooghly districts of West Bengal, road mileage was increased to 6,460 miles, of which 28.9% was metalled. In Bihar, the road system was not developed. The total road mileage in 1944 was about 29,000 of which nearly 96% was unmetalled and of lower types.

The Second World War, famine and floods left severely affected the economy of the valley. In Bengal alone, 3.5 million people starved to death, epidemics followed in the wake of famine, and an additional 1.2 million people died in disease. The aftermath of the famine brought further impoverishment to the peasantry, while landlords and money-lenders multiplied their land holdings many times over. The actual tilling of the soil was done solely by local tenants or the peasant class. Wages averaged 17.5 annas per day (22.5 cents US) for men and 10.8 annas (14 cents US) for women while nutrition was 25% below the normal minimum.

This was the general picture about the time that DVC was established by the Indian Parliament to develop the watershed.

Natural resources

The primary resources existing in the Damodar valley prior to any major development were soils, minerals, water and abundant manpower.

Land availability for agricultural expansion has been briefly described in a previous section though a detailed discussion of this subject will be covered in a later chapter.

The mineral resources of the valley and contiguous areas loom very large and some of these minerals far exceed those in other parts of India.

Both metallic and non-metallic minerals abound in the valley. It is said that geological investigations have been going forward for nearly one hundred years.

The mineralized area considered as coming within the scope of the Damodar project is the distance over which the electric transmission system can economically be extended to exploit mineral resources. The general area can be defined as falling within the states of Bihar, West Bengal, Orissa between latitudes 22° to 24°, 30° and longitudes 84° 45' to 88° 30' and the southeastern portion of Uttar Pradesh.

There exists a wide range of metallic and non-metallic minerals. Perhaps the more predominate minerals,

although the assessment is by no means conclusive, are bauxite, coal, copper, iron, limestone and mica. As a result large crucible plants and steel mills, cement and aluminium plants are being constructed and expanded throughout the entire service area.

A tabulation of the mineral occurrences within the Damodar service area are given in table 6, and the location of these occurrences is indicated on the map of the area (figure 2).

The concept and basis of development

The gratifying experiences of other nations in the field of water resource developments highlighted the imagination of the framers of the Damodar Valley Corporation and concluded that private enterprise and good management are not the exclusive possession of private industry; that the destiny of the people of the "valley" and their future is an obligation of the government.

TABLE 6. MINERALS WITHIN THE OPERATION AREA OF THE DAMODAR VALLEY CORPORATION^a

Mineral	Reserves
1. Abrasives	Satisfactory.
2. Apatite	700,000 tons (20-25 % P ₂ 11°5).
3. Asbestos	294,247 tons (in Singhbhum to a depth of 20-120 ft).
4. Barytes	No information available.
5. Bauxite	8.5 million tons.
6. ^a Beryl	Not estimated.
7. ^a Cassiterite	Not economic
8. ^a Chromite	Considerable but may not be great.
9. Clay	
(a) China clay	6,782,000 tons (in Singhbhum). 42,000 tons (in Serikela). Large (in Bhagalpur & Santal Parg). 60,000 tons (in Birbhum district). At least 264,000 tons (Rajmahal Hills in Santal Parg). 435,000 tons (Intertrappean in Rajmahal Hills in Santal Parg). 200,000 tons for a thickness of 15 ft i.e. 40,000 tons refined clay (Haridih, Ranchi district). 50,000 tons for a thickness of 15 ft i.e. 11,000 tons refined clay (Sursu, Ranchi district). About 945,000 tons (tertiary rocks at Birbhum district).
(b) Refractory clay	Approx. total reserves to a depth of 20 ft 4,064,500 tons.
Raniganj coalfield	Approx. total reserves to a depth of 20 ft 5,326,000 tons.
Jharia coalfield	25,950 million tons but only 4,672 million tons workable under present method of mining.
10. Coal	
11. Construction materials	Unlimited.
12. Copper ores	407,000 short tons with av. 3.8% copper (Rakha Mines). 3,087,195 short tons with av. 2.51% copper (Mosabani) (1 short ton 2,000 lbs). 4,716 tons with 2.89% copper (north Badia, Singhbhum).

Mineral	Reserves
13. Felspar	59,766 tons with 2.7% copper (Badia, Singhbhum). 1,250 tons (Phalguni mine, Kodarma, Hazaribagh). 312 tons (Belwa mine Kodarma, Hazaribagh). 28,000 tons (Hazaribagh, Manbhum, Santal Parg district). 15,000 tons (S. W. of Rupnarainpur Burdwan district).
14. Glass sand	30,000 tons (in the vicinity of Taldanga, 1.5 miles E.S.E. of Churulia station, E. Railway, Burdwan). 55,000 tons (Dabor area 2.5 miles S.E. of Rupnaryanpur station E. Rly. Burdwan). 700 tons to a depth of 20 ft (Itapore area, Manbhum district).
15. Graphite	Not estimated.
16. Gold	Not so economic.
17. Iron ore	8,000 million tons of high grade (Singhbhum, Bonai and Keonjhar).
18. Kyanite	300,000 tons to depth of 3 ft (Lapsa Buru, Singhbhum). 6,000 tons (belt between Ichadih and Salbani, South Manbhum).
19. Lead and silver	Poor.
20. Limestone	Very large e.g. 2.4 million tons, crystalline. 380,000 tons coarse crystalline (Belwadah in Mirzapur). 3 million tons (Bundu-Basaria area near Bhurkunda, Hazaribagh). 1,250,000 tons, crystalline (at Hansapathar, Arts, Kulbaba, Danara, Manbhum district). 2.7 million tons up to a depth of 100 ft (Jabar, Jhalda, Purulia district).
21. Manganese ore	Not rich.
22. Mica	Very extensive but cannot be calculated.
23. Mineral fertiliser	Considerable.
24. Mineral springs	About 32 mineral springs of which 6 springs of very high radioactivity 10 springs of high radioactivity 3 springs of moderately high radioactivity 3 springs of mild radioactivity 1 spring with mineralised water.
25. Ochres	Fairly large but mostly of poor quality.
26. Radioactive minerals	In traces.
27. Refractory materials	Extensive.
28. Salt	Vast.
29. Silica & quartz	103,000 tons (Porloyang deposit near Pandrasali Stn. Singhbhum). 12,000 tons (Bicha Gutu deposit near Pandrasali Stn. Singhbhum). 149,000 tons (Sangajata deposit near Pandrasali Stn. Singhbhum). 9,000 tons (in two other neighbouring Veins). 6,250 tons (Phalgunimmine, Kodarma area, Hazaribagh). 781 tons (Belwa mine, Kodarma area, Hazaribagh).

Mineral	Reserves
	902,550 tons (near Bagmara and Ghagidih, Singhbhum).
	50,000 tons (near Sundarna, Singhbhum).
	136,000 tons (Hazaribagh, Manbhum and Santal Parg district).
	17,000 tons (S.W. of Rupnarainpur Burdwan district).
30. Steatite	Fair.
31. Sulphur	Native variety nil; some metallic sulphides only.
32. Vanadium	25,000,000 tons of with an average 1.154% V 2°5.
33. Vermulite	4,100 tons (Ranchi district).
34. Wolfram	Small.

^a Geological Survey of India, 1950.

The scene of this noble undertaking lies in the northeastern portion of Bihar and western West Bengal states of India.

Rising in the Palamau hills on the Chotanapur plateau at an elevation slightly above 2,000, the Damodar river flows southeastward for a distance of 336 miles to join the Hooghly river before entering the Bay of Bengal.

At one time, as recently as 1757, the Damodar flowed directly eastward entering the Bhagirathi channel of the Ganga (Ganges) river delta, then considerably north of Calcutta. Through the years, silt built up in the northern portion of the Bay of Bengal and caused the Damodar river to follow an escape course by veering sharply to the south midway of Burdwan and the Bhagirathi river almost at right angles before entering the Hooghly river about 30 miles below the city of Calcutta.

Every decade or so, for more than a century the behavior of the Damodar river has caused destruction, famine and poverty. Engineers continued to survey the watershed and ponder its control, though all efforts came to naught for want of adequate funds.

In 1943 the unchecked Damodar river was the scene of a historic cataclysm. During the afternoon of 14 July rain commenced falling at Asansol in West Bengal state, it was followed the next day with a cloudburst that continued through to the 16th and brought with it eleven inches of water. By midnight the Damodar river was transporting 350,000 cubic feet of water per second past Burdwan. This water pressure caused the north bank of the river to break into an abandoned river bed depression sweeping away the village of Amirpore, the Grand Trunk

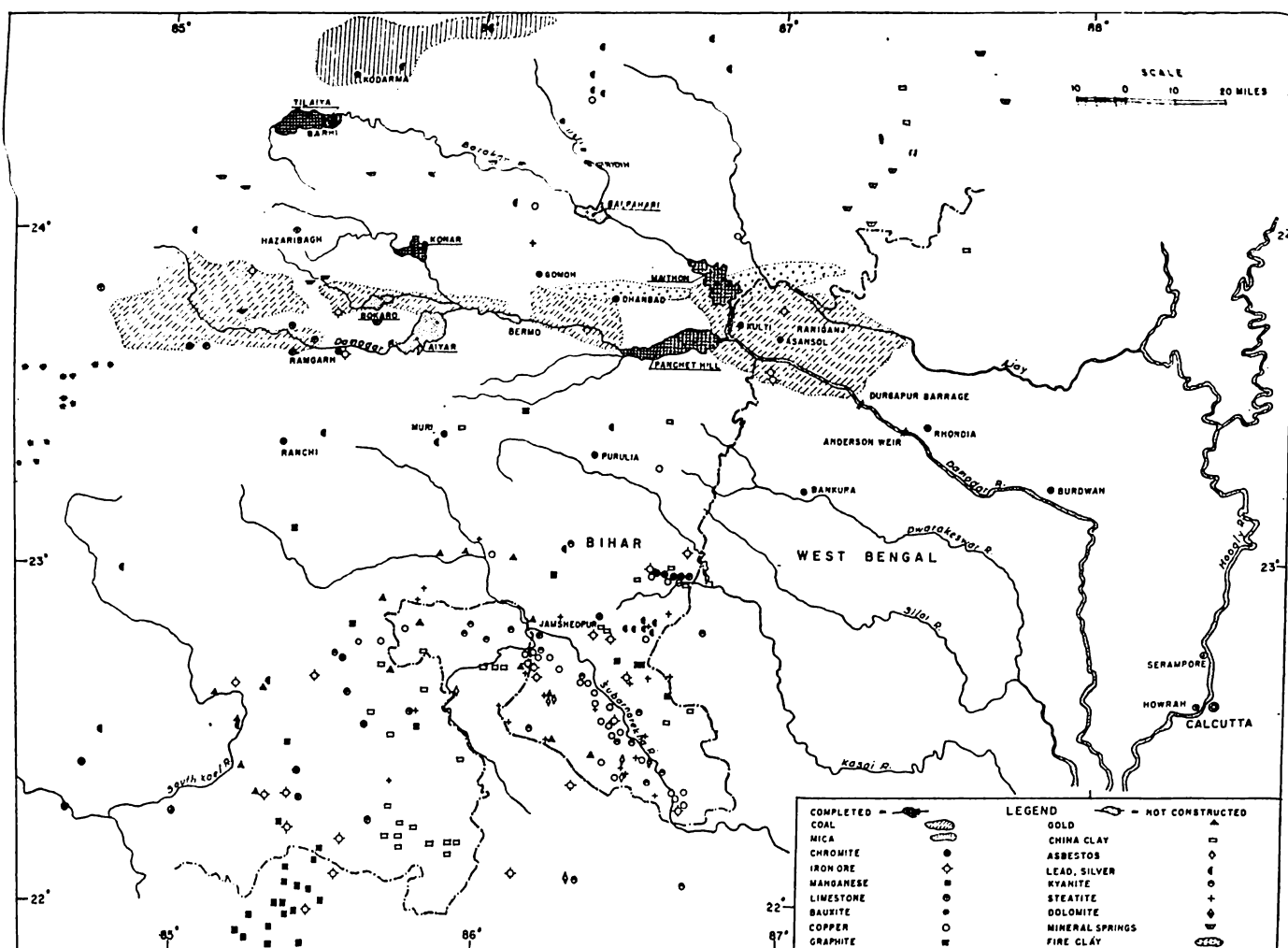


Figure. 1. MINERAL OCCURRENCES IN DVC OPERATIONS AREA

highway connecting Calcutta and westward to Delhi; the adjacent mainline East Indian railway as well as several railroad bridges. The Ministry of Public Works reported that in addition to the above destruction, 70 villages were washed away and thousands of acres of once fertile paddy lands were destroyed.

The catastrophe stirred up great public indignation, as a result the Governor of Bengal appointed a Board of Inquiry, entitled the "Damodar Flood Inquiry Committee". The Board's report to the Government of India (August 1944) suggested the creation of an authority similar to that of the Tennessee Valley Authority (TVA) in the United States. The Government of India then commissioned the Central Technical Power Board to study the proposal. This led to a conference of representatives of the Central Government and the governments of Bihar and West Bengal. On 3 January 1945, the conference concluded that all relative data bearing on unified river development should be collected and a preliminary memorandum drawn up. The memorandum of August 1945 stipulated that:

- (a) "The project would provide an adequate measure of flood control at a cost representing a not unreasonable insurance premium. This premium would offset the incalculable loss in the form of destruction of life and property which has resulted in economic disaster to a community in the past, and which may well occur on a still graver scale in the future if measures are not taken to prevent it.
- (b) "The project would make it possible to provide perennial irrigation over an area of three-quarters of a million acres, strategically situated in a part of India where the food production outlook is grave.
- (c) "The project would make available a substantial amount of power at a low cost in a region well suited to become the centre of a great industrial development. The relative proximity of the power system to neighbouring industrial concentration is conducive to a well-coordinated system of power development in this part of India.
- (d) "The project would make it possible to carry out important measures of social and economic rehabilitation which, if they were taken up individually, would be much more costly and more difficult of attainment.
- (e) "The project would, if adequate engineering forces are brought to bear without delay, provide a very substantial volume of productive work for many thousands of people. This would go some way to effect the fall of employment consequent upon the forthcoming reduction in war activity in India".

In following the suggestion made by the Damodar Flood Inquiry Committee that an "authority" comparable to TVA should be created, the Central Technical Power

Board appointed Mr. W. L. Voorduin, Senior Engineer, for the Tennessee Valley Authority to further strengthen the position of its staff.

Mr. Voorduin drafted a memorandum embodying an outline of a plan designed for achieving flood control, irrigation, power generation and navigation, known as the "Voorduin Preliminary Memorandum". This Memorandum urged that the prime objective of the multiple-purpose Damodar valley scheme should be that "the benefits obtained be distributed on the widest possible basis to the population of the area". The Memorandum endorsed the creation of an "authority" comparable in structure to TVA. After careful deliberation, the Voorduin Memorandum and the reports of a special high-level United States Technical Mission and two Indian associates, the three governments came to an agreement which resulted in the appointment of an administrator for the Damodar Valley Project. This appointment, made in May 1946, was an interim arrangement to enable the administrator to proceed with preliminary design plans of structures and to advise the Central Government in regard to all pertinent problems arising in connexion with the creation of a permanent authority for executing the long-range development programme.

Further action on a suitable bill was then deferred by the three governments until India had achieved its independence. An agreed draft of the constitution was prepared and placed before Legislative Assembly of India on 1 December 1947. The Central Government, in drafting the constitution for the proposed corporation, emphasized that "for efficient administration, the authority must be vested with a high degree of autonomy for conducting the undertaking". The state governments agreed to surrender to the "corporation" their power in order to enable it to discharge its functions effectively. The bill was passed by the Bihar and West Bengal legislatures and the Constituent Assembly (Legislative Parliament of India) on 18 February 1948, and was placed on the Statute Book on 27 March 1948. On 7 July 1948, DVC became a corporate entity, with far-reaching authority for accomplishing the prescribed objectives.

Legislative history

The Damodar Valley Corporation Bill was introduced in the Constituent Assembly of India (Legislative) on 1 December 1947.

Proposing a reference of the bill to a Select Committee, Shri N. V. Gadgil, Minister for Works, Mines and Power, explained briefly the objects and the provisions of the measure. He described the disasters caused frequently by the Damodar floods and stated how the romance of TVA ushered in an era of prosperity in the Tennessee valley by taming the wayward Tennessee river, inspired the concept of the Damodar valley project which was to provide flood control, water for irrigation, power for industry and general development. He said that when the scheme became a reality "a valley of death and destruction" would be turned into "a valley of

prosperity and happiness". As regards the rehabilitation of displaced persons, he assured the House that those whose lands and houses would be acquired for the purposes of the project would be resettled "not in similar but in better surroundings" and they would exchange their "hovels for decent cottages, darkness for light and fanaticism for faith". Further, it was the intention that model villages were to be made available and every effort made as far as possible to see that those who were resettled did not feel themselves in some strange unknown world but would be resettled in fairly familiar circumstances. When it was sought to show that the scheme was not subjected to scrutiny or criticism by experts, the Minister assured the House that it had been fully realized that schemes involving millions of rupees must be proceeded with all reasonable care and caution and that at every stage, expert advice had been taken and that at every stage from designing to construction, from construction to utilization, expert advice, whether foreign or Indian, would be taken.

With regard to the selection of the persons forming the Corporation, the Minister said that they would do well if they possess the following qualifications:

- (i) The highest integrity and incorruptibility.
- (ii) High intelligence.
- (iii) A clear concept of economic development in India on modern scientific lines, especially in the industrial and agricultural fields, and alignment of economic life on a co-operative basis.
- (iv) Fairly wide experience of men and affairs.

It was not the intention of the Central Government to interfere with the day-to-day administration of the Corporation, and control would be exercised in matters of policy only and that too, would be consistent with the autonomy of the Corporation.

The Bill was welcomed warmly by all sections of the House, was passed on an unprecedented wave of enthusiasm on 18 February 1948, and received the assent of the Governor-General on 27 March 1948.

Scope of authority

The Damodar Valley Corporation is a corporate body vested with autonomous authority under the DVC Act (Act XIV of 1948). The Corporation consists of a Chairman and two members appointed by the Central Government, after consultation with the state governments

of Bihar and West Bengal. It has a Secretary, who is its chief executive officer, and a financial advisor, who are both appointed by the Central Government.

The statutory functions of the Corporation are:

- (1) Flood control.
- (2) Promotion and operation of irrigation schemes, water supply and drainage.
- (3) Generation, transmission and distribution of electric power.
- (4) Promotion and control of navigation.
- (5) Promotion of afforestation and soil erosion control in the Damodar valley.
- (6) Promotion of public health, agriculture, industrial, economic and general well-being of the Damodar valley and its area of operations.

The Corporation is given broad and unlimited powers to carry out these functions, including the power to acquire property, erect structures, canals, etc., to stock fish in reservoirs, to provide for the resettlement of displaced families living in the contemplated reservoir areas, and to take measures for the prevention of malaria. It is authorized to supply irrigation water in bulk to state governments for end consumption by the cultivators and other consumers, to make available bulk supply and retail distribution of water for industrial and domestic consumption, and to levy rates for services rendered.

The Corporation is authorized to generate and sell electric power to any consumer in the Damodar valley at a potential of not less than 30,000 V. Upon approval of the state government concerned, the Corporation's transmission system may be extended to any area beyond the Damodar valley, and electric services can be provided in such areas at rates based on sound business principles.

Section 18 (i) of the DVC Act provides that no person within the Damodar valley can sell or transmit electric power at an installation having an aggregate capacity of more than 10,000 kW or a potential of 30,000 V or more without the permission of the Corporation.

The Corporation is empowered to divert and close any road or open space, providing it pays compensation to the persons affected; it can make regulations, generally for carrying out its functions under the Act, and particularly for regulating its proceedings and business, for making appointments and promotions of its officers and specifying their conditions of service.

THE DEVELOPMENT PROGRAMME AND WATERSHED MANAGEMENT

General description of objectives

The basic feature of the Damodar valley project is that it constitutes a compact unified multiple-purpose river basin development. Unlike most river basin engineering works, it lies in the heart of a rich mineralized region. The presence of these minerals is advantageous from an economic standpoint, but raises difficult problems in the selection of damsites owing to the inundation of valuable mineralized fields.

Of necessity, the fundamental consideration in the development of the Damodar valley was flood control. Other considerations were the generation of electric power, the regulation of water flows for the irrigation of cultivable land which was predominately situated in the lower portion of the valley where damsites for power do not exist, navigation, municipal water supply, malaria control, afforestation and soil conservation.

One of the main guiding principles used in siting dams was that the uncontrolled area downstream of the dams should not be of such size that it could produce a flood greater than the controlled flood from the upstream area, if a storm of maximum intensity centered over the uncontrolled area.

The topography of the valley did not lend itself to the construction of a large storage dam below the confluence of the Barakar and the Damodar rivers. The drainage area below this point was of the order of 1,540 sq mi, which in itself was sufficiently large to produce serious floods. Fortunately, the shape of the area was not conducive to high flood rates because its width is small compared to its length. On the other hand, the drainage area above the confluence of these two rivers was conducive to higher rates of flow in the event of a storm rainfall. For this reason, the control dams had to be as far downstream on both the Damodar and Barakar rivers as topography would permit. This consideration dictated the site of the Maithon structure on the Barakar, and the Panchet Hill dam on the Damodar; each is within approximately 7.5 and 3.5 mi of the confluence of the two rivers.

The uncontrolled drainage area above Rhondia (Anderson weir) and below these two dams in the upper valley is approximately 1,026 sq mi. The maximum peak flow from this lower drainage area, including minor discharges through the sluice gates, is estimated at 250,000 cusecs. During a large flood it is felt that

the peak flow from the lower area would have passed down the river by the time the flood storage space in the control dams had filled up and water was discharging over their spillways. It was, therefore, decided that provision should be made in the lower river for flows not exceeding 250,000 cusecs, which is the bankful capacity, regardless of the amount of reduction in flood peaks that could be achieved in upper storage reservoirs. Obviously, with such protection provided in the lower river, it was unnecessary for the upper storage reservoirs to reduce the flood peaks below a flow of 250,000 cusecs. These two reservoirs, however, could not provide sufficient storage capacity for the combined requirements of flood control and minimum flow regulation. Provisions for additional reservoirs on both the Damodar and Barakar rivers were considered expedient. Of the various sites considered on the upper Damodar and Barakar rivers and their tributaries, were the dams Aiyar and Panchet Hill on the Damodar, Maithon, Balpahari, and Tilaiya on the Barakar, Konar on the Konar river and possibly one across the Bokaro river. With these 7 reservoirs, it was felt that a sufficiently large capacity could be impounded to meet all multiple-purpose objectives. Other damsites were taken into consideration but abandoned for one reason or another.

After much deliberation, it was decided that the Tilaiya dam on the Barakar and the Konar dam on the Konar river, a tributary of the Damodar, should be constructed. On completion of these two reservoirs, construction of the two larger downstream dams would be somewhat simplified at Maithon and Panchet Hill, across the Barakar and Damodar respectively. The Tilaiya dam structure was completed in February 1953, the Konar dam about September 1955, the Maithon dam in 1957 and Panchet Hill dam at the end of 1959. Those reservoirs now yield a total capacity of 2.9 million acre feet, whereas to provide adequate flood protection a storage capacity of 5.3 million acre feet is required.

The four reservoir capacities now in operation and their equivalent flood benefits are given in table 7.

Another principal aspect of the multiple-purpose Damodar valley scheme relates to headworks of a barrage across the Damodar at Durgapur and the head regulators for canals on either bank. The water discharged from the upper dams is diverted for irrigation into an extensive system of canals and distributaries by the Durgapur barrage, 34 miles down river from the confluence of the Damodar and

Barakar rivers. Details of the irrigation features are given in a subsequent chapter.

TABLE 7. RESERVOIRS CONSTRUCTED, THEIR OPERATING CAPACITIES AND EQUIVALENT FLOOD BENEFITS

Name of project	Reservoir capacity (acre feet)	Million m ³
Tilaiya	320,000	395
Konar	273,000	339
Maithon	1,104,000	1,363
Panchet Hill	1,214,000	1,500
Total	2,911,000	3,597

History of the watershed

The Damodar river originates in the Palamau Hills, about 2,000 ft above mean sea level, in the state of Bihar and flows in a southeasterly direction. On reaching Burdwan, it swings southward to join the Hooghly, 30 mi south of Calcutta, before entering the Bay of Bengal. During the first 150 mi, the slope of its course drops about 10 feet per mile, flattening out in the next 100 mi to 3 feet per mile, while in the last 86 mi the gradient is less than one foot per mile, assuming a deltaic bed with many distributaries. The river in the headwaters is fed by nine tributaries, with an aggregate drainage area of 17,250 km² (6,664 sq mi). The tributaries are the Maulah, Sophi, Hahro, Bokaro, Konar, Jamunia, Gowai, Ijri and Barakar, the latter being the largest.

TABLE 8. FLOODS IN EXCESS OF 100,000 CUSECS AT RHONDIA 1823 THROUGH 1959

Year	Peak flow	Year	Peak flow
1823	650,000	1940	310,000
1840	640,000	1941	625,000
1855	350,000	1942	375,000
1860	350,000	1943	296,000
1864	340,000	1944	190,000
1865	450,000	1945	121,000
1866	420,000	1946	314,000
1877	500,000	1947	260,000
1878	250,000	1948	230,000
1902	220,000	1949	272,000
1907	240,000	1950	338,000
1911	220,000	1951	389,000
1913	650,000	1952	181,000
1914	210,000	1953	293,000
1915	160,000	1954	262,000
1916	395,000	1955	(less than 100,000)
1917	395,000	1956	303,000
1933	226,000	1957	201,000
1934	170,000	1958 (without dams)	665,000 ^a
1935	650,000	(with dams) ..	205,000
1936	250,000	1959 (without dams)	800,000 ^a
1937	210,000	(with dams) ..	350,000
1938	110,000		
1939	282,000		

^a Computed.

TABLE 9. AVERAGE DISCHARGE OF THE DAMODAR RIVER AT RHONDIA, 1933-1958
(DRAINAGE AREA 19,900 km²)

Year	Monsoon period June to October inclusive		Year	Dry period November to May inclusive	
	average discharge (m ³ /sec)	Average runoff (mm)		average discharge (m ³ /sec)	Average runoff (mm)
1933	725	482	1933-34	29.9	26.6
1934	414	274	1934-35	8.2	7.4
1935	385	256	1935-36	9.1	8.4
1936	776	516	1936-37	84	77.7
1937	577	386	1937-38	13.4	12.4
1938	535	356	1938-39	9.5	8.6
1939	897	596	1939-40	58	53.6
1940	515	343	1940-41	12.8	11.7
1941	884	589	1941-42	46.2	42.2
1942	988	658	1942-43	no record	no record
1943	1,033	688	1943-44	no record	no record
1944	866	577	1944-45	—	—
1945	665	439	1945-46	62	40.6
1946	1,105	721	1946-47	69.7	45.7
1947	793	515	1947-48	34.4	22.8
1948	756	493	1948-49	110.5	76.2
1949	1,010	663	1949-50	27.2	17.8
1950	1,075	721	1950-51	15.6	10.2
1951	604	391	1951-52	30.8	23.0
1952	671	477	1952-53	34.8	22.8
1953	1,040	782	1953-54	46.4	35.0
1954	557)	378)	1954-55	15.6	10.2
1955	453)	307)	1955-56	34.8	22.8
1956	850) after dams	577) after dams	1956-57	—	—
1957	586)	394)	1957-58	—	—
1958	530)	356)			

Source:.. "Preliminary Memorandum on the Unified Development of the Damodar River" (August 1945), including records of subsequent years.

The upper valley of the Damodar basin is very rugged and is characterized by outcroppings, deep gorges, gullies and badly eroded desolate waste lands. In this area, the Damodar behaves as a wild torrential stream, carrying with it heavy loads of mud and debris. Much of this land, once a fertile region, has become almost a barren waste.

In the lower portion of the upper basin, where the Barakar joins the Damodar near the boundary of Bihar and West Bengal states, the terrain flattens out into a fertile stretch of land. During favourable climatic periods the region is covered by lush crops usually paddy. However about once every three years droughts occur, frequently followed by devastating floods.

The Damodar, over the last three centuries, has at times been a trickling stream and at others a raging torrent, with levels, in some instances, rising to as much as 10 ft within a few hours. Records disclose that as much as 665,000 cusecs has surged through the valley.

Table 8 shows the occurrence of these floods from 1823 through 1959. The intensity and frequency of floods during last 50 years is notable. These floods consistently occur during the monsoon season, between June and October.

Stream flow records of the Damodar go back to 1901, although readings up to 1932 are not considered reliable. Average discharge readings have been taken at Anderson Weir near Rhondia from 1933 through 1959. Table 9 shows the average discharges during the monsoon period and for the dry period from 1933 through 1959. Between 92 and 98% of the average annual flow occurs during the five monsoon months, June through October.

The Damodar is a small river compared with the Ganges or the Indus, and the discrepancies between the ratios of flood discharge to the catchment areas of the three rivers are extremely large, as may be seen from table 10.

TABLE 10. CHARACTERISTICS OF DAMODAR RIVER COMPARED WITH THOSE OF THE GANGES AND INDUS RIVERS

River	Catchment area (sq mi)	Recorded flood discharges cfs
Ganges	350,000	2,125,000 ^a
Indus	174,500	917,000 ^b
Damodar	7,500	800,000

^a At Faracca, India.

^b At Kalabah, West Pakistan.

Flood discharges of the order of 650,000 cfs have been recorded five times during the past 50 years in the Damodar watershed.

During these floods, vast stretches of topsoil are eroded all over the upper catchment area, and are carried down the river, the sand load being deposited along the river bed, and the organic and other fine material remaining in suspension. The latter has great fertilizer value and, whenever the flood waters overtop the banks, some of this valuable silt is spread over adjacent fields yielding bumper crops, but the portion of silt thus deposited represents only a small part of the annual silt load. As a consequence very

valuable topsoil is being carried out to sea. This process has been going on for many centuries with the result that the agricultural produce of the upper valley has continuously decreased for many decades.

The accumulation of sand deposited in the channel bed has resulted in the river frequently overtopping its banks and even changing its course. Records show that, in the eighteenth century, the Damodar joined the Hooghly at Tribeni, some 40 mi upstream of Calcutta; in the early part of the nineteenth century, the confluence moved down to opposite Falta point, some 30 mi downstream of Calcutta; at the present moment more than 90% of the annual flow is diverted to the Mundeswari channel, which joins the Rupnarain river to the south. The sand and silt deposits of the Damodar have seriously affected even the wide channel of the Rupnarain, with the result that inland navigation along the latter river became impossible during the early decades of this century.

The river has spread fertile deposits of silt over the entire delta, attracting agricultural inhabitants in great numbers. As a result, the region around Burdwan has become one of the most densely populated areas in the lower valley. Occasionally, the Damodar floods sweep over these areas and cause considerable loss of life and property. The 1943 flood caused an estimated loss of property worth about 8 crores (US\$17 million). In today's prices, the loss would be over Rs 50 crores (US\$100 million).

During the process of changing courses, the river has left many stagnant pools of water, an excellent breeding place for mosquitoes carrying one of the worst kinds of virulent malaria, Burdwan Fever as it is known, which takes thousands of lives every year.

In addition to such natural calamities, various interests are constantly at loggerheads. Some want floods because of their silt-laden water and so protest against flood control. Some are interested in the sand and vehemently oppose soil conservation measures in the upper valley. Those who have an interest in Calcutta port, want the big floods of the Damodar to flush the Hooghly channel, but fail to realize that uncontrolled floods bring in huge quantities of sand and silt which choke up the channels. Other groups oppose any changes which might affect their riparian rights. Yet others believe that flood control and irrigation projects should be deferred because they do not yield adequate returns on the capital outlay.

The present situation, brought about by neglect of the Damodar river over the past centuries, may be summarized as follows:

- (i) The top soil all over the upper catchment area is being eroded and most of it is being carried out to sea.
- (ii) The lower valley has continuously suffered due to changing courses of the river even as late as 1959, and a virulent type of malaria and frequent floods still prevail.
- (iii) The river channels in the lower valley are choked up with unbelievable amounts of sand deposits

which has affected inland navigation and Calcutta port.

- (iv) Owing to a rapid decline in prosperity, opposing interests have sprung up, and further aggravated the situation in the region.

The Soil Conservation Department was established in 1949 under DVC to deal with the problem of conserving the soil over the entire upper catchment area of about 6,664 sq mi. In this area, ruthless exploitation of forests, over-grazing and improper management of agricultural land over many years have exposed the undulating land surface to the beating action of rains. Most of the rain that falls on such areas, therefore, rushes down the sloping lands as runoff water, eroding the topsoil and gradually rendering it unable to sustain plant life. This eroded soil is finally deposited as silt in the stream beds, reducing their capacities for transporting water. Soil erosion is a double menace in that it impoverishes the soil, thus reducing the productive capacity of the land of the catchment, and fills up the stream and river beds with silt washed down from the land above, contributing to flood conditions in the lower reaches. This has been going on in the Damodar valley area for ages. However, since the erection of four dams across the Damodar and its tributaries, the flood menace has been somewhat reduced. Yet the dams, if left to themselves, will remain effective in controlling floods only for a short period, because the silt which had long been deposited in the river beds is now being trapped behind the dams and is gradually filling up the reservoirs.

Soil conservation not only improves the productivity of the land but also reduces the silting rate of the reservoirs to a minimum. Past experience has shown that the crop yield in catchment areas can easily be doubled through the introduction of soil conservation measures. Such measures will also extend the revenue-yielding capacity of the reservoirs through fish production, irrigation, navigation and power production and bring valuable flood control benefits to the lower reaches.

At the outset, one of the prime functions of the Soil Conservation Department was to reclaim wastelands as paddy fields and for the resettlement of families who were displaced by the construction of reservoirs. By the four dams so far constructed, 6,541 acres of land have been reclaimed under this programme. The second, and equally important undertaking, was the investigation into scientific soil conservation measures and their introduction in the upper valley to reduce flood peaks and silt transport and to improve the productivity of the land. With the temporary end of the land reclamation programme of the reservoir areas, soil conservation work has become the chief function of the Department in the upper valley.

Silt sampling stations have been established at each of the four reservoirs now in operation. The data collected between 1951-1955 as a result of research show that the silt load transported by the rivers is appreciable. Table 11 shows the amount of silt entering each of the four reservoirs and give their operational life expectancy.

Silt loads passing through the Tilaiya and Konar dams will be largely deposited in the two upper reservoirs.

TABLE 11. SILT CONTENT ENTERING THE FOUR MAIN RESERVOIRS

Dam	Drainage area sq miles	Average annual silt load (ac/ft)	Silt storage provided (ac/ft)	Estimated life (years)
Tilaiya	380	404	60,000	149
Konar	385	224	49,000	219
Maithon	2,050	684	168,000	246
Panchet Hill	3,849	1,952	148,000	75

Although some fine materials will pass through the undersluices and over the spillway of each dam, anti-erosion measures are expected to improve the silting situation and somewhat reduce the calculations in table 11 which are considered reasonably conservative.

If the Aiyar dam on the Damodar, with a silt storage estimated at 170,000 acre feet is constructed, the life of the Panchet Hill reservoir can be expected to be lengthened by as much as 50 years.

The Soil Conservation and Land Utilization Department, according to the organization chart of DVC, is responsible to the Director of Administration and the Joint Secretary. The latter's office reports directly to the Secretary of the Corporation. The structure of the Department is shown in figure 48. Its headquarters are at Harzaribagh, Hazaribagh district, Bihar.

The technical work of the Department is done by the following units:

- (1) Soil Conservation Station at Deochanda, Hazaribagh, Bihar.
- (2) Soil Survey and Planning.
- (3) Soils Laboratory.
- (4) Soil Conservation Extension on Cultivators' Fields.
 - (i) General extension.
 - (ii) Extension in collaboration with the government of Bihar in National Extension Service Blocks.
 - (iii) Study of the economics of conservation farming.
- (5) Soil Conservation in Reservoir Foreshore Lands.
- (6) Soil Conservation Engineering.
- (7) Forestry.
- (8) Fisheries.
- (9) Special projects subsidised by the Central Soil Conservation Board — Upper Sewani Soil Conservation Project.
- (10) Irrigation Experiment Station, lower valley, Panagarh, West Bengal.
- (11) Training in Soil Conservation.
- (12) Rapid Soil Testing Service.

The following paragraphs are devoted to a summarized description of the functions performed by the various units in the Department of Soil Conservation and Land Utilization.

The work of the Department has been facilitated by aerial mapping on a scale of six inches to the mile. Maps covering an area of over 5,131 sq mi have thus far been completed in the upper valley.

Soil Conservation Experiment Station

Soil Conservation Experiment Station at Deochanda, Bihar, comprises 355 acres of badly eroded lands representing the conditions prevailing in this region. The soils of this region are poor in fertility and water retentive capacity, and are highly erodible. Besides, the land surface is undulating and, therefore, very conducive to severe sheet and gully erosion, specially under the erratic and intense rainfall conditions prevailing in this region. All these factors combined with constant misuse of the land and faulty farming practices have been responsible for severe soil erosion in this area. Runoff plot studies at this Station have revealed that soil loss from a 50-ft long cultivated field on a 2% slope, ranges from 1 to 14 tons or even more per acre per year, depending upon the different farming practices. Want of fodder and good pasture is responsible for severe over-grazing of the local grasslands and subsequently to erosion from them. Studies conducted at this station revealed that over-grazing causes nearly four times more soil loss and reduces the fodder yield by 50% as compared to properly grazed pastures. With a view to improving the local grasslands and finding out suitable species for fodder, gully control, stabilization of waterways, embankments etc., a large number of grasses and legumes are under study. A quick growing grass called 'Giant Star Grass' has been successfully used as a soil stabilizer on the earthen dams of the DVC. Trials to improve the yield from local over-grazed grasslands have revealed that forage yield can be increased by 100% simply by regulating grazing and by 300% with a small dose of fertilizer along with it. Besides the above, experiments have also been conducted for finding out the optimum fertilizer and cultural requirements of the crops and for working out crop rotations suitable under the local conditions. A study with different types of terraces at the station has shown that broad-based graded channel terraces are the most suitable ones for upland cropping in this area. A trial has also been going on at the station with different fruit trees to select a few suitable ones that can be recommended to the local farmers for growing them under rain-fed conditions. Since soil moisture becomes the limiting factor during dry season for raising fruit trees here, a study has been undertaken to find out suitable moisture conservation measures for growing them.

Soil Survey and Planning Branch

The Soil Survey provides the basis for better land use planning. A soil conservation survey, designed to group soils on the basis of their capabilities, is being emphasised in the valley. The maps being drawn up give an accurate inventory of soil and land characteristics, slope, erosion, present land use, location and extent of gullies, etc. These maps form the basis for effective planning of soil conservation measures in a catchment area. So far, systematic soil conservation survey has been carried out over an area of 756.69 sq mi.

Soils Laboratory

The work of the Soils Laboratory is considered an essential prerequisite in the formulation of sound land management plans. The Laboratory furnishes assistance to the different sections of the Department by analysing soil samples, as well as by carrying out certain other allied investigations. In addition to this, it also helps other sections by analysing samples of rocks, water, manure, fertilizers, etc.

Soil Conservation Extension Branch

Successful soil conservation in the catchment area is possible if the owners of the land take up the necessary works. The only way to achieve this is by educating the farmers and convincing them of the benefits to be secured. The educational programme carried out by the Extension Branch consists mainly of demonstrations of the various techniques of soil and water conservation. These demonstrations are conducted on the lands of the farmers and with their active participation. So far, 142 such demonstrations have been carried out over an area of 8,233 acres belonging to 4,099 farmers.

Reservoir Foreshore Conservation Experiment and Demonstration Station

Owing to the annual draw-down programme of the four major reservoirs of DVC, a total of more than 30,000 acres of peripheral land emerge every year. These peripheral areas are of high agriculture potential owing to their annual submergence. It was with the objective of finding out how best these lands could be utilized agriculturally that a 75-acre research-cum-demonstration station was started on the peripheral land of Tilaiya, at Sewai. Subsequently, two demonstration farms were established on Tilaiya land and one each on Konar Panchet and Maithon reservoir land. These demonstration farms also act as seed multiplication farms, as seeds of selected crops are not generally available in large quantities for seasonal distribution.

At the Experiment Station at Sewai, experiments with different crops and cropping patterns synchronizing with rise and fall of water level of the reservoir are being conducted. A number of deep-water paddy varieties have been tried and a few of them have turned out quite promising for such lands for growing them during the monsoon. Studies are also going on for finding out the extent to which the productivity of these lands have gone up wherever silt accumulation has taken place as well as for finding out the effect of annual submergence on organic matter and nutrient status of the lands. The findings are demonstrated in all the demonstration farms for the benefit of the people of the locality. Some small-scale demonstrations are also conducted in the plots of the local farmers who come forward to take these lands on lease for cropping. As a result of these demonstration activities, a total of 7,720 acres could be leased out to the local farmers up to 1959-60.

Soil Conservation Engineering Division

Engineering works form an integral part of a soil conservation programme. The structures built are generally terraces, chutes, spillways, culverts, diversion channels and small earthen check dams. These are meant for reducing erosion, for disposal of excess runoff water, for trapping silt and water in the upstream region thereby reducing flash floods. The small earthen check dams act as storage-cum-silt retention reservoirs which hold back the silt that would have otherwise flowed into the main reservoirs. Besides this, such small reservoirs can be utilized as drinking ponds for cattle, for raising fish as well as for providing irrigation in the adjacent areas on a limited scale. So far 360 conservation structures have been built at different places protecting an area of 4,780 acres.

Besides the construction of different kinds of conservation structures some hydrological investigations are also being conducted in the Ijri-Garga upper Konar and Sewani sub-catchments. These investigations would help in evaluating the effects of soil conservation practices executed in the water sheds, as well as in plotting hydrographs which are necessary for designing the different types of structures with precision.

A soil conservation pilot scheme involving the construction of a large number of anti-erosion structures was initiated in a 250-acre block of land in the village Gonda near Hazaribagh town. This block was badly cut up by

a very large number of gullies which extended into the up-lands, and eroded the soil at a very rapid rate. The anti-erosion structures since constructed have considerably reduced the extension of the gullies, which are now being gradually reclaimed by local farmers and brought under paddy cultivation. Sills of some of the structures have since been raised for further silt accumulation. Such small engineering structures have also been built over 620 acres of badly eroded areas in the upper Damodar and upper Barakar catchments. A typically eroded area and type of structure devised is shown in figure 2.

Forestry Division

The importance of forests as a means of reducing soil erosion and prolonging the life of costly reservoirs, and of proper utilization of lands that are steep and unfit for cultivation has been recognized by DVC from the outset. Most of the land suitable for afforestation in the upper catchment area is under the control of the Bihar Forest Department. However, in order to ensure that the urgency of the problem is not overlooked, DVC maintain a separate Forestry Section in the Soil Conservation Department. This Section first started afforesting areas near rehabilitation villages, where the people displaced by reservoir submergence have been resettled, in order to supply firewood, small dimensional timber for domestic construction and fodder.

During the second five-year plan, provision was made for afforestation of 25,000 acres in the upper valley. Of



Figure 2. PHOTOGRAPH OF UPPER VALLEY ANTI-EROSION STRUCTURES

this total, 5,000 acres is being afforested by the Forestry Section of DVC, and the remainder by the State Bihar Forest Department on behalf of DVC.

The total area of all categories of plantations completed at the end of 1955/60 by the Forestry Division was 4,596 acres.

Fisheries

On completion of the DVC construction phase, the total stockable water area will be about 200 sq mi. The fish production potential of these vast water areas is expected to be appreciable. The Fisheries Unit of the Department was organized in October 1950 with the object of utilizing all these water areas for fish production.

During the first three years, this Unit made a survey of the existing fish and fisheries of the valley, investigated some local problems relating to fish biology in small reservoirs built by DVC at Deochanda and Gouriakarma, and carried out fish raising extension work along sound lines in village ponds.

All four reservoirs have been stocked with four economic species, i.e. Rohu, Catla, Mrigal and Calbausa. Annual stocking was necessary because none of these species were found to breed in these waters. By 1957, Tilaiya reservoir had been stocked with 2,850,000 fingerlings as compared to its optimum capacity of about 10 million. Stocking of Konar reservoir was begun only in 1957-1958, with 150,000 fingerlings. All stock is purchased from outside. Fingerlings are placed directly in the reservoir, whereas spawn and fry are kept in the DVC fish-nursery ponds until they reach the desirable fingerling size.

None of the dam structures thus far constructed contain fish ladders or passages. It is believed that the habits of the fish being used do not warrant the cost of these special features.

Irrigation Experiment Station, Lower Valley, Panagarh, West Bengal

There is ample evidence in India and in other countries to show that injudicious use of irrigation facilities is not only wasteful, but is also ruinous for the land. A 210 acre Experiment-cum-Demonstration Station was, therefore, set up in January, 1956 at Panagarh which lies within the commanded area of the DVC Irrigation System. The object of this station is to study and find out the solutions of problems connected with irrigation farming. Studies in proper utilization of irrigation water, evaluation of irrigation techniques, effect of irrigation water on physical and chemical properties of the soil, irrigation requirements of various crops along with their cultural and manurial requirements etc. are under way. The ultimate object of these studies is to recommend sound techniques of irrigation farming for optimum production on a sustained basis. Besides carrying out such investigations, the farm also has a small extension set-up for carrying out demonstrations on farmers' lands in the neighbouring areas with the idea of educating them in the technique of better utilization of irrigation facilities. So

far 281 such demonstrations have been conducted, out of which 221 were with monsoon crops and 60 were with winter crops.

Training in soil conservation

A training course under the Soil Conservation Training Scheme of the Central Government has been provided by the DVC Soil Conservation Department since July 1954. Trainees are deputed by the different state governments and are trained in both theory and practice of all aspects of soil conservation techniques. The course lasts six months and two groups of trainees are trained each year. So far 193 trainees have gone through the course at this centre in 10 batches.

Rapid Soil Testing Service

Under the Technical Co-operation Programme, the Government of India has sanctioned a Soil Testing Laboratory under DVC which is meant to give free service to the farmers in the Damodar valley and the adjoining areas. This is done by carrying out rapid tests of soils from the farmers' fields with a view to finding out soil deficiencies and then by giving manurial recommendations for rectifying them in order to increase crop production. The laboratory was set up in June 1958 and started functioning from October that year. So far 3,508 soil samples have been analysed by this laboratory and recommendations sent.

Conclusions

There are more than 4 million acres of land under various categories in the catchment area above the confluence of the Barakar and Damodar rivers. It is estimated that 1.5 million acres are under forests, 800,000 acres are under paddy, 700,000 acres are cultivable, 200,000 acres are utility land including ponds and wells, and 800,000 acres are wasteland. The forest lands are mostly in a very bad stage of denudation and at places they are badly gullied. As a result of this, most of the forest lands are contributing a heavy silt load to the down-stream region. The paddy lands are comparatively safer as regards the problem of erosion. But sloping cultivable lands are also contributing a considerably high silt load because of bad farming practices as well as over grazing by an extremely heavy cattle population in this region. The land which is categorised as wasteland is usually very badly gullied and naturally its contribution to the silt load is extremely heavy. The distribution of monsoon is rather erratic in this area and 80% of the annual rainfall is received during the four monsoon months of the year. Therefore, during the monsoon season, there is a surplus of water which can be stored in the head-water regions in small reservoirs without jeopardizing the inflow of the main river system. If all major dams now contemplated were constructed not more than 50% of the total rainfall could have been stored in them. Thus, the storing of surplus water in the headwaters as it has been contemplated under the Engineering Division of the Soil Conservation Department will augment the soil moisture

during the dry season in the uplands which will not only benefit agriculture but will reduce flood peaks and provide greater storage capacity in the main reservoirs for multiple uses.

It is imperative that soil and water conservation programmes in the upland area be enlarged. Storage irrigation schemes on a modest scale in the uplands should be undertaken where the cost of reclaiming wasteland does not exceed present prices of purchasable arable land.

The face of the Damodar valley has been completely transformed over the past 12 years. The main accomplishments are:

- (1) Four sizable dams have been constructed and possible flood protection to the lower valley, provided inflows do not exceed 650,000 cusecs.
- (2) One million acres of fertile lands in West Bengal are assured of adequate water for kharif

irrigation, and about 100,000 acres of rabi crops.

- (3) Availability of peaking electric power has been increased by 100,000 kW, and energy amounting to 250 million kWh.
- (4) Inland navigation from Hooghly to Durgapur, a distance of 85 mi is expected to start commercial service in 1962.
- (5) Malaria has been brought under complete control.
- (6) The lower river channel is kept free of sand, thereby eliminating further deterioration of the regime.
- (7) Larger quantities of water are available throughout the year for domestic and industrial purposes.

Chapter III

FLOOD AND DROUGHT CONTROL

Cause of floods and description of area affected

Flood problems of a region can be classified as:

- (a) Inundation due to:
 - (i) Exceeding bank limits.
 - (ii) Riverbed obstructions.
 - (iii) Lack of gradient.
 - (iv) Abnormal sea tides.
- (b) Scouring of river banks.
- (c) Shifting of river course:
 - (i) Avulsions.
 - (ii) Oscillatory.

Inundation usually occurs when there is excessive precipitation and channel capacity is inadequate to transport the flood waters. However, floods do not necessarily stem from excessive precipitation, a constriction in the riverbed, due either to a landslide or erosion, can also aggravate flow conditions. Channel congestion causes stream meandering and inundation of large areas. Tropical storms accompanied by high tides can block the mouth of a river, causing back-up of water over low-lying terrain.

Erosion or bank scouring may deteriorate vast tracts of agricultural lands or even townships.

Shifting of river courses introduces additional flood problems. River instability can aggravate the action of erosion and cause excessive silting. Avulsion results when abrupt variations in bed gradients and excessive sediment charge tend to make a river to shift its course to that of an adjacent regime. One other category of river shifting is typified by oscillatory beds, where a river emerging from a gorge swings from side to side in a flood plain within reasonably defined limits.

The Damodar's drainage area is only 8,500 sq mi, about one-fifth the size of the Tennessee valley.

The upper valley, with a drainage area of nearly 6,664 sq mi, is shaped somewhat like a cone. The confluence of the Barakar with the Damodar forms the apex of the cone. From the apex, the river flows through the undulating plain for 156 mi, to join the Hooghly. It is in the latter stretch that flood problems arise.

Flood records as can be seen in table 8 go back to year 1823, yet the data that had been compiled were not considered reliable for design flood control works until the beginning of 1911.

The Voorduin team had noted that, during the cloudburst of 1913, only 12 in of rain fell over the

upper valley, but that 20 in of rain fell in a nearby watershed during the same period. They therefore assumed that storms of equal intensity might at times be centered over the upper catchment area.

Further investigations disclosed that the upper catchment would support a runoff coefficient of 90%, hence 18 of 20 in of rainfall would probably converge on the apex of the cone or outfall of the upper valley. From earlier experience, it was known that the river channel in the lower basin could transport 9 in out of 18 in runoff without topping its banks, hence, all that remained to be done was to provide storage capacity, in a system, of reservoirs, for withholding the remaining 9 in in the upper basin. However, the cost of building structures to pond-up 9 in of runoff was as prohibitive as in the past, hence a paying partner had to be found otherwise the scheme would fold-up for want of economic feasibility.

Further research revealed that rainfall of 20 in proportions in the upper basin did not occur much after 15 August. From this it was concluded that it would be safe, during the latter half of the monsoon season, to replenish 4 of the 9 in of runoff stored in the reservoirs for use for power and irrigation, assuming that there would be sufficient water available in the latter half of the monsoon for filling up this capacity. It was also determined that a 7 in runoff afforded sufficient storage to provide power and irrigation water throughout the dry season, i.e. from November through May, and could be fitted into the flood space after 15 August. Hence only 3 in added to the reservoir capacity would give the desired flood protection to the lower valley, not to exceed 250,000 cusecs. The advantages of multiple-purpose operations were obvious. The construction of a single-purpose flood control system would have required a reservoir capable of ponding-up 16 in of flood runoff, whereas for the construction of multiple-purpose services, storage for only 12 in of runoff was needed, a saving of 25% in construction materials, etc.

Accomplishments

As pointed out earlier, in order to safeguard the lower basin against floods exceeding 250,000 cusecs, storage capacity amounting to 3,198,720 acre feet is required.

The present system of reservoirs consists of Konar and Panchet Hill on the main stem of the Damodar, and the Tilaiya and Maithon on the Barakar branch. These reservoirs were in service at the beginning of the

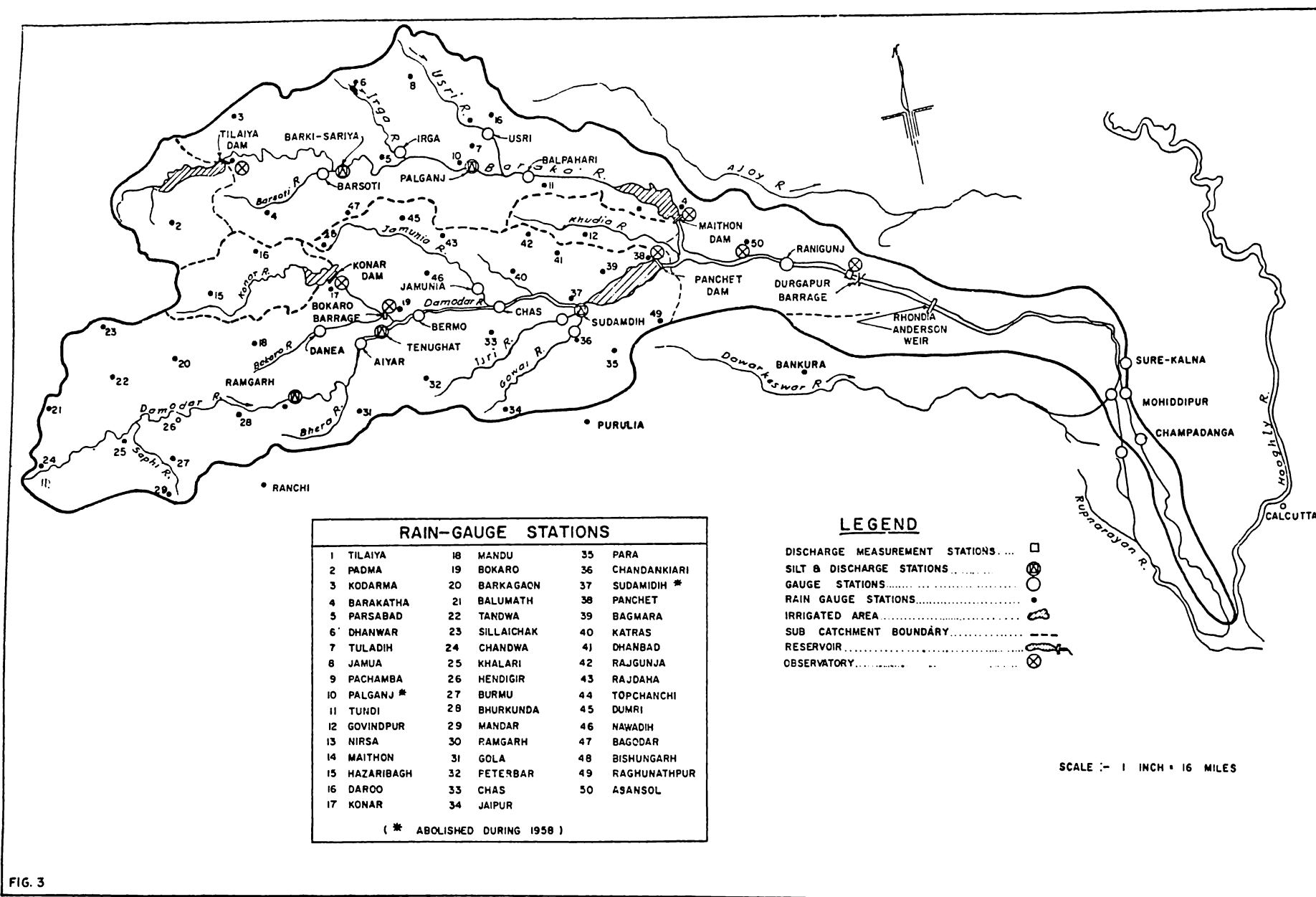


FIG. 3

Figure 3. LOCATION OF RAIN-GAUGE STATIONS IN THE MAITHON-PANCHET CATCHMENTS.

1958 monsoon season, but the Panchet Hill reservoir could impound water only up to spillway crest level elevation 405. All ten under sluice gates were open in operating position. On 1 September 1958, the reservoir was 48 ft below dead storage level.

Guide curves had been worked out for each reservoir using data of the past eight years, and were issued before the beginning of the monsoon to the officers in charge of actual operations at each damsite. Operations during the period as a whole were smooth, systematic and successful.

The following details on reservoir operation activities during the unusual monsoon season of 1958, relating to all three purposes, i.e. flood control, irrigation and power generation, were obtained from the Executive Engineer of ROC.¹

Flood control

The lower valley below Maithon and Panchet was to be protected by the existing four dams against all floods up to a peak flow of 650,000 cusecs by regulating the water in the reservoirs and moderating the peaks to a safe flow of 250,000 cusecs below the Durgapur barrage. This was achieved mainly through the Maithon and Panchet reservoirs, where storage capacities are provided for this purpose.

¹ Reservoir Operational Control.

Preparation for flood control operations

(i) Several stream-gauging stations along the river course and a network of self-recording and ordinary rain-gauging stations were established at strategic places in the Maithon and Panchet catchment areas, as shown in figure 3. These stations recorded the flood data.

(ii) Arrangements were made to receive reservoir data in the Reservoir Operation Control Office every day before 9 A.M. from Tilaiya, Konar, Maithon and Panchet dams over the VHF and Carrier network during normal periods, and every three hours during flood periods.

(iii) Arrangements were made with the DVC Meteorological Unit at Alipore, Calcutta, to issue daily weather message giving (i) the qualitative forecast in terms of light, moderate, scattered, heavy, widespread rainfall, etc. for the next 24 hrs., (ii) outlook in terms of whether rainfall will increase or will decrease during the subsequent 24 hrs. and (iii) on a few occasions increase or decrease of rainfall during a further 24 hrs. period. This information was given separately for the Damodar, Barakar and Lower Valley catchment areas. The same message also contained actual rainfall recorded at some of the stations in the three catchment areas during the past 24 hour period.

(iv) Reservoir operation schedules, as shown in figures 4, 5 and 6, were prepared for each reservoir, using data of the past eight years and the water require-

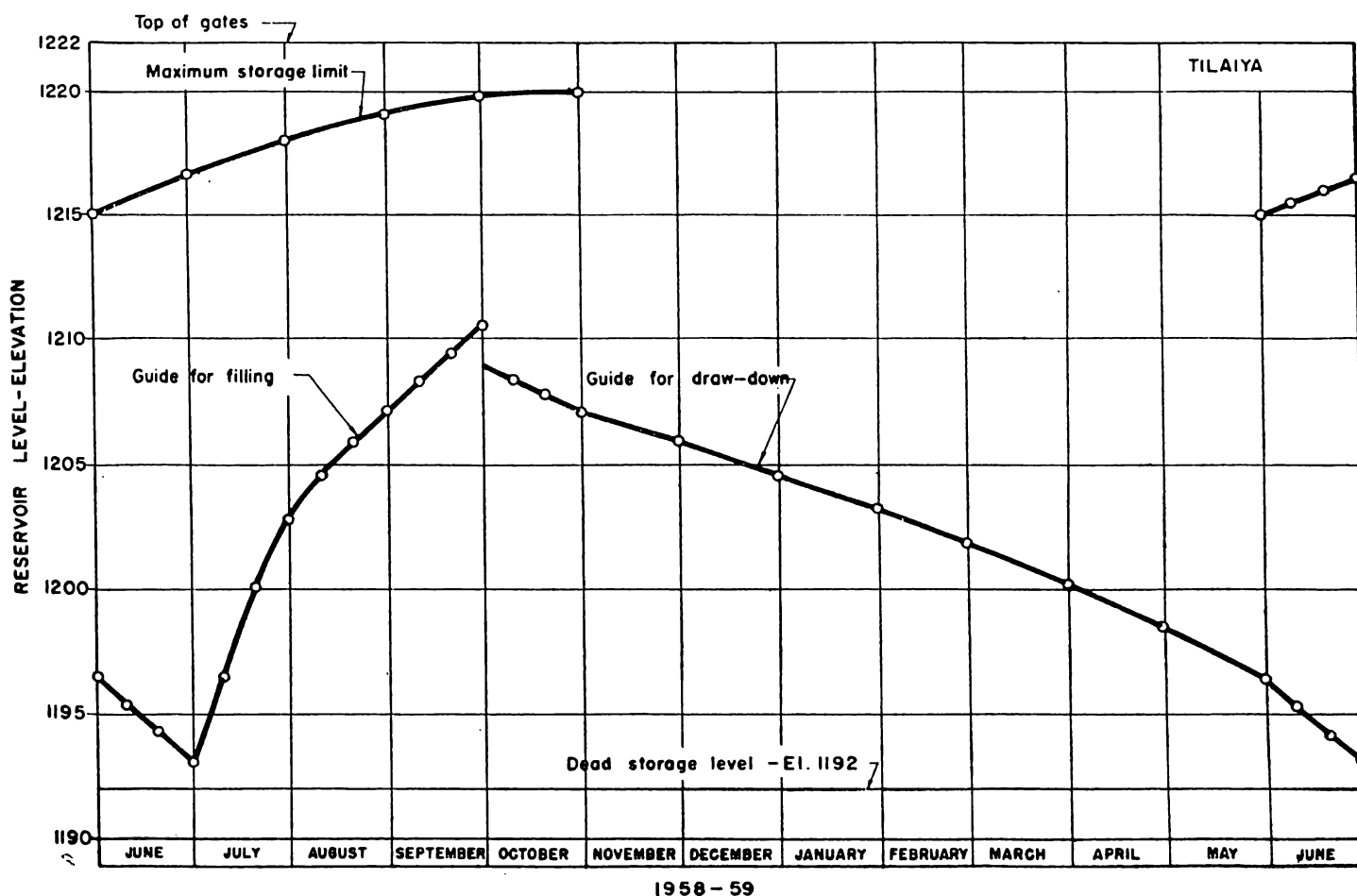


Figure 4. FLOW REGULATION CHART FOR TILAIYA RESERVOIR.

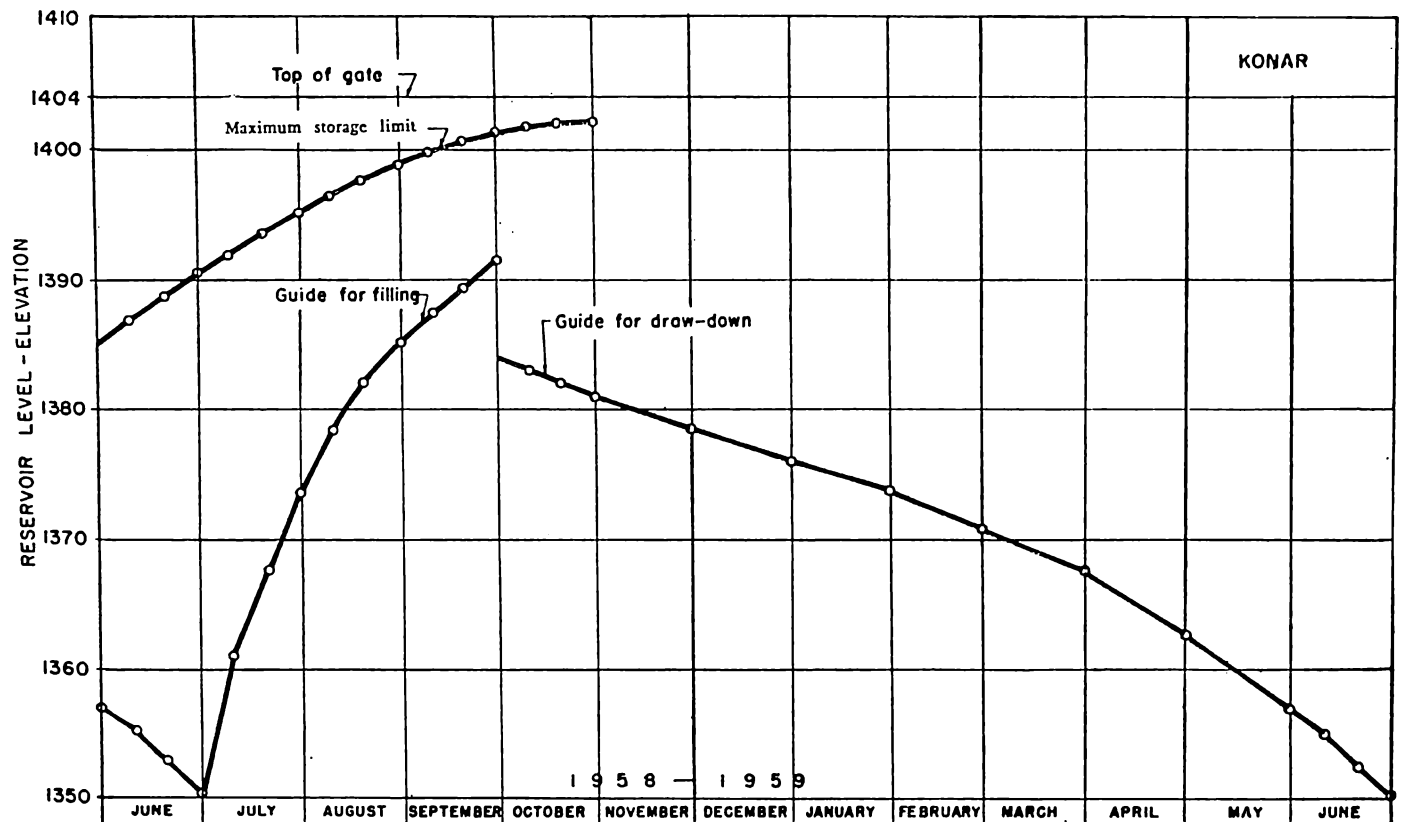
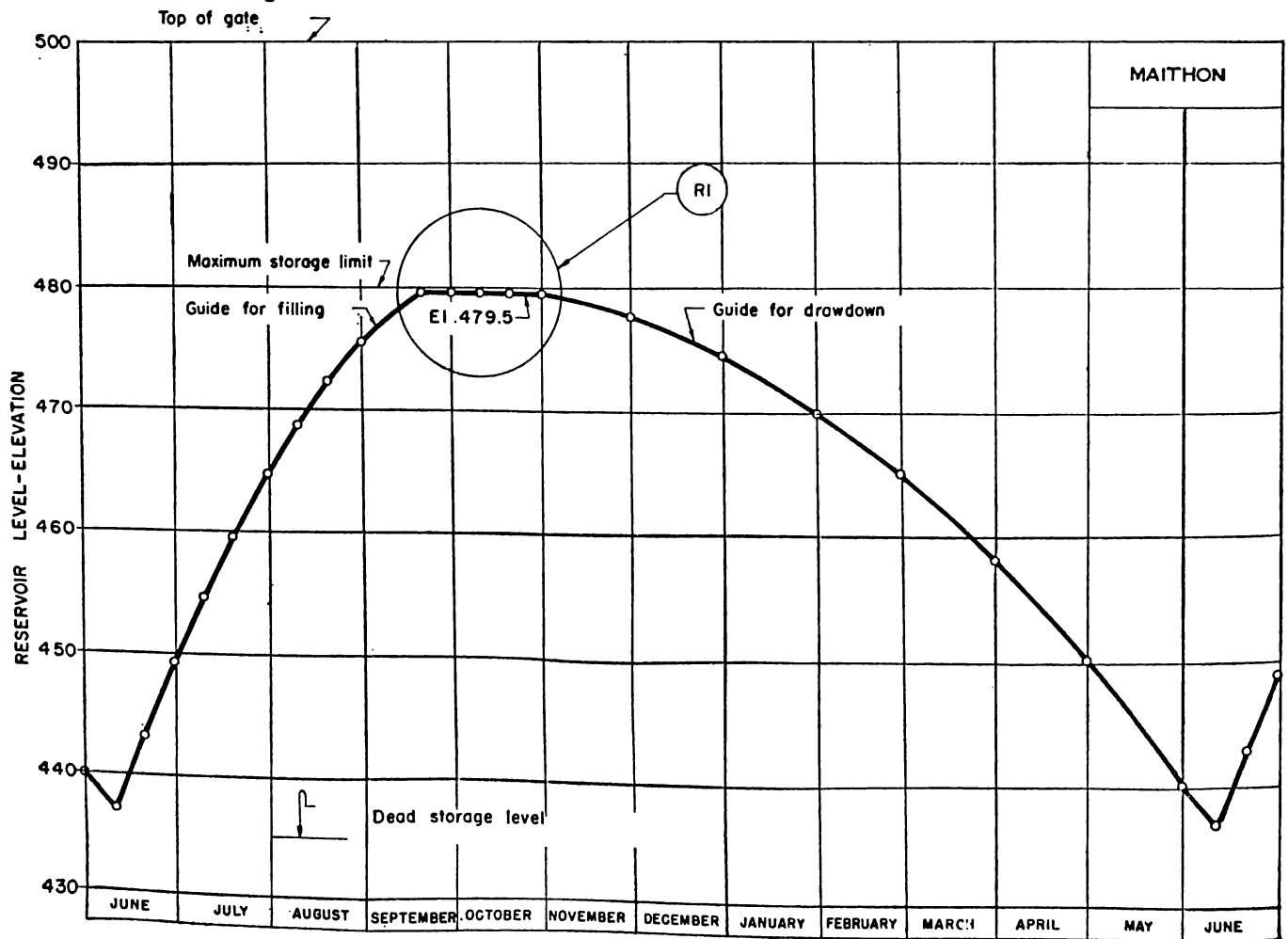


Figure 5. FLOW REGULATION CHART FOR KONAR RESERVOIR.



1958-59

Figure 6. FLOW REGULATION CHART FOR MAITHON RESERVOIR.

ments for each of the three main purposes. Detailed notes are added, describing the operational procedure for flood control, irrigation and power. Also several printed sheets of daily and three-hourly log sheets for recording reservoir data and other computation sheets were supplied to all officers at the damsites in order to have uniformity of records and methods of computation.

(v) Shift work from 8 a.m. to 9 p.m. every day was introduced in the ROC office for five months, June through October, so that all flood messages could be received and timely instructions to the officers at respective damsites issued.

(vi) Arrangements were made to issue a reservoir operation bulletin before 1 p.m. every day, giving the rainfall in the catchment areas, river stage and discharge at important river-gauging stations, and the reservoir data, such as inflow, outflow, levels, etc. In addition to the bulletin, the ROC office furnished, each day by teleprinter service or carrier telephone, reservoir data to the Secretary of DVC, the Executive Engineer, Damodar Canal Division, government of West Bengal.

Actual flood control

In all, there were three flood peak flows exceeding 100,000 cusecs. The first one occurred on 23-26 July, the second on 11-14 August, and the third on 14-18 September 1958. Had there been no dams, the peak flows at Durgapur barrage during these floods would have been of the order of 240,000, 125,000 and 665,000 cusecs respectively. The shapes of the three flood hydrographs are shown in figures 7, 8 and 9. The 14 to 18 September flood had the largest flood peak ever recorded in the valley up to that date. A separate report was prepared and submitted by the Executive Engineer of ROC to the Chief Engineer, giving a detailed description of the rainstorm, the pre-flood condition of each reservoir, the contribution of each reservoir in holding back the flood waters, etc. A copy of this report is given in appendix II. During this flood, the officers and staff of the ROC office worked almost constantly for three successive days and nights to co-ordinate operations at all damsites. This unprecedented flood was successfully controlled and damage to life and property in the lower reaches averted.

Irrigation

During the dry period prior to the 1958 monsoon, extensive studies were made to determine how best the four reservoirs should be operated to meet the requirements of the three main objectives. For this purpose, the water potential of each dam was revised for the period 1949-58 on the basis of actual reservoir data; the demand for water to irrigate one million acres was also revised in consultation with West Bengal government officers. On the basis of these revisions, several alternative plans to meet this revised demand for irrigation water were worked out by operating Maithon and Panchet reservoirs in several ways. After studying these alternatives, the ROC office was directed to operate Maithon reservoir mainly to meet power requirements during the 1958-59 dry season, with a minimum average release of 1,000 cusecs to be assured

all the time to generate electric power. It was further directed that the extra demand for irrigation water during September and October should be met from the Panchet reservoir. In accordance with these broad directives, the reservoir operation schedules were prepared for Maithon as shown on figure 6. At the beginning of the season, the West Bengal government had informed DVC that, during the kharif season, they would require water to irrigate about 520,000 acres of land.

On the basis of these requests, the ROC office issued bi-weekly instructions to the Superintending Engineer (Hydel Stations), DVC, Maithon and Superintending Engineer, Panchet Hill Project to regulate the release from the reservoirs accordingly. Figure 10 shows the indents received and the actual use of water for kharif irrigation during 1958 season. It may be seen from this drawing that the release for irrigation water was effective from 1 July. It may be further seen that, against a theoretical canal takeoff of 660,000 acre feet, which was worked out on the basis of the recommended approach to irrigate about 520,000 acres, the total indent received was 974,000 acre feet and the actual takeoff was 921,000 acre feet.

Power generation

The flow regulation procedures for hydropower generation during 1958-59 were described in detail in the form of notes as well as diagrams as shown in figures 4, 5 and 6 for Tilaiya, Konar and Maithon respectively. The total hydropower generated at Maithon and Tilaiya during the period July to October was 60.6 and 1.16 million kWh respectively. Panchet Hill power station had not been placed in service until late 1959.

Water balance account for the season

The total rainfall during the monsoon as recorded over the four catchment areas, Tilaiya, Konar, Maithon and Panchet, and the corresponding runoff in inches are shown in cumulative form in figure 11. It may be seen that an average rainfall of 38 in for Tilaiya, 41 in for Konar, 39 in for Maithon and 43 in for Panchet Hill occurred during the season. The corresponding runoffs, as estimated on the basis of reservoir data, were 12 in, 14 in, 13 in and 16 in. Statement No. STA-69 (figure 12) gives the 10-day and total inflow, outflow and storage for each reservoir during the period under observation.

It may be seen from the above figures that, for Tilaiya, 19.6% of the inflow occurred in July, 31.5% in August, 42.5% in September and 5.6% in October. For Konar, the corresponding figures were 21.3% in July, 24.0% in August, 37.0% in September, and 9.6% in October. For Maithon, they were 15.8% in July, 31.5% in August, 35.6% in September and 14.2% in October. For Panchet, 20.0% in July, 30.0% in August, 36.4% in September and 11.4% in October.

From the foregoing it may be concluded that the inflow during July was only 16% to 21% of the total inflow during the monsoon period, whereas it was 61% to 74% in August and September. Furthermore,

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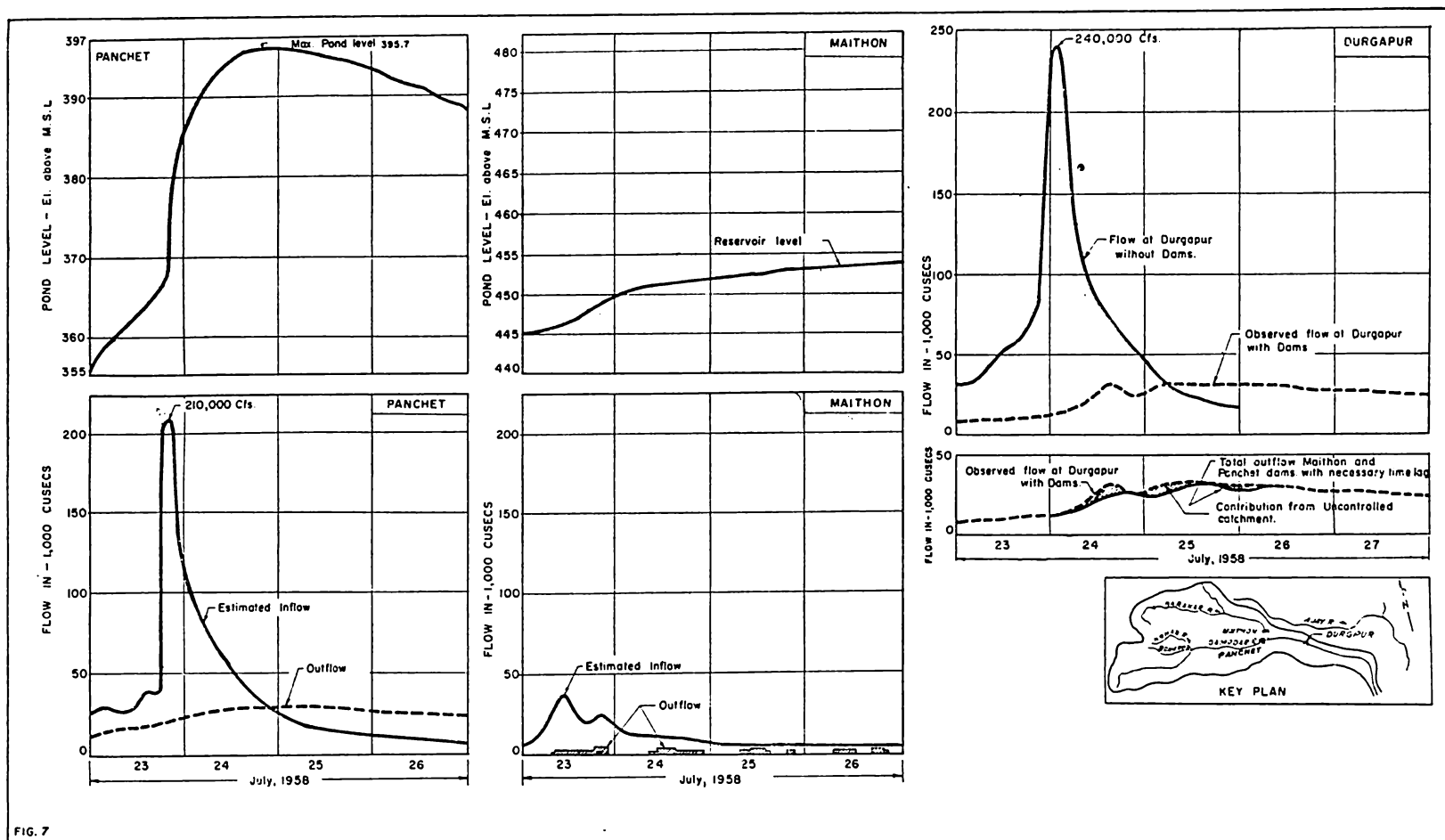


Figure 7. CONTROL OF FLOOD 23 TO 26 JULY 1958.

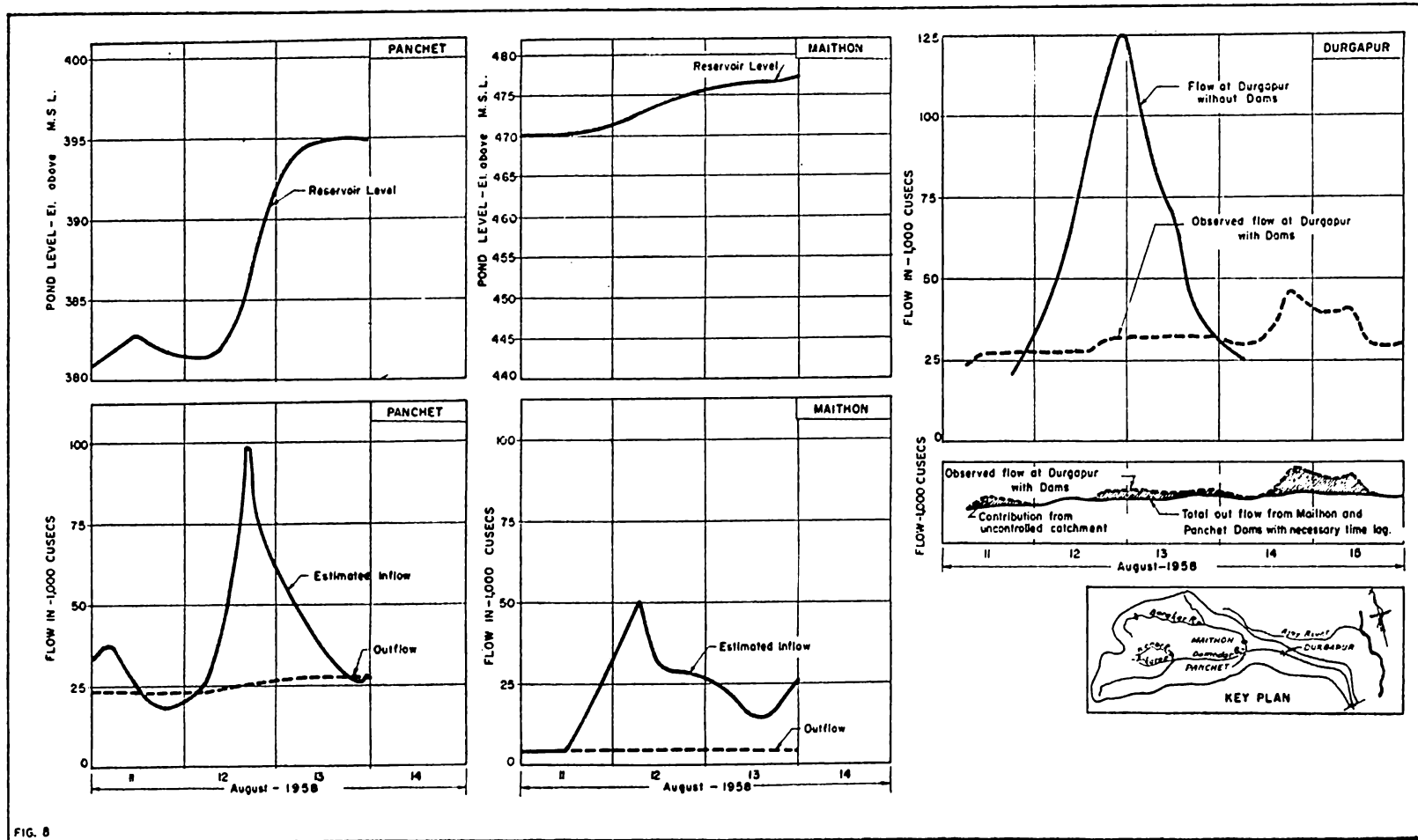


Figure 8. CONTROL OF FLOOD, 11 TO 14 AUGUST 1958.

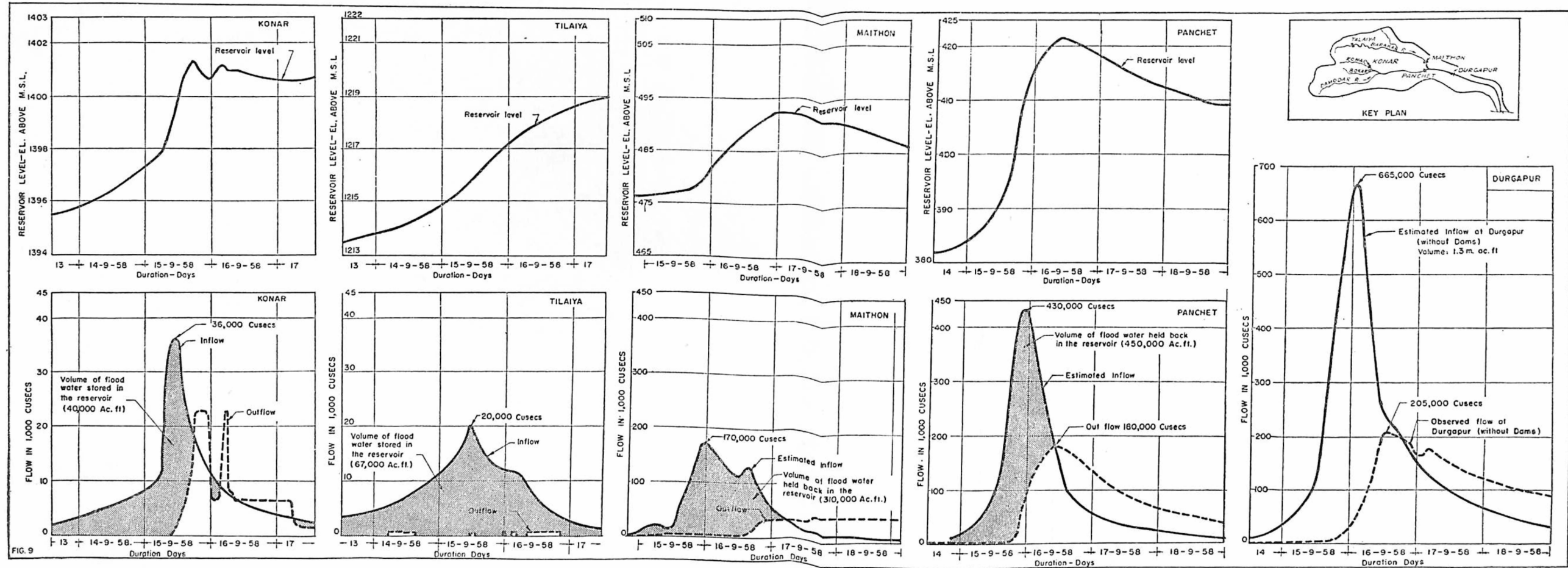


Figure 9. CONDITION OF RESERVOIRS DURING CONTROL OF SEPTEMBER 1958 FLOOD.

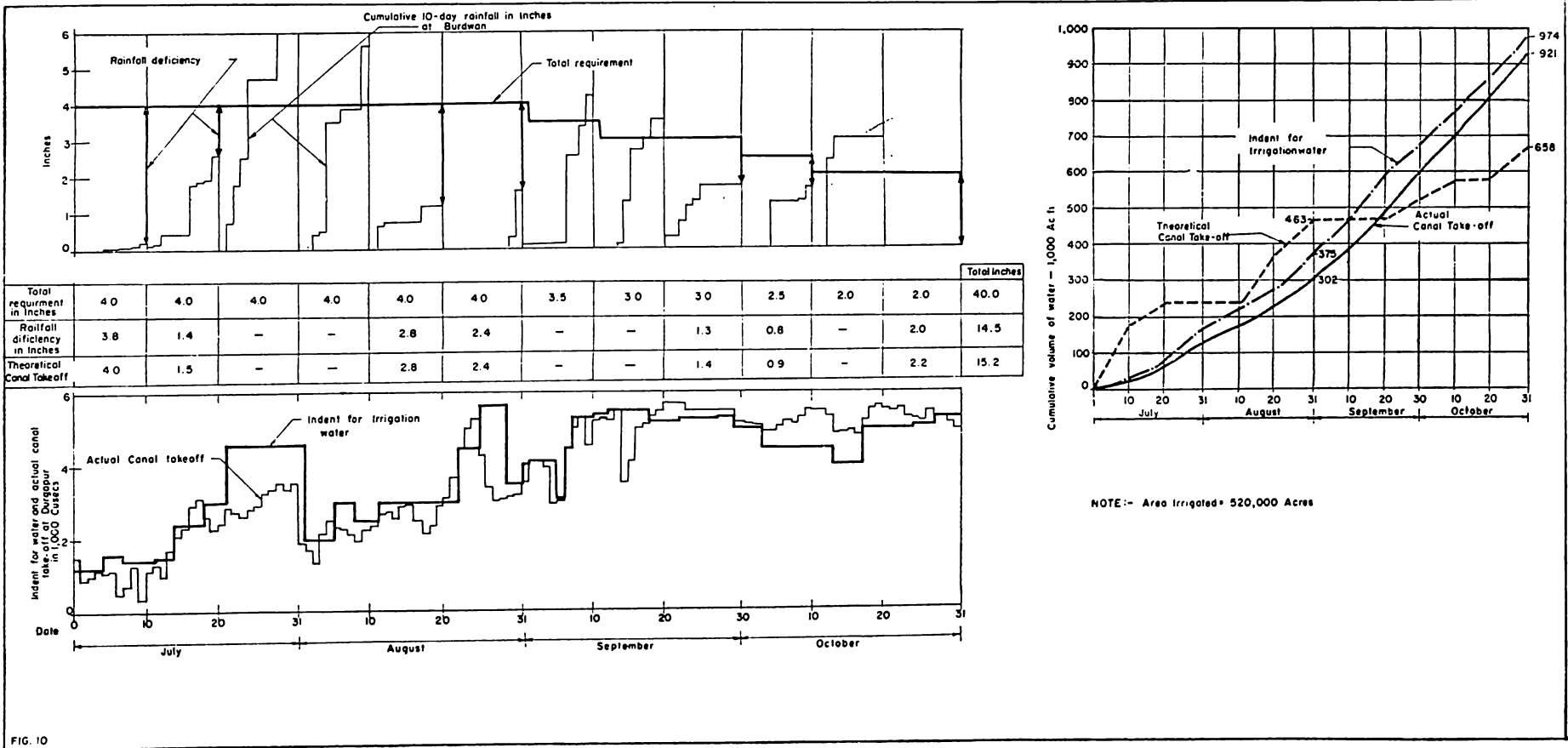


Figure 10. CHART OF WATER USE FOR KHARIF IRRIGATION 1958.

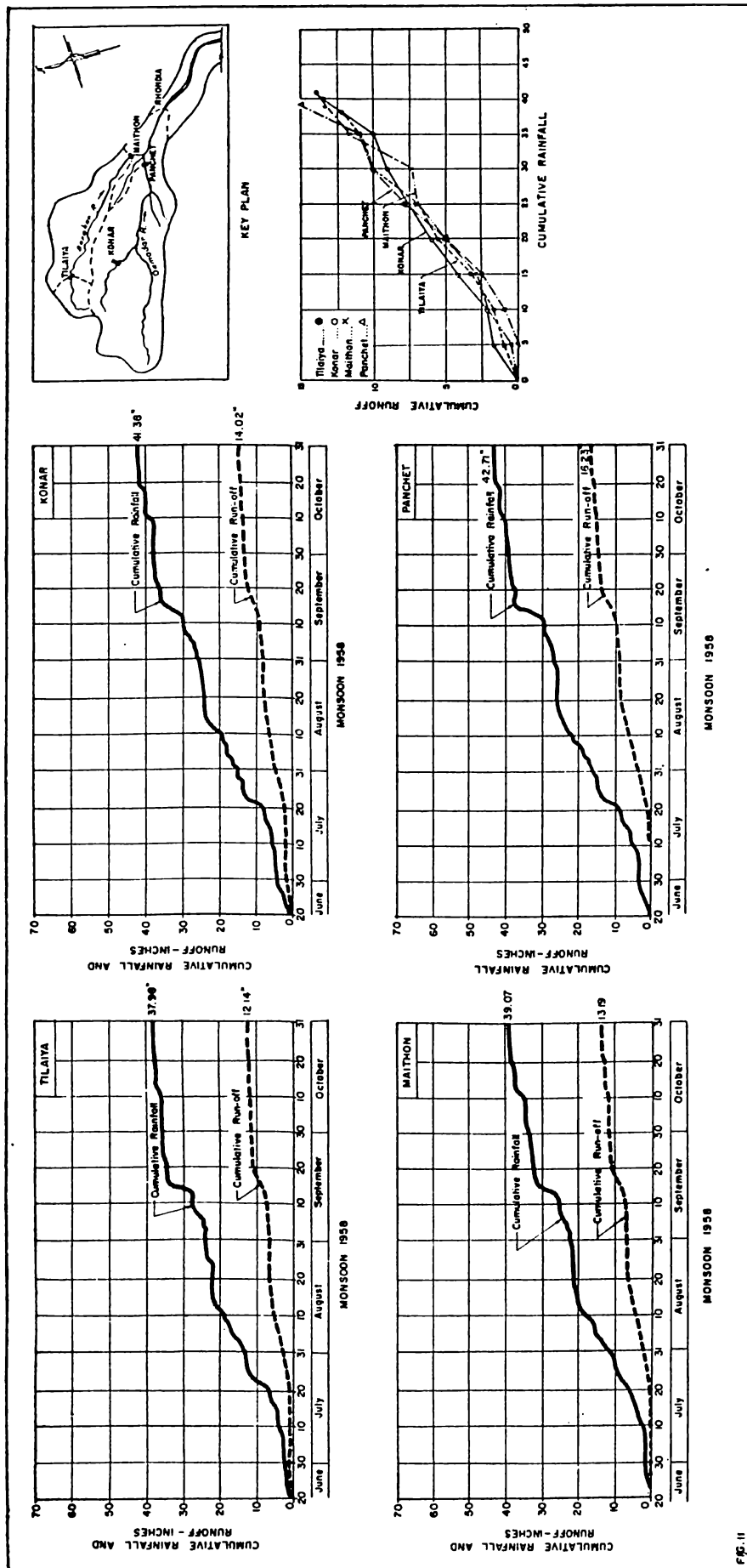


Figure 11. CUMULATIVE RAINFALL RUNOFF MONSOON CHART 1958.

Month	Period		In 1,000 acre-feet											
			Tilaiya			Konar			Maithon			Panchet		
	From	To	Inflow	Outflow	Storage	Inflow	Outflow	Storage	Inflow	Outflow	Storage	Inflow	Outflow	Storage
June	21	30	3.49	7.94	-4.45	24.88	14.51	10.37	36.07	18.97	17.10	97.81	85.22	12.59
July	1	10	0.72	3.18	-2.46	2.81	7.63	-4.82	6.96	36.10	-29.14	16.08	29.84	-13.76
	11	20	8.62	1.95	6.67	9.45	5.70	3.75	52.99	22.70	30.29	144.84	131.70	13.14
August	21	31	39.42	1.26	38.16	48.80	2.61	46.19	172.64	26.39	146.25	521.12	480.53	40.59
	1	10	51.52	2.33	49.19	28.75	3.18	25.57	203.41	63.98	139.43	474.53	434.94	39.59
	11	20	20.90	1.96	18.94	34.50	3.34	31.16	243.41	105.81	137.60	476.76	514.74	-37.98
September	21	31	5.48	0.47	5.01	5.83	6.31	-0.48	15.77	87.82	-72.05	69.27	118.19	-48.92
	1	10	19.12	0.38	18.74	20.33	2.39	17.94	69.61	27.82	41.79	186.63	124.59	62.04
	11	20	73.95	1.68	72.27	73.38	33.84	39.54	401.84	347.13	54.71	895.08	711.49	183.59
October	21	30	9.50	2.07	7.43	13.20	12.28	0.92	51.10	84.05	-32.95	166.91	168.02	-1.11
	1	10	3.17	3.85	-0.68	5.60	5.91	-0.31	44.55	29.13	15.42	80.51	91.48	-10.97
	11	20	6.76	4.06	2.70	16.23	10.92	5.31	129.10	93.64	35.46	196.31	168.01	28.30
Total			245.81	34.97	210.84	288.77	115.28	173.49	1465.31	972.34	492.97	3443.16	3215.87	227.29

Figure 12. TEN-DAY WATER BALANCE ACCOUNT FOR THE MONSOON MONTHS 1958.

referring to the nature of 10-day inflows into the reservoirs, as given in statement No. STA-69 the filling rate of the reservoirs was accordingly recommended. Figure 13 shows the actual operations of reservoirs as against the recommended guide for filling and the maximum storage limit.

Some important observations

Some of the important observations made while operating the reservoir during this season are as follows:

- (i) There are practically no rain-gauge stations in the catchment area between Panchet dam and Sudamdih (about 1,100 sq mi) to record and transmit the actual rainfall to the ROC office as soon as it is measured at 8.30 a.m. every day. During the 14 to 18 September flood, this particular section of the catchment area had received very heavy and uniform rainfall during the night on 14 September, but owing to lack of this information, the estimated time of reaching water level to E1.405 at Panchet dam was misjudged by five hours. The rate of rise of reservoir levels as supplied by the Superintending Engineer at Panchet, was the only source of information available to the ROC office.
- (ii) The weather forecasts of 15 and 16 September did not give actual rainfall at practically any rain-gauge station in the Barakar catchment area. This may have been due to the failure of P & T communication system owing to heavy rainfall. They only information about the flood in this branch that reached ROC office 1 p.m. on 15 September was the message sent by the DVC Silt Surveyor stationed at Barkisara. Officers were therefore, requested to arrange for 24-hour vigilance at the damsite to observe pond levels every hour and estimating the magnitude of the incoming flood.

Similarly, the P & T telephone line (there was no VHF or Carrier telephone) be-

tween Maithon and Durgapur went out of service on the 15 September 1958. Advance flood warning to Durgapur was sent over Carrier telephone via Kalipahari and Burdwan substations.

- (iii) There was some confusion while issuing instructions for the actual operation of crest and sluice gates during this flood at Tilaiya reservoir. It was felt that responsibility had not yet been clearly divided between the Civil and Electrical Sub-divisions at Tilaiya.
- (iv) The jeep is not a suitable vehicle during heavy rains, a closed vehicle should have been provided. However since then, corrective measures have been taken.

Flood warnings in practice

Earlier in this chapter, it was pointed out that the four existing dams could not provide adequate flood protection to the lower valley when inflows exceed 650,000 cu ft per second. It was also assumed, on the basis of past history, that unprecedented inflows were not known to occur much after 15 August, and that 4 of the 9 inches of runoff into the reservoirs could be utilized for power and irrigation releases, predicated on refilling the reservoirs to full capacity during October with the ending of the monsoon season.

The monsoon season of 1958 jarred this hypothesis somewhat shaken with the storm of 13-15 September hit both the upper and lower valleys. Again in 1959, during early October, a cyclonic storm developed from a depression in the Bay of Bengal, travelling northward and hitting the West Bengal coast near Contai. On the morning of 1 October, a rainfall of 5.24 inches was recorded in the lower Damodar valley. At Durgapur barrage, a discharge of 350,000 cusecs was recorded at 7 a.m. on 2 October. On the same day, the Maithon project reported an inflow of 310,000 cusecs and at Panchet Hill, 420,000 cusecs. Had it not been for the

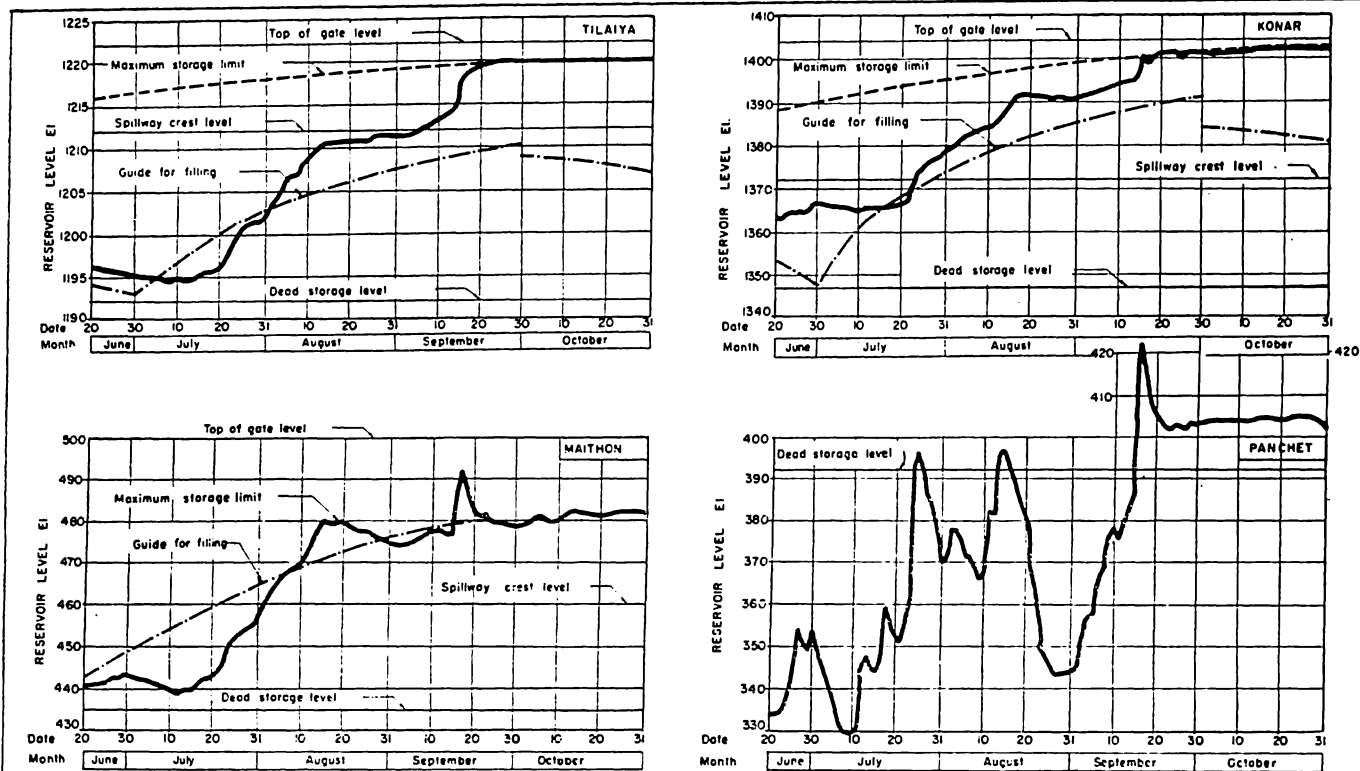


FIG. 13

Figure 13. RESERVOIR LEVELS MONSOON OF 1958.

four dams in the upper basin, discharge conditions in the lower valley would have been in excess of 800,000 cusecs. Nevertheless, great damage was done over more than 4,300 sq mi of West Bengal territory. In brief it cost lives of 63 people, 271,535 homes were destroyed or badly damaged, 4,023 heads of cattle and other live-stock perished, 134,000 people had to be evacuated, 1,034,000 acres of paddy lands were damaged involving the loss of 517,000 tons of rice.

The authorities decided that action can no longer be deferred, and an investigating committee was appointed to study the causes and to suggest comprehensive remedial measures forthwith.

At the outset, the DVC planners thought of providing protection against the flood of one million cusecs in the lower Damodar basin by constructing all the seven dams, namely, Tilaiya, Konar, Maithon, Panchet, Aiyar, Bokaro, and Balpahari. Subsequently, the planners, owing to financial difficulties, decided to construct all the dams in two stages. Four dams, namely at Maithon, Panchet, Tilaiya and Konar would be built in the first stage and the Aiyar, Bokaro and Balpahari dams during the second.

The four dams selected for construction during the first stage have been completed. The question now arises, in view of the construction of these four dams and the further study made in recent years of the Damodar river and its basin, whether there is any need to construct more dams in the Damodar basin. On the basis of what happened in 1959, there can be no further doubt as to the need for one, and perhaps two, additional dams.

The question of water potential at the dams and the operation of all the four reservoirs, i.e. Panchet, Maithon, Tilaiya and Konar, already constructed was examined in detail by the technical committee, and it has been found that plenty of water is available for storage in another dam. Moreover, the Aiyar dam appears most feasible to construct. If another dam is not built, this huge quantity of water will continue flowing into the Bay of Bengal.

When the first stage construction of the four dams was planned, DVC hoped to irrigate over one million acres below the Durgapur barrage. These four dams have provided some protection against flood. Since the river below Maithon and Panchet was made perennial as a result of the construction of reservoirs, many industries have sprung up around Durgapur, which may become a major industrial centre. The industrial demand for water at Durgapur now appears to be 430 cusecs plus 570 cusecs above Durgapur. If this water is taken from the river, which was not originally planned, it will be very difficult to meet the kharif irrigation requirements during the critical months of September and October. To meet this demand, the reservoir level at Panchet has to be drawn down below dead storage level. As a result, it

will not be impossible to satisfy industrial water demands during the summer season. If the water going to waste during the flood months of June, July, August and September can be stored in another dam, water will be available to meet kharif and rabi irrigation requirements, as well as industrial demand, throughout the year.

The four dams taken up during the first stage are designed to protect the lower valley against floods of 650,000 cusecs. The unprecedented floods which occurred in the Damodar valley on 15 and 16 September 1958, and again in 1959 have shown that the flood protection provided by these dams is insufficient.

In the upper valley, there is a growing water demand of around 450 cusecs, yet only 250 cusecs can be assured from the Konar dam. The Government of India contemplates construction of a fourth and largest steel plant at Bokaro, with a capacity of about 5 to 6 million tons. The water requirements for this size plant are estimated at 750 cusecs. Many auxiliary industries will spring up around the steel plant and their water requirements may amount to an additional 100 cusecs. Yet the present release from the Konar dam is 250 cusecs. The Aiyar dam is ideally situated to meet these projected industrial demands and to supply circulating water to the new thermal station where construction has been authorized.

The Central Water and Power Commission made a study of the rate of increase in power demand in this region, and concluded that it was necessary to have at least one unit of 125,000 kW every year for the next 7 years. As hydropower potential is very small, the installation of thermal power stations is an obvious choice, especially in view of the abundance of coal in the area and as middlings from the washery can be used profitably. Each unit of 125,000 kW will require roughly about 200 cusecs of cooling water. With the present assured supply of 250 cusecs from the Konar dam, one can hardly expect more than one unit of 125,000 kW capacity in any station. Construction of the Aiyar dam would assure a water supply, together with the Konar, for the installation of 5 to 6 units of 125,000 kW each. This would result in very substantial economies. Construction of the Aiyar dam would not only increase the power supply capacity of the area by 60,000 kW but also provide downstream benefits to the Panchet Hill project, by permitting the full plant capacity of 80,000 kW to operate throughout the dry season.²

An exhaustive study of total demand for water in the near future indicated that 1.38 million acre feet will be needed. However, taking into account the supply from the existing reservoir, including losses, there will be a deficit of 620,000 acre feet. Therefore, construction of Aiyar dam is imperative.

² The second unit at Panchet has not been authorized during the third five-year plan.

Chapter IV

IRRIGATION AND NAVIGATION DEVELOPMENT

IRRIGATION

General

Flowing water is a natural resource of potential energy. Man has known and utilized it in sundry ways for diversified purposes ever since the beginning of civilization.

Fifty centuries ago, the Mohan-Jo Daro civilization of the Indus valley, then India, enjoyed the benefits of a well designed water supply, irrigation and drainage canals and even public swimming pools.

Our present-day civilization is faced with a more serious problem—how to regulate, distribute and conserve this dwindling but valuable gift whose behavior is so erratic and unpredictable.

Conventional means for releasing water that has been impounded by dam structures are:

- (1) Adaptation of penstocks and governing devices.
- (2) Employment of undersluices.
- (3) Overflow spillways, and independent structures.

Description of command areas

Irrigation schemes in the lower Damodar valley have been in existence for nearly one hundred years. The Eden canal, constructed in 1873-1881, functioned as a sanitary canal, flushing the riverbeds and provided drinking water to areas adjacent to the canal. Subsequently, its primary use was to provide water for irrigating 25,000 acres of paddy lands.

In 1926-1933, the Anderson weir across the Damodar and Damodar canal were constructed near Rhondia to provide supplement water to the Eden canal, and to irrigate an additional 161,000 acres of paddy lands. The scheme, however, was not successful, because about once in five years the flow of the Damodar in October was too low to meet irrigation requirements. Consequently, 60,000 acres under perennial irrigation had to depend on storage tanks scattered about the area.

In the lower Damodar valley, large areas of arable lands were in need of a dependable supply of water, while other smaller areas required drainage schemes. One of the three principal purposes of multiple-purpose development in the Damodar valley was irrigation and drainage schemes.

The preliminary planning of a long-range irrigation and drainage programme envisioned the servicing of a large area of fertile agricultural land in West Bengal by

the release of storage water from dams in the upper valley to a diversion barrage and regulator works across the Damodar, 34 mi downstream near Durgapur (See photograph of Durgapur barrage, figure 14).

A total of 9.73 lakhs acres of kharif (summer) crops and 100,000 acres of rabi can be irrigated from the canals. Figure 15 shows the location of the irrigated lands in the lower valley. The plan includes the development of 18,000 acres in the Arambagh sub-division of the Hooghly district of West Bengal.

The gross command area covers four districts in West Bengal. The division of land and length of canals constructed in each district are shown in table 12.

TABLE 12. GROSS COMMAND AREA AND LENGTHS OF CANALS IN WEST BENGAL

District	Length of canal (mi)	Left bank (sq mi)	Right bank (sq mi)
Burdwan	180	1,180	232
Bankura	150	—	164
Hooghly	500	526	40
Howrah	60	55	—
Total	890	1,761	436

It is estimated that an allowable water duty of 90 acres per cusecs for a kharif area of 9.73 lakhs acres is adequate. The canals have been designed on the basis of the latest non-silting and non-scouring velocity principles. The slopes of the canals have been designed in accordance with Lacey's Regime Channel Slope, with due consideration to the ground slope to minimize the number of falls and earthworks.

The irrigable area is supplied with water by a network of canals, divided into suitable blocks, which are directly fed by the small village channels. The excavation and maintenance of these works is accomplished by the collective efforts of the villagers themselves. Maintenance and operation of the village channels and distributaries is essential to the efficient and economic distribution of water. Deterioration of these works would not only interfere with the normal flow through the outlets, but contribute to higher conveyance losses and consequently loss of command area.

The major feature of the project is the Durgapur barrage, which is designed for a flood stage of 550,000 cusecs, plus a concentration factor of 20% for a super flood. This became necessary because of the delay in constructing the dams in the upper valley.

The barrage is 2,271 ft long, and has two main canals branching off on the left and right banks; the former also serves as a navigation canal to the Hooghly river, 85 mi away. The right bank canal, 55 mi in length, is used solely for irrigation. Details of the navigation features are given in a subsequent chapter.

The barrage is a floating raft-type structure. The salient features of the barrage are listed in table 13.

TABLE 13. SALIENT FEATURES OF THE DURGAPUR BARRAGE

Number of weir bays (each 60ft)	24
Number of left under-sluice bays (each 60ft)	5
Number of right under-sluice bays (each 60ft)	5
Total length between the abutment-faces	2,271 ft
Pond-level	211.5 R.L.

<i>Pavement level</i>	<i>Weir bay</i>	<i>Left under-sluice</i>	<i>Right under-sluice</i>
Upstream	190	188	187
Downstream	184	181	180
Crest level	196	194	193
Height of gates	16ft	18ft	19ft

Width of roadway (I.R.C. loading), including a 3ft wide footpath on one side	25ft
Top level of roadway	222.5
Submerged area due to ponding, including river bed, 3,200 acres	

<i>Head regulators</i>	<i>Left bank.</i>	<i>Right Bank.</i>
Discharge at head	9,137 cusecs	2,271 cusecs
Waterway	8 spans of 20ft each	2 spans of 20ft each

Irrigation benefits

For the present, the net irrigable area has been assessed at 9.73 lakhs acres, which utilizes only 69% of the gross command area. The net irrigable area may ultimately prove to be 3 to 5% higher than this figure.

Adequacy of water supply

The water is to be supplied for irrigation during the kharif and rabi seasons, for navigation purposes and for industrial and domestic use. With the growth of industries in the region, industrial demand is increasing rapidly. The extent of the water requirements for kharif and rabi irrigation depends on a variety of factors, such as rainfall in the irrigated areas, flow in the river at the time, the rate of irrigation development from year to year, the fact that crops may mature with a limited supply of water and the improvements that can be effected in the distribution system for better utilization of water.

The lower Damodar valley is a wet area with a high rainfall which, in spite of year-to-year fluctuations, averages at well over 50 in annually. Table 14 shows the average rainfall in the districts to be serviced with irrigation under the Damodar scheme:

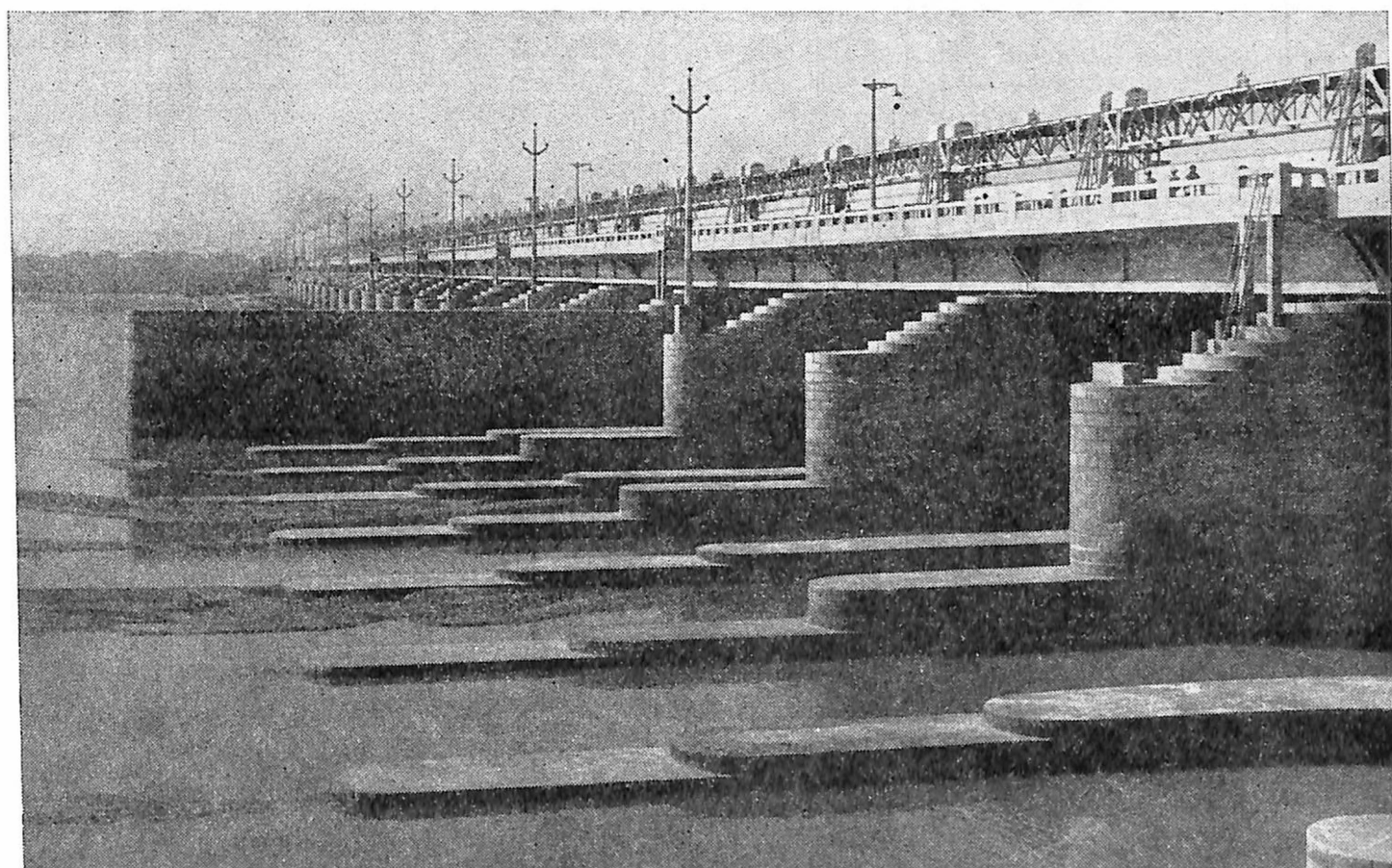


Figure 14. PHOTOGRAPH OF THE DURGAPUR BARRAGE.

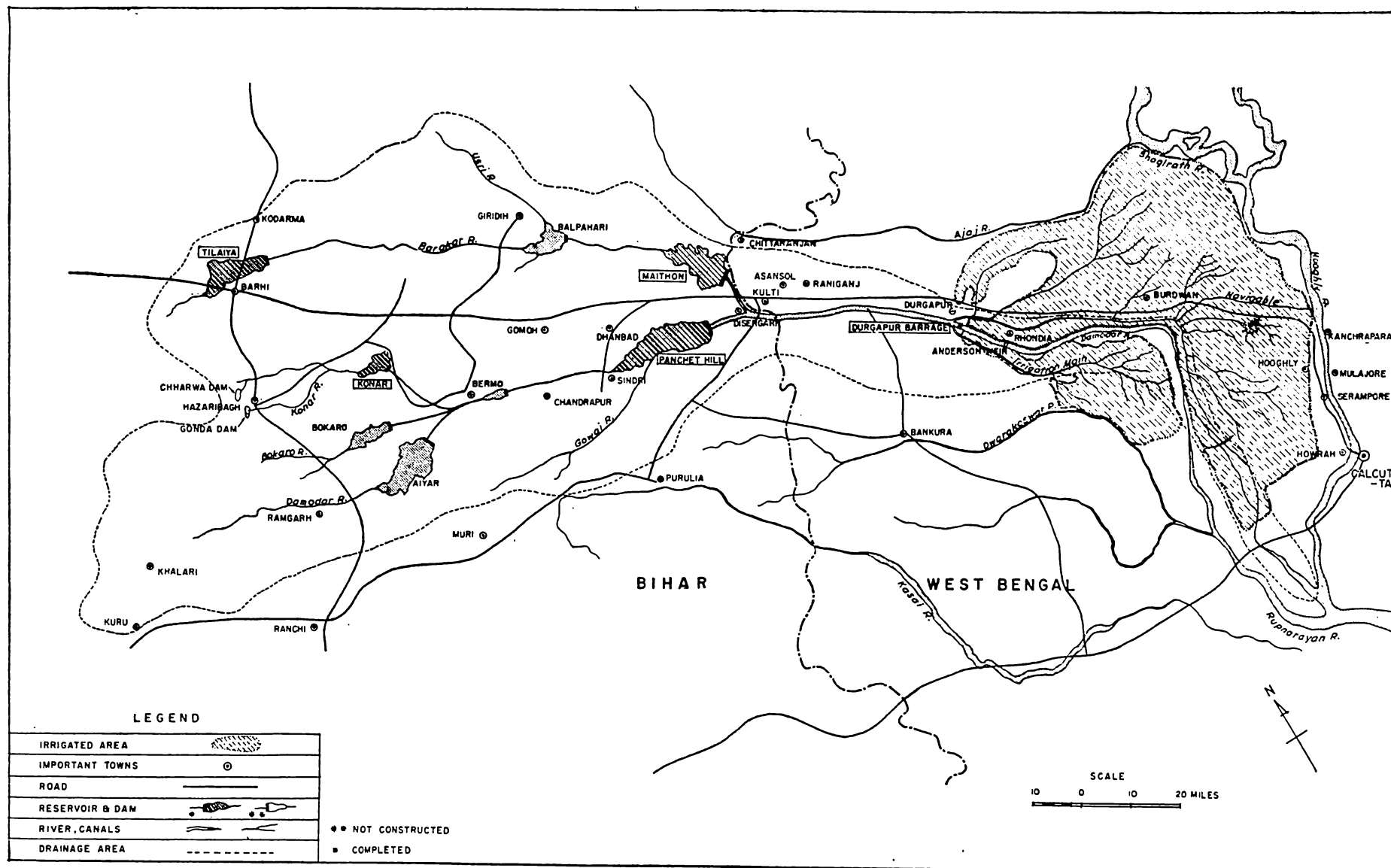


Figure 15. DAMODAR VALLEY IRRIGATION SCHEME IN WEST BENGAL.

TABLE 14. AVERAGE ANNUAL RAINFALL DURING 1930-1950 IN THE WEST BENGAL DISTRICTS

District	No. of rainy days	Rainfall in inches		
		Maximum	Minimum	Average
Burdwan	72.21	68.36	36.46	52.46
Hooghly	78.58	79.11	32.98	60.46
Howrah	82.12	91.16	42.93	67.57
Bankura	70.88	65.47	37.93	53.25

West Bengal is one of the heaviest rainfall areas in India. Most of the land is practically flat, and much of it deltaic in nature, gradually built up over the years with the soil washed down from up-country. As a result the water-table is high during the monsoon; this alluvial soil normally has a high moisture content and a low degree of water absorption; the atmosphere is humid and evaporation losses are low.

Practically the entire area now grows rice as a kharif crop. Except for the 220,000 acres irrigated from the existing Damodar canal system, rice is grown as a rain-fed crop. The water requirements in West Bengal for rice, based on authoritative assessments, is 40 in. The latest 10 days schedule of distributing 40 in of water is given in table 15.

TABLE 15. SUPPLEMENTED WATER REQUIREMENTS FOR AMAN RICE IN WEST BENGAL (BY DAYS)
(In inches)

Monthly	1-10	11-20	21-30	Total
July	4	4	4	12
August	4	3.5	3.5	11
September	3.4	3.3	3.3	10
October	2.5	2.5	2.0	7
				40

Note: Aman rice—depends on rainfall.

On the basis of this requirement, considering the contribution of rainfall, and allowing for transit losses, the usual takeoff has been worked out for eight successive years from 1949. This study shows that the delta at the canal head as a whole is on an average 14.8 in varying from a minimum of 8.49 in to a maximum of 19.99 in.

Rainfall itself should be more than enough to meet the entire requirements of the rice crop, with the exception of a very few years in which it drops below 40 in in the kharif season. The rice crop, however, yields the best results only when it is grown under conditions of waterlogging with a minimum depth of 4-6 in of water in the fields. A rain-fed rice crop is, therefore, at a disadvantage, because the rainfall is not evenly distributed over the monsoon period. Although the total rainfall in a particular year may be normal, a brief spell of drought extending can seriously damage the crop. October is usually a critical month for rain-fed rice; by then, the monsoon slackens and the supply of rainwater becomes undependable. Yet this is the month when the rice begins to flower and therefore needs a good supply of water to

ensure a satisfactory yield. The primary object of kharif irrigation is, therefore, to supplement seasonal fluctuations in rainfall and thereby to counteract the effects of periods of drought which frequently occur in the growing season. Irrigation will only supplement the rainfall to ensure a satisfactory output per acre.

High as these water duties are, they can be substantially improved upon when the present flow of irrigation water, depending on river discharge, is replaced by dependable supplementary irrigation through regulated releases from storage reservoirs.

Accordingly, it is safe to assume that, with better utilization of water made possible by the storage dams, irrigation requirement for crops will be substantially lower.

In a normal year, far more water is available than would be required to irrigate 9.73 lakhs acres. Not only is there no shortage of water at present, but the available discharges would be adequate for irrigating a much larger area. There are, however, certain physical factors which make it difficult to extend the gross command, and therefore the net irrigable, area. The barrage site could not be shifted further up from Durgapur, as it would run into the Raniganj coalfields. The Hooghly river on one side, and the Dwarkeswar on the other, set limits in other directions to the gross area that can be commanded from the barrage at Durgapur. What is important to note is that the availability of land, not of water, is the factor limiting the size of the irrigable area.

Water for rabi crops, industrial and domestic uses, and navigation

The water requirements for growing rabi crops varies from 7.5 inches for mustard to 25 inches for sugarcane. The development of rabi irrigation is likely to be slow, as the farmers have to be convinced about its advantages. It will be a number of years before rotation of crops can be introduced. The revised target for rabi irrigation is 100,000 acres. The amount of water required for this purpose is estimated to be 110,000 acre-ft. Practically all will come from storage.

Lack of an assured water supply has undoubtedly been a direct cause of the slow industrial development of the valley. In India, coal areas have failed to attract industries sufficiently, so that, instead of industries moving to the coal area, coal must only too often be moved to distant factories over long distances over congested railway lines. Harnessing of the Damodar is, therefore, the first essential condition for the development of the high industrial potential of the valley.

The people on both sides of the river now suffer from an acute shortage of drinking water in the dry season, some of the worst affected parts being the coal-mining areas. The Corporation has, in the past, been approached on behalf of the Jharia and Raniganj coalfields, the Chittaranjan Locomotive Works, the factory of Indian Explosives Ltd. at Gumia, the Indian Iron and Steel Company's works at Kulti and at Burnpur and also Asansol, and other townships for an assurance that adequate water

would be supplied from the Damodar after completion of the first few dams.

As result of the priority given to industrial development in the second five-year plan, a number of industries have been started in this valley, notable among which is the Durgapur steel plant.

On the basis of the 1959 survey, the water requirements for industrial and domestic uses are as follows:

	cusecs
Above Panchet dam	570
Below Panchet dam up to Durgapur ..	430
Below Durgapur	From 50 to 100

Water can be obtained directly from the rivers for 3 months and will have to come from storage for 9 months. Therefore, the supply from storage will be

(i) above Panchet dam	= 570 x 2 x 365 x .75
	= 310,000 acre-ft
(ii) below Panchet dam up to Durgapur	= 430 x 2 x 365 x .75
	= 230,000 acre-ft
Total	540,000 acre-ft

In addition to these industrial and domestic requirements above Durgapur, it is felt that a flow varying from 50 cusecs to 100 cusecs should be released below Durgapur barrage. The main purpose of this flow would be to meet domestic requirements in this region. The entire dry period supply has to come from storage, which may therefore be estimated as follows:

Domestic uses below Durgapur	= 75 x 2 x 365 x .75
	= 40,000 acre-ft

The water required in the navigation canal during the dry period has been estimated at 200,000 acre-ft, as follows:

(a) Absorption, including evaporation	= 305 cusecs x 242 (No. of days during the period Nov. to June) x 2
	= 147,620 acre-ft
(b) Losses in locks	= 100 cusecs x 242 x 2
	= 48,400 acre-ft
Total	196,020 acre-ft, or, in round figure 200,000 acre-ft

Considering all the requirements as stated above, the total requirement from storage will be:

	acre-ft
(i) Kharif irrigation	400,000
(ii) Rabi irrigation	110,000
(iii) Navigation	200,000
(iv) Domestic water supply below Durgapur	40,000
(v) Industrial and domestic uses	540,000
Total	1.29 million

Allowing 10% for losses in the river and regulating difficulties in items (ii), (iii), (iv) and (v)

	90,000
Total	1.38 million
Reservoir capacity provided at present for purposes other than flood control	980,000 acre-ft
Deduct evaporation loss in the reservoirs ..	220,000 "
Net reservoir capacity	760,000 "
Additional capacity required (1.38-0.76)	620,000 "

The above shows that the total demand is very much in excess of the storage provided in the present four dams. It is, therefore, necessary to embark upon further water conservation measures to meet the increasing demand for water.

The acre yield of paddy, grown under the existing Damodar canal irrigation system and unirrigated conditions respectively, was evaluated in the lower Damodar valley, as rice is now grown there both as a rain-fed and as an irrigated crop.

The results of the experiments (see table 16) were interesting in several ways. The average yield per acre even under unirrigated conditions turned out to be appreciably higher than those published in official agricultural statistics. They also showed that, on an average, the post-canal yield exceeded the pre-canal figure by as much as 10.39 maunds per acre. A closed analysis would, however, show that the difference in yield should, in fact, be higher than 10.39 maunds. With assured irrigation, a further increase in the acre yield of paddy and straw may be confidently expected.

The results of these experiments carried out in the Damodar canal area during the nine years ending 1949-50, and figures for the Eden canal area for four years ending 1948-49 reveal the following points:

- (i) For the Damodar canal area, the average annual yield for the nine-year period ending 1949-50 amounts to 30.75 mds for irrigated paddy, and 20.9 mds for unirrigated paddy respectively. The difference is therefore slightly less than 10 mds per acre between pre-canal and post-canal yield.
- (ii) The yield figure for irrigated paddy is appreciably higher, both in the Damodar and the Eden canal areas, for the four years from 1945-46 to 1948-49. For this period, the difference between pre-canal and post-canal yield amounts, on an average, to be less than 15.1 mds per acre.
- (iii) The appreciably higher yield in more recent years has been due to the increased use of fertilizers, especially ammonium sulphate, bone-meal and oilcakes. In view of the shortage of foodgrains and raw materials in the country, soaring agricultural prices, and a wide margin of profit to the cultivating class, further extension in the use of manures and fertilizers may be reasonably expected.
- (iv) The Anderson weir did not provide assured irrigation, even in the kharif season, owing to lack of any storage, so that irrigation depends on river flow. The yield, even from the irrigated areas, shows considerable year-to-year fluctuations. This must be due partly to variations in the irrigation flow from the Anderson weir as a result of its dependence on the river flow, and partly to differences in manures and fertilizers used by the cultivators. Now that

TABLE 16. SUMMARY OF PRE-CANAL AND POST-CANAL YIELD OF PADDY AND STRAW IN THE DAMODAR CANAL AREA^a

Crop	Pre-canal yield per acre (in mds)		Post-canal yield per acre (in mds)		Difference in yield per acre (in mds)		Value of extra yield due to irrigation (Rs)	
	Paddy	Straw	Paddy	Straw	Paddy	Straw	Paddy	Straw
Sali, high	12.09	20.99	24.66	47.44	12.57	26.45	98.42	63.40
Sali, medium	16.82	31.16	27.17	54.81	10.35	23.64	81.04	62.86
Sali, low	22.18	43.19	27.64	55.99	5.46	12.80	42.75	47.20
Suna, high	9.58	15.24	22.20	38.35	12.64	23.10	98.97	53.82
Suna, low	11.26	18.03	22.20	38.35	10.94	20.32	85.66	49.66
Average	14.39	25.72	24.77	46.99	10.39	21.26	81.35	55.38

Note:

(Value per maund in rupees).

Paddy 7.83

Straw—a) For post-canal yield 2.00

b) Extra for pre-canal yield 0.50

^a The yield data are based on the Gazette Notification of 29 February 1940, of the Bengal government.

irrigation is a reality from storage reservoirs, such fluctuations have disappeared. The average annual yield may then be expected to conform closely to the highest figures so far recorded for yield under irrigated conditions, i.e. over 35 mds per acre.

- (v) The straw yield shows wide fluctuations from year to year, as may be seen from table 17.

TABLE 17. STRAW YIELD PER ACRE (In maunds)

Item	Irrigated	Unirrigated	Difference
As per Notification of 29 February 1940	46.99	25.72	21.27
Damodar canal area:			
Average for 9 years ending 1949-50	73.75	43.48	30.27
Eden canal area:			
Average for four years ending 1948-49	59.58	31.35	28.23
Damodar and Eden canal areas:			
Average for four years ending 1948-49	70.18	36.38	33.80

Estimated gross value of four classified crops

KHARIF CROPS

On the basis of output and price data, the gross value of the additional production to be expected from kharif irrigation has been estimated in table 18.

The extra yield of paddy has been taken at 10 mds per acre; the extra yield of straw has been taken at 15.00 mds per acre, the price of paddy has been taken at Rs 8.5 per md, and the price of straw at Rs 1/- per md. Even using these very conservative assumptions of yield per acre, the gross value of additional kharif crops will amount to Rs 7.53 crores per year, or about 25% of the total capital outlay on the irrigation barrage and canals inclusive of the shares of the dams.

TABLE 18. ESTIMATED GROSS VALUE OF ADDITIONAL OUTPUT OF KHARIF CROPS

Crop	Per acre Rs	For entire additional irrigable area, i.e. 753,000 acres (in 100,000 rupees)
A. Extra yield (field value)		
Paddy at 10 mds per acre		
Straw at 15 mds per acre		
Price		
Paddy at Rs 8.5 per mound, i.e. average government procurement price	85.00	640.05
Straw at 1 rupee per mound of extra yield	15.00	112.95
B. Extra yield as under 'A' above (market value)		
Price		
Rice at Rs 24/4/- per mound i.e. controlled price supplied by the Government through Emergency Ration Shop in Calcutta	242.50	1,826.03
Straw as under 'A' above	15.00	112.95

The actual benefit to the national economy will be much greater, as is clear from the data given in table 19. A 50% higher yield, both for paddy and straw, is quite likely in view of the latest experience in the Damodar and Eden canal areas.

RABI CROPS

The lower Damodar valley is now mostly a single-cropped area devoted overwhelmingly to rice culture in the kharif season. A second crop is raised in the winter months from only 5 to 6% of the cultivated land. Yet the lower valley, with its thick, fertile topsoil and proximity to large urban markets is ideally suited to extensive rabi cultivation. In view of its favourable humid conditions even during the dry months of the year, all that is needed for growing a second crop is an external supply of 9 to 12 in of water. The absence of this critical amount of water is by far the most

important single factor responsible for the present low intensity of cropping in this area.

The existing Damodar canal system cannot provide any irrigation in the dry season, as it is not backed by any storage reservoir. The only source of water supply available to the cultivators is the irrigation tanks, most of which have, however, silted up and are now in bad shape. It is therefore natural that, in spite of the incentive provided by soaring agricultural prices, double cropping is restricted to a small fraction of the total cultivated area.

The duty for rabi irrigation, exclusive of rainfall, has been estimated at 200 acres per cusec. The regulated release from Tilaiya, Konar, Maithon and Panchet will give a continuous flow of about 1,100 cusecs during the entire dry period from November to May. Although this release would be enough to irrigate an area of something like 220,000 acres, it has been assumed for the present that only one-half of this irrigation potential will be utilized or, say, an additional area of 100,000 acres actually sown with rabi crops, even after full development has been achieved under the first phase of the programme.

Of the 100,000 acres to be under rabi crops, portions will be under winter cereals, sugarcane, oilseeds, vegetables and potatoes and winter pulses, which are valuable cash crops. The yield rate and average price, according to very conservative estimates, are given in table 19.

TABLE 19. YIELD RATE AND AVERAGE REVENUE FROM THE CULTIVATION OF WINTER CROPS

Crop	Expected percentage of total area under rabi crops	Yield rate in maunds per acre	Price per maund in Rs	Revenue in 1,000 Rs
Winter cereals	35	15	12.0	18,900
Sugarcane	10	800	1.5	36,000
Oilseeds	10	12	16.0	5,760
Vegetables and potatoes	25	150	7.0	78,750
Winter pulses	20	15	10.0	9,000

On this basis, the average gross income from rabi cultivation will amount to Rs 495 per acre, or Rs 4.95 crores per year from the total additional area of 100,000 acres to be brought under rabi crops.

Table 20 shows the estimated output per acre of the principal rabi crops that can be grown under irrigated conditions, together with their respective values (in wholesale prices prevailing in May 1959). Sugarcane, which takes two full seasons to mature, has also been included in the list. As will be noticed from this table, the gross income per acre exceeds Rs 350 in the cases of potatoes, sweet potatoes, onions, vegetables and sugarcane (gur equivalent).³ The income from such rabi crops varies between 2.0 to 4.6 times. In the case of vegetables, this income is more than 10 times the average value.

³ Raw sugar.

OTHER CROPS

In estimating the additional output and value of crops, it has been assumed that the entire irrigated area, both in the kharif and rabi seasons, would be devoted to the production of cereals, pulses, sugarcane, oilseeds, vegetables and potatoes. It is of particular interest to know what contribution the Damodar scheme could make to meet the present shortage of these foodstuffs, especially of cereal. There is, however, no reason why part of the irrigated area should not be diverted to the cultivation of non-food crops, such as cotton, tobacco and, above all, jute. Relative profitability should normally be the principal consideration in determining the acreages to be devoted to different crops.

According to the estimate of the Agricultural Department of the West Bengal government, 100,000 acres could easily be brought under jute cultivation, out of a total of 9.73 lakhs acres to be irrigated under the Damodar scheme, as against only 19,000 acres now under jute. This estimate of 100,000 acres includes the "aman" area that can be double-cropped with jute. An average yield of 3 bales or 15 mds per acre or an additional yield of 1,215,000 mds in all, may be reasonably expected. If we reckon with an average long-term price of raw jute of Rs 30 per maund, the gross value of the yield will amount to Rs 450 per acre, or to Rs 3.6 crores per year for the additional jute acreage.

TABLE 20. OUTPUT AND VALUE OF HIGHLAND RABI CROPS PER ACRE

Crop	Estimated output (in mds.)	Average price			Gross value of output		
		Rs	as	p	Rs	as	p
Wheat	15	15	9	6	234	3	6
Lentils	12	13	6	4	160	12	0
Khesari	15	10	0	9	150	11	3
Gram	15	12	8	9	188	3	3
Mung	9	12	10	4	113	13	0
Mustard	9	30	9	7	275	6	3
Til	6	26	3	2	157	3	0
Linseed	9	17	2	0	154	2	0
Potatoes	120	13	0	9	1,565	10	0
Sweet potatoes	150	5	9	7	839	13	6
Onions	100	6	5	0	631	5	0
Vegetables, including country types	300	8	11	0	3,506	4	0
Sugarcane	800	—	—	—	—	—	—
Gur equivalent	60	21	14	0	1,312	8	0

Note: Prices refer to those published in the wholesale price bulletin, Calcutta for August 1954, by the Directorate of Agriculture, government of West Bengal.

LONG-TERM BENEFITS

In the above analysis, no basic change in the existing pattern of agriculture has been assumed. Attention has been focussed on those essentially short-term benefits which are expected to be derived more or less automatically from the provision of irrigation facilities. Yet, taking a longer view, the wealth-creating potentialities of the lower Damodar valley area are far greater than what has been indicated above.

It has long been recognized by many leading agriculturalists that the lower Damodar area has some of the richest soils in the world. It is believed that there is no reason why a three-crop-year programme, after the pattern of Egyptian agriculture, should not ultimately be feasible in the lower Damodar valley. It has sometimes been argued that the cultivator will not make more than a partial use of the irrigation facilities to grow a second crop because of his inertia, or indifference to "profit motive", or both. Such pessimism is, however, hardly warranted by facts.

It should not be overlooked that in one important respect DVC's approach to the irrigation problem will differ from past practice in India. DVC cannot afford to be content merely with supplying water, but will have to expand its activities in every possible way for the special reason that, as a business undertaking, it must look to its own profit and loss account, and, as a public corporation, it has a specific statutory responsibility for promoting social and economic welfare in the area. If, for example, DVC finds that the cultivator is not making adequate use of the available water to grow a second or third crop, even though such a crop is definitely an economic proposition, it will have to examine the causes closely and devise suitable remedies, such as low promotional rates for water in the early stages, test demonstrations through selected enterprising farmers, coupled with such inducements as the provision of free or subsidized seeds, manures, fish fry, and even water. With such concentrated efforts, the intensity of cropping in the area could be raised steadily. In, say, ten years' time from the introduction of perennial irrigation, it might be possible to convert the entire irrigable area into a two-crop area.

Moreover, the DVC's agricultural programme includes proper drainage, soil improvement and conservation, better manuring, better seeds and better strains, scientific crop rotation and improved agronomic practices. Irrigation, when accompanied by such measures, automatically increases the output of rice and other crops per acre. A 100% increase in production per acre, both for kharif and rabi crops, over the present levels is by no means illusory. It is well known that China grows twice, and Japan three times, as much rice per unit of land as India. Given the unusually favourable climatic factors and the high fertility of the soil, there is no reason why the lower valley should not be able to produce more rice per acre of irrigated land than elsewhere. Similarly, it should be possible to double the average yield of rabi crops per acre and considerably improve their quality. Lastly, a third crop in the Damodar delta is a distinct possibility in the not too distant future, and, as in the lower Nile valley, it should gradually become a permanent feature of agriculture in this area.

So far as marketing agricultural produce is concerned, hardly any other area in India is more favourably situated than the lower Damodar valley. The large and expanding market of Calcutta and industrial areas lies almost next door, while the coalfields of West Bengal and Bihar, as well as other urban centres in and around the valley,

including Jamshedpur, should draw their supplies largely from this area. The problem of feeding these centres, and especially the ever-increasing mass of people in Calcutta, is becoming increasingly difficult, and has placed considerable strain on the transport system. Nothing could be more logical in the circumstances than to develop the agriculture of the perennially irrigated lower Damodar region, primarily to meet the food requirements of these urban areas. This, however, calls for a diversified pattern of agriculture in place of the present monoculture of rice, in order to meet the urban demand for milk, eggs, fish, meat, potatoes and other vegetables, and fruit, which will yield a much higher income than the cultivation of food-grains. If properly replanned, increased yields of rice per acre should go hand in hand with a diminishing acreage under rice and an increasing acreage under vegetables, fruit, fodder, substantial provision for potatoes, sweet potatoes, and other heavy-yielding vegetables.

However fertile the soil in the lower valley may be, indefinite perennial cropping would impoverish it, unless steps are taken to build up and maintain its fertility. Proper crop rotation with leguminous crops whenever feasible can, in large measure, meet the need for nitrogen. Better utilization of farmyard manure, with proper composting of all vegetable matter, can also go a long way to replenish the nitrogen content. Even then, however, special care will have to be taken not to deplete the soil minerals. As in other countries, phosphate and potash, and even lime, will almost certainly become the critical minerals. Sooner or later, they will have to be applied in judicious amounts, so as to maintain a proper mineral balance in the soil and thereby its long-term productivity.

The upper valley

In the upper valley, two small irrigation schemes have been constructed. The average rainfall in this upper region is about 50 in, but 40 in occur between July and September. The annual runoff is approximately 20 in. It is in this area that, in an average rainfall year, less than 50% of the runoff can be stored in the major reservoirs, including those yet to be constructed. There is a demand for new agricultural land. Furthermore, it is maintained that the present gullied lands can be reclaimed at lower cost than the purchase price of existing agricultural lands.

There are probably as many as 30 good damsites commanding existing cultivable or reclaimable land. Of the one million acres of waste land, 250,000 acres are considered cultivable and can be supplied with irrigation water.

Two projects have so far been completed, namely, the Charwa and Gonda irrigation schemes (see figure 16). The Charwa project supplies water primarily to the town of Hazaribagh, whose population is 40,000. In addition, the project provides irrigation water to about 1,000 acres of paddy land. A photograph of the Charwa dam is shown in figure 17. The Charwa reservoir has a gross capacity of 4,750 acre feet; 2,000 acre feet are reserved

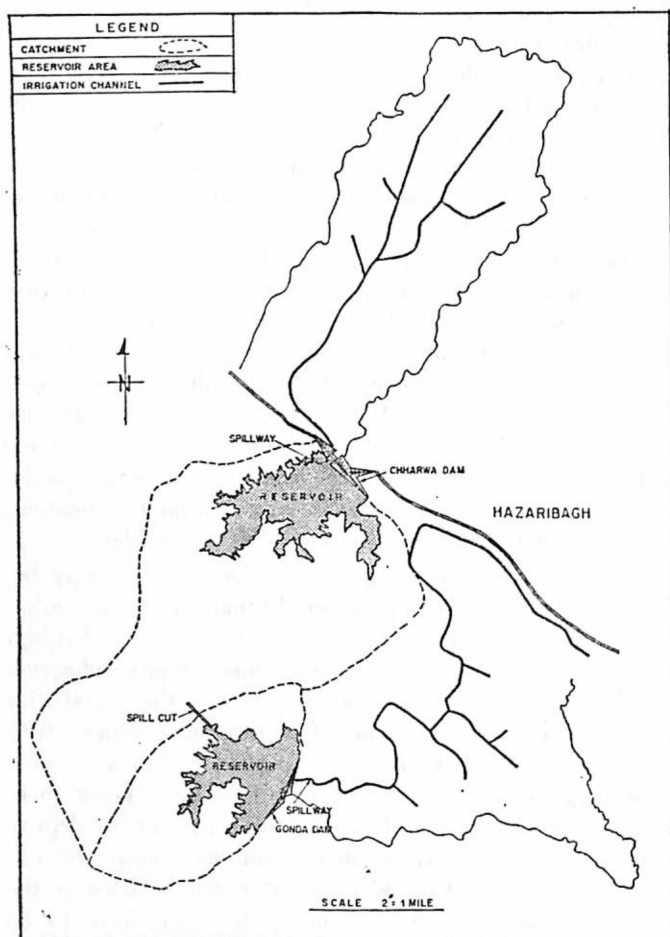


Figure 16. CHARWA AND GONDA IRRIGATION SCHEMES, BIHAR UPPER VALLEY.

for water supply to Hazaribagh, 1,700 acre feet, in an average year, for irrigation, and the remaining 1,000 acre feet are maintained as dead storage and for losses.

The design and construction of the dam is along conventional lines. The maximum height of the dam is 47 ft; on the earth section a crest width of 14 ft with side slopes of $2\frac{1}{2}$ to 1 is maintained. The total length of the dam is 2,633 ft. The upstream side is rip-rapped, while the downstream slope is turfed with star grass. An impervious core cutoff within the foundation, and a homogeneous fill and filter to drain away the seepage are the main structural features.

The main channel is 9,500 ft in length, conveying 12 cusecs of water to the distributary system. The entire channel system totals 33,000 ft, and includes 30 drops.

In this particular scheme, the "water supply" feature to Hazaribagh enabled the "dam structure" to be feasible and reduced the average cost of the irrigation project from Rs 200 to Rs 111 per acre.

The Gonda irrigation project is adjacent to the Charwa project, although situated in a separate watershed.

The dam structure is 40 ft in height and consists of a homogeneous fill; it has a 12 ft crest width. The upstream side is rip-rapped, the lower side has been turfed and contains a filter drain. The catchment area was formerly one of the worst eroded areas in the entire upper valley.

By virtue of a low saddle between the Charwa and Gonda projects, the two schemes are partially integrated, in that Gonda reservoir at times spills into the Charwa

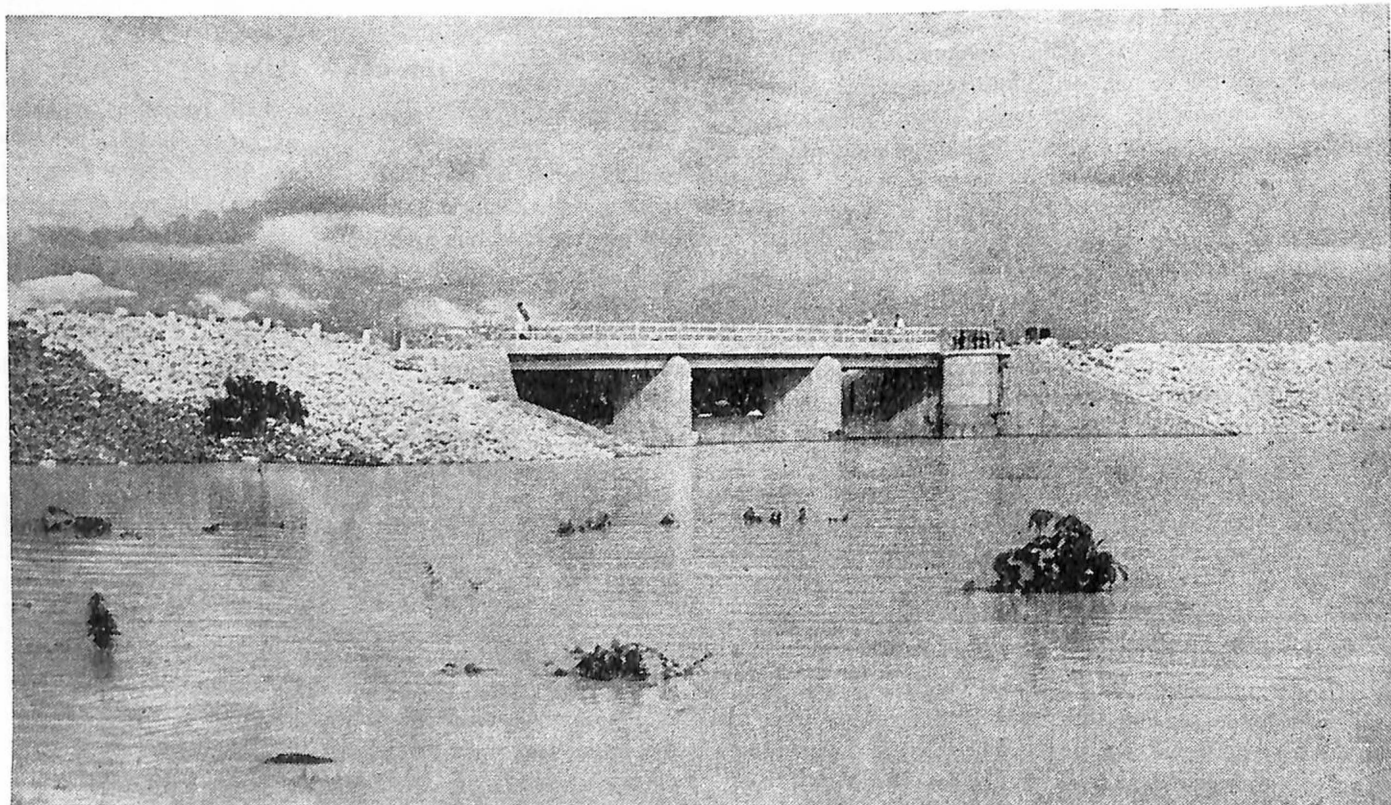


Figure 17. PHOTOGRAPH OF THE CHARWA DAM.

catchment areas thereby affording maximum utilization of water in both schemes.

The Gonda project canal system is 43,400 ft in length, and contains 19 drops which irrigate 1,300 acres.

A third irrigation scheme, the Jamunia project, was placed in service in late 1957. This is an earth-filled dam with a masonry spillway on the Jamunia river situated about one mile south of the town of Bishungarh, which is in the vicinity of Hazaribagh. The project commands 2,400 acres of kharif and 1,200 acres of rabi crops.

The direct benefits from these projects include the irrigation of 4,700 acres of paddy land and 1,200 acres of rabi crops as well as a water supply of 1.5 million gallons to the town of Hazaribagh. This is a case

where the indirect benefits are greater than the direct benefits, in that 6.6 sq mi of once badly eroded lands have been stocked with fish, they serve as a refuge for game fowl and the ground water level has been raised.

The two schemes demonstrate:

- (i) The multiple aspects of the utilization of head-water schemes;
- (ii) The need for careful planning and execution to ensure maximum utilization of the soil and water available; and
- (iii) The balancing of different financial aspects which vary from scheme to scheme to form an integrated economic project.

NAVIGATION

Another statutory function of DVC is the promotion and control of navigation on the Damodar river and its tributaries.

At the outset no provision was made for navigation facilities, which were then considered not to be economically feasible. Nevertheless, various schemes were studied, but none passed beyond the planning stage and no funds were earmarked in the Voorduin estimate for multiple-purpose river development. However, it was recognized that, in the event of heavy industrialization in the valley, the scheme would be economically feasible. It was also recognized that the financial position of any irrigation undertaking in the lower valley would unquestionably be improved if a reasonable allocation of the "barrage and canal" construction charges could be assigned to navigation features. Ultimately it was concluded that the development of a water transport system would further stimulate industrial expansion within the valley, and that to further delay the undertaking would only increase the cost of the land required and call for the remodeling of the canal features, regulators and clearance to the bridges that had originally been designed to serve as an irrigation facility.

The navigation-cum-irrigation canal is to be completed and opened commercial service some time in 1962.

The anticipated annual volume of cargo to be handled over this waterway has been estimated at 2 million tons. A breakdown by commodity classification of the cargo to be transported is given in table 21.

The anticipated revenue from tolls collected annually is estimated at Rs 30 lakhs.

The constructed waterway commences at Durgapur lock and continues eastward for a distance of 85 mi where it connects with the Hooghly river near Calcutta.

The canal system is 172 ft in width at the headworks, and tapers off to 60 ft at the tail. There

is a minimum water level of 8 feet to accommodate barges with a draught of not more than 6 ft. A photograph of the navigation-irrigation canal is shown in figure 18.

TABLE 21. TOTAL ANNUAL ANTICIPATED VOLUME OF CARGO ON THE NAVIGATION CANAL
(In thousand tons)

<i>Commodity</i>	<i>Tonnage</i>
Coal	1,000
Construction materials	200
Paddy	500
Colliery stores	50
Industrial products	200
Inter-canal transport	50
Total	2,000

There is a total of 22 locks; each is 286 ft in length and 20 ft in width, with metre gates both in the upstream and downstream ends. There are three general types of locks employed, namely, basin type, chamber type, and combined type.

In the chamber and combined type, the floor of the lock is a reinforced concrete slab, whereas in the basin type only rip rap is used.

At strategic points along the canal, loading and unloading structures, including waste weirs and bathing ghats, have been erected.

The regulator at the head of the canal consists of 8 spans of 20 ft each, with discharge capacity of 9,137 cusecs. The total cost earmarked for the construction of navigation features is about Rs 5 crores (US\$10 million).

There has been some talk of extending the navigation service to a point near the upper basin owing to the large industrial area that could be serviced. The loss of valuable mineral lands enroute have so far deferred the likelihood of such probabilities.



Figure 18. PHOTOGRAPH OF THE NAVIGATION-IRRIGATION CANAL AT DURGAPUR.

Chapter V

THE POWER PROGRAMME

General

The power of water at high elevation is charged with energy. As it relinquishes its obligation to the force of gravity useful work is extracted. From time immemorial man has made use of water to lighten his burdens and the advent of electric water power is but a new and convenient transformation of the same age-old resource.

Water power unlike fossil fuels is inexhaustible. Rivers passing out to sea are returned as vapour to the clouds and again released to earth, a completed cycle.

A 1943 estimate of the total installed electric generating capacity in the Damodar valley was 137,098 kW. Table 22 gives a breakdown of the source of power and energy generated.

TABLE 22. TOTAL INSTALLED GENERATING CAPACITY, DAMODAR VALLEY (1943)

Classification	Number	Installed capacity (kW)	Energy generated (million kWh)
Electric public utilities	5	40,308	108,754
Railway power plants	9	2,080	4,113
Colliery power plants	32	43,235	65,304
Other power plants	6	51,475	105,989
Total		137,098	284,160

In addition to the installed generating capacity in the Damodar valley, there was in operation in 1943 a total installed capacity of 515,000 kW within transmission distance of the valley. By and large, these installations were owned and operated by mining, industrial and railway corporations.

It is believed that the average cost of generation by the electric public utilities in the Damodar valley was of the order of 0.62 annas per kWh, or slightly above 8 mills per kWh, United States currency.

In view of load expansion, obsolescence of existing plants and suspension of construction during the Second World War, the planned addition of new generating capacity prior to 1950 about 327,000 kW, of which around 200,000 kW were scheduled for the Calcutta area. At that time it was envisioned that, by 1960, an additional 325,000 kW would be needed in the Damodar region, the bulk to be installed in and around Calcutta.

The architects of the Damodar valley scheme evaluated the water power resources of the basin and concluded that it would be feasible to provide power facilities at 8 damsites, for an aggregate installed capacity of 200,000 kW.

These estimates were based solely on the hydrologic data maintained at the one gauging station near Rhondia for an area of 7,690 sq mi. Had more gauging stations been strategically located in the upper basin years earlier, prime power capacities could have been determined with greater accuracy and the estimate would have undoubtedly been appreciably higher.

It was finally concluded that 80% of the annual rainfall occurred during the 4 to 5 monsoon months, and that the prime capacity of the hydro plants could not safely be assessed at more than 65,000 kW. Fortunately, the main coalfields were located in the upper basin, and it was therefore logical to erect a thermal plant with an initial capacity of about 150,000 kW. The plant would function as a base load station while the hydropower facilities would operate only during the peak demand hours, which seemed to be an economical solution in planning.

The cost of power, in the view of the power planners, would be considerably lower by combining the hydroelectric system with the thermal system, particularly if the thermal plant were located at the coal mine. Then too, lower rates would result if the thermal plant supplied the base load requirements during the dry season, leaving the hydro plant to service only the peak load hours. During the monsoon season, when water was plentiful, the plan of operation could be reversed, thereby conserving fuel.

It was eventually decided to install a total capacity of 350,000 kW, 200,000 kW of hydro and 150,000 kW of thermal. The system peak demand was estimated at 300,000 kW. A reserve margin of 50,000 kW was considered adequate for emergencies and overhaul of units; normal steam spinning reserve could therefore be eliminated.

Except for the transmission plant, which is discussed in a later section, the following description covers the general strategy prescribed in the Voorduin memorandum.

The power supply situation ten years later

The Damodar hydroelectric facilities, at the end of 1959, had made progress although they fell far short of earlier ambitions because only four dams had been constructed for a total capacity of 104,000 kW.

At one of the meetings held by the three participating governments during August 1945, top priority was given to investigate the damsite at Maithon, for immediate development. A month later, after much deliberations the governments concluded it was not possible to complete arrangements for the design and construction of the

Maithon project within the dry season of 1946. As an alternate, it was decided the Tilaiya dam should be promptly investigated and in advance of all other projects. More delay however was experienced because it was decided to change Tilaiya's design of construction from a "sandfill" to a "masonry dam", another obstacle, the enactment of DVC legislation was being prolonged. At the same time little interest among the contractors was shown to bid the Tilaiya project. As a result, construction was delayed until January 1950. Then there followed labour strikes, foundation difficulties arose, a change for the third time was made in the dam design, this time from a "masonry" to a "concrete" structure. In March, an unprecedented and unseasonal flood occurred. Not until February 1953 was the Tilaiya dam finally completed. Much criticism was levelled at the DVC officials for the delay, which had increased the cost appreciably. The general criticism being that had a Chief Engineer been appointed earlier, authoritative advice would have been available for the Corporation to have decided on a solution to a major problem.

TABLE 23. CONSTRUCTION DETAILS AND COST FEATURES OF THE TILAIYA PROJECT

Date of commencement	January 1950
Date of completion —	
Dam	
Power	February 1953
Catchment area	380 sq mi (984 km ²)
Dam:	
Type	Concrete
Length	1,200 ft (366 m)
Height above the —	
(a) Lowest riverbed	99 ft (30 m)
(b) Lowest level of foundation ...	148 ft (45 m)
Volume of dam	142,000 cu yd (109,000 m ³)
Estimated life	149 years
Reservoir:	
Highest flood level (above MSL) ..	1,230 ft (375 m)
Area (to top of gates level 1,222 ft (372 m)	22.8 sq mi (59.05 km ²)
	Lakh acre ft or Million m ³
Storage capacity in	
(i) To maximum flood level	4.51 556
(ii) To top of gates level	3.20 395
(iii) To normal storage level	3.20 395
Reservoir level at 6 a.m. on 23 August 1960	EL. 1,201.50 ft (366.83m)
Powerhouse:	
(a) Installed capacity	4 MW
(b) Generation:	
1956-57	1.63 million kWh
1957-58	8.361 "
1958-59	12.29 "
1959-60	27.13 "
(d) Expected generation	23 million kWh per annum
Total expenditure incurred up to January 1960 ^a	
(a) Dam	Rs 3.16 crores
(b) Hydroelectricity	Rs 0.53 "
Estimated cost:	
(a) Dam	Rs 3.18 crores
(b) Hydroelectricity	Rs 0.53 "

^a Excluding overhead and general charges.

The Tilaiya project

The Tilaiya project has an installed capacity of 4,000 kW comprising two units with space provided for the third generator. It has a firm capacity rating of 3,000 kW, with an average annual power output of 21 million kWh. The dam which is on the Barakar river is of gravity section design and is about 12 mi from Kodarma, the nearest railway station. The catchment area above the dam is about 380 sq mi. Mean annual rainfall averages 49.65 inches. Construction details of the project and cost features are given in table 23. A photograph of the dam structure and powerhouse is shown in figure 19. Operating charges are given in table 24.

TABLE 24. ESTIMATED ANNUAL OPERATION CHARGES — TILAIYA HYDRO STATION
(Saleable energy—21 million kWh per annum)
(In 100,000 rupees)

Item	Engineering Cost (1)	Overhead and audit (2)	Total (1+2)
I. Capital outlay			
(a) Land (97 + 12) 109	371	47	418
(b) Dam and appurtenant works (221 + 28) 249			
(c) Hydro installation (53 + 7) 60			
II. Capital outlay for power			
(a) Land (33%) 36	32	4	
(b) Dam and appurtenant works (33%) 82	73	9	
(c) Hydro installation .. 60	53	7	
	158	20	178
III. Annual charges			
Depreciation			
(i) .116% of 82	0.10		
(ii) 1.35% of 60	0.81		
	0.91		0.91
Operation and maintenance			
(i) .8% of 105	0.84		
(ii) 1.5% of 53	0.80		1.64
	1.64		
Interest on capital @ 4% of 178	7.12		7.12
			Total annual charge 9.67

The Konar project

The Konar dam is located on the Konar river about 19 mi from its confluence with the Damodar in the district of Hazaribagh, state of Bihar. This was the second of the four dams that were completed during the first phase of development.

According to the original Voorduin plan, the Konar scheme was to consist of three separate damsites. The present Konar dam is located at site No. 1 of the original plan. It is a composite structure, with concrete spillway and an extensive earth-fill on each end.

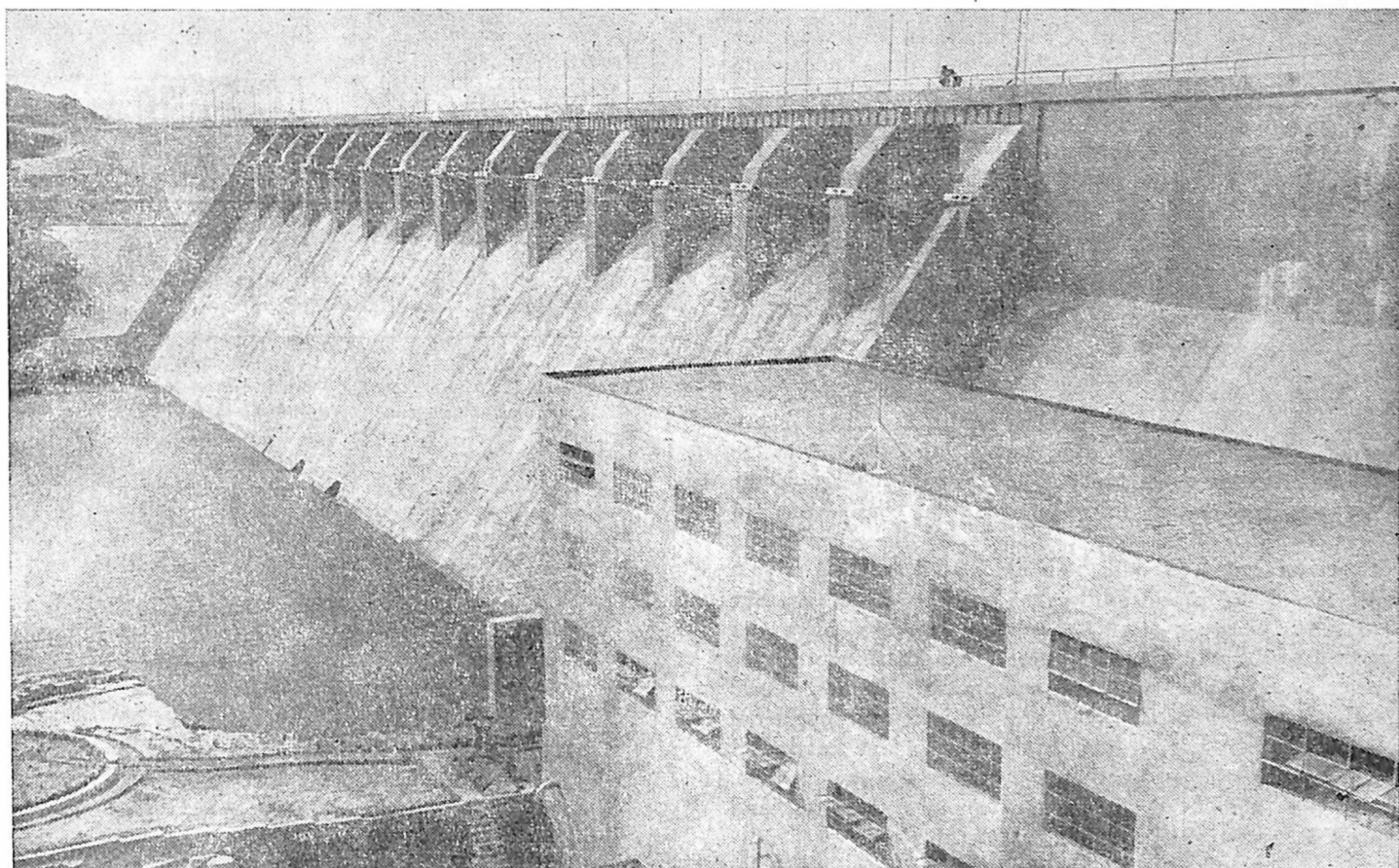


Figure 19. PHOTOGRAPH OF TILAIYA DAM AND POWERHOUSE.

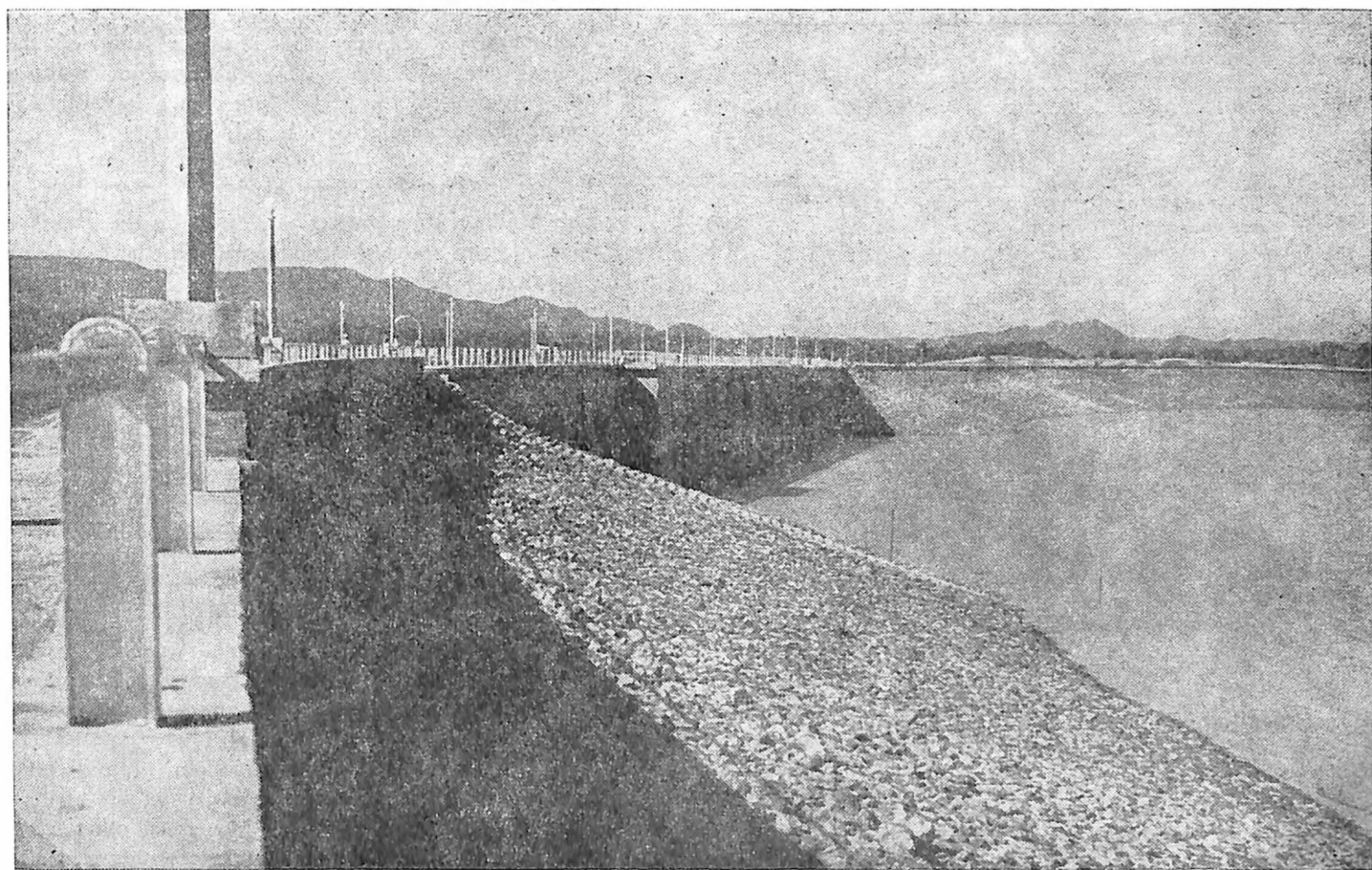


Figure 20. PHOTOGRAPH OF UPSTREAM VIEW OF KONAR DAM.

TABLE 27. CONSTRUCTION FEATURES AND BASIC COST DATA OF THE MAITHON PROJECT

Date of commencement:	December 1951
Date of completion:	December 1958
(a) Dam	July 1956
(b) Power station — 1st Unit	October 1957
2nd Unit	May 1958
3rd Unit	December 1958
Catchment area:	2,430 sq mi (6,294 km ²)
Dam:	
Type	Earth dam with concrete spillway
Length (over-all)	15,712 ft (4,789 m)
Height above the:	
(a) Lowest riverbed	162 ft (49 m)
(b) Lowest level of foundation	184 ft (56 m)
Volume of dam:	
(a) Concrete	319,000 cu yd (244,000 m ³)
(b) Earth	5,140,000 cu yd (3,930,000 m ³)
Estimated life	246 years
Reservoir:	
Highest flood level (above MSL)	504 ft (154 m)
Area (to top of gates level 500 ft or 152 m)	41.4 sq mi (107.2 km ²)
Storage capacity:	
(a) To highest flood level	12.00 lakh acre ft (1,480 million m ³)
(b) To top of gates level	11.04 " " " (1,362 " ")
(c) To normal storage level	6.64 " " " (818 " ")
Reservoir level at 6 a.m. on 23 August 1960	EL. 473.04 ft (144.41 m)
Spillway:	
(a) Number of gates	12
(h) Size of gates	41 ft × 40 ft (12.5 m × 12.2 m)
Power (hydroelectric)	
(a) Installed capacity	60 MW
(b) Generation 1957-58	8.656 million kWh
1958-59	97.71 " "
1959-60	217.41 " "
Total expenditure incurred up to March 1960^a	
(a) Dam	Rs 13.25 crores
(b) Hydroelectricity	Rs 4.05 "
Estimated cost	
(a) Dam	Rs 13.34 crores
(b) Hydroelectricity	Rs 4.59 "

^a Excluding overhead and general charges.

underground at a depth of 184 ft. The station itself contains three 20,000 kW units producing 136 million kWh, annually in an average water year.

The project was inaugurated on 27 September 1957. A photograph of the downstream side of the Maithon spillway is shown in figure 21. Basic construction data of the project are shown in table 27. Table 28 shows the estimated annual operating charges of the hydroelectric station.

The Panchet Hill project

The Panchet Hill was the first dam to be constructed on the Damodar river. It is located about 3.5 mi above the confluence of the Barakar river, and was the fourth dam to be constructed during the first phase of the development programme. The average annual rainfall is nearly 45 in; the drainage area is 4,234 sq mi.

The primary functions of the project are to provide flood protection to the lower valley, electric generation to the interconnected system, irrigation water to the lower valley agricultural area, and ensuring industrial and

municipal water supply to facilities situated downstream from the dam structure.

Like the Maithon structure, the Panchet dam is ideally located, geographically, to hold back the heavy runoff normally occurring in the lower reaches of the upper basin. Another advantage is that all lands in the basin above the pre-flood level are submerged only during the later part of the year, so that a large fringed area is well suited for rice growing.

The loss of power and irrigation storage due to flood control operations at Maithon and Panchet dams is offset to some extent by the power and irrigation storage capacity that is available at the beginning of the dry season from the Konar and Tilaiya reservoirs.

The design of the Panchet Hill dam is similar to that of the Konar and Maithon structure. It is a composite concrete gravity type spillway, with extensive earth embankments on the right and left ends of the spillway; in addition, two saddle dikes were necessary at the extreme ends of each earth embankment.

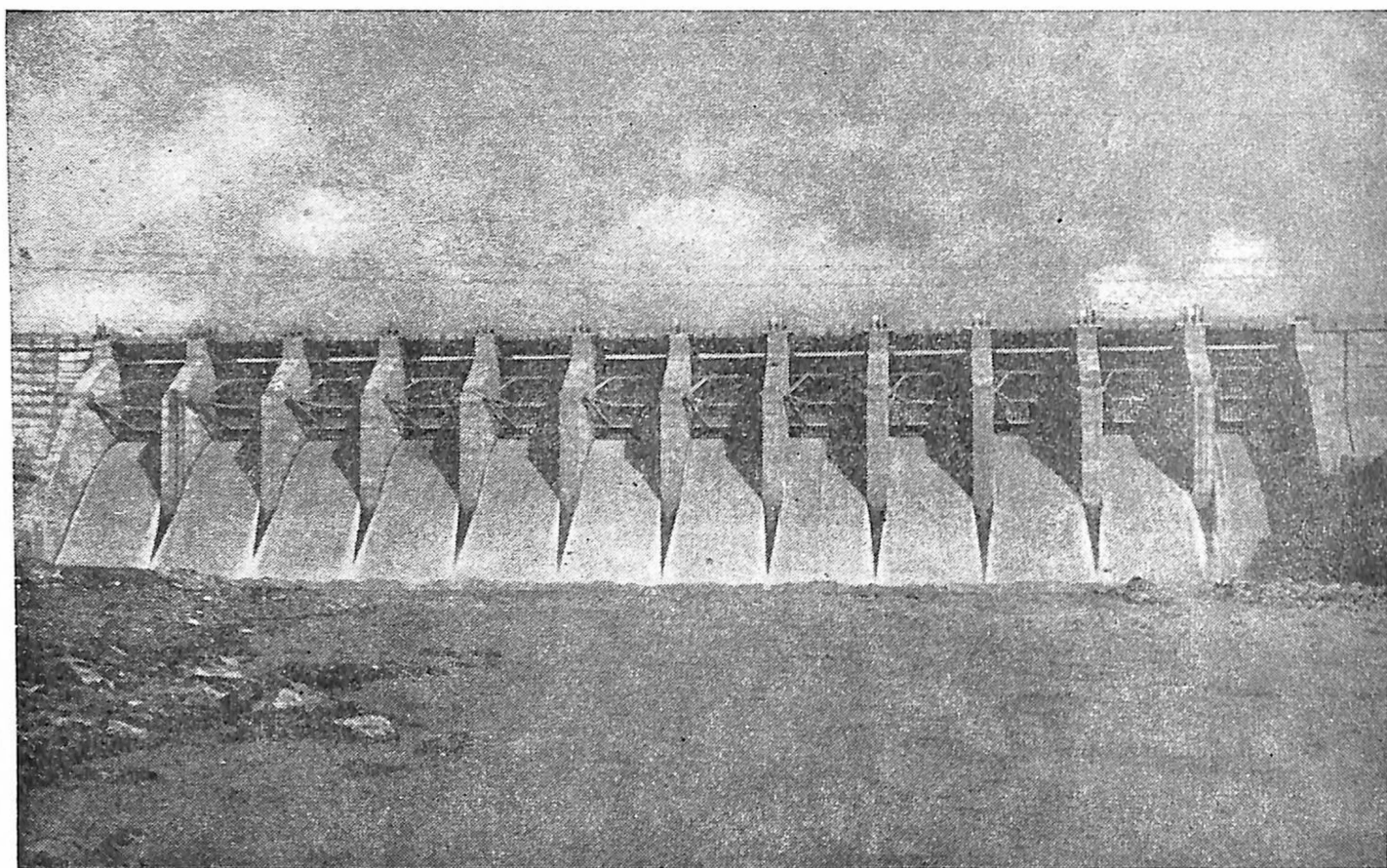


Figure 21. PHOTOGRAPH OF DOWNSTREAM VIEW OF MAITHON DAM.

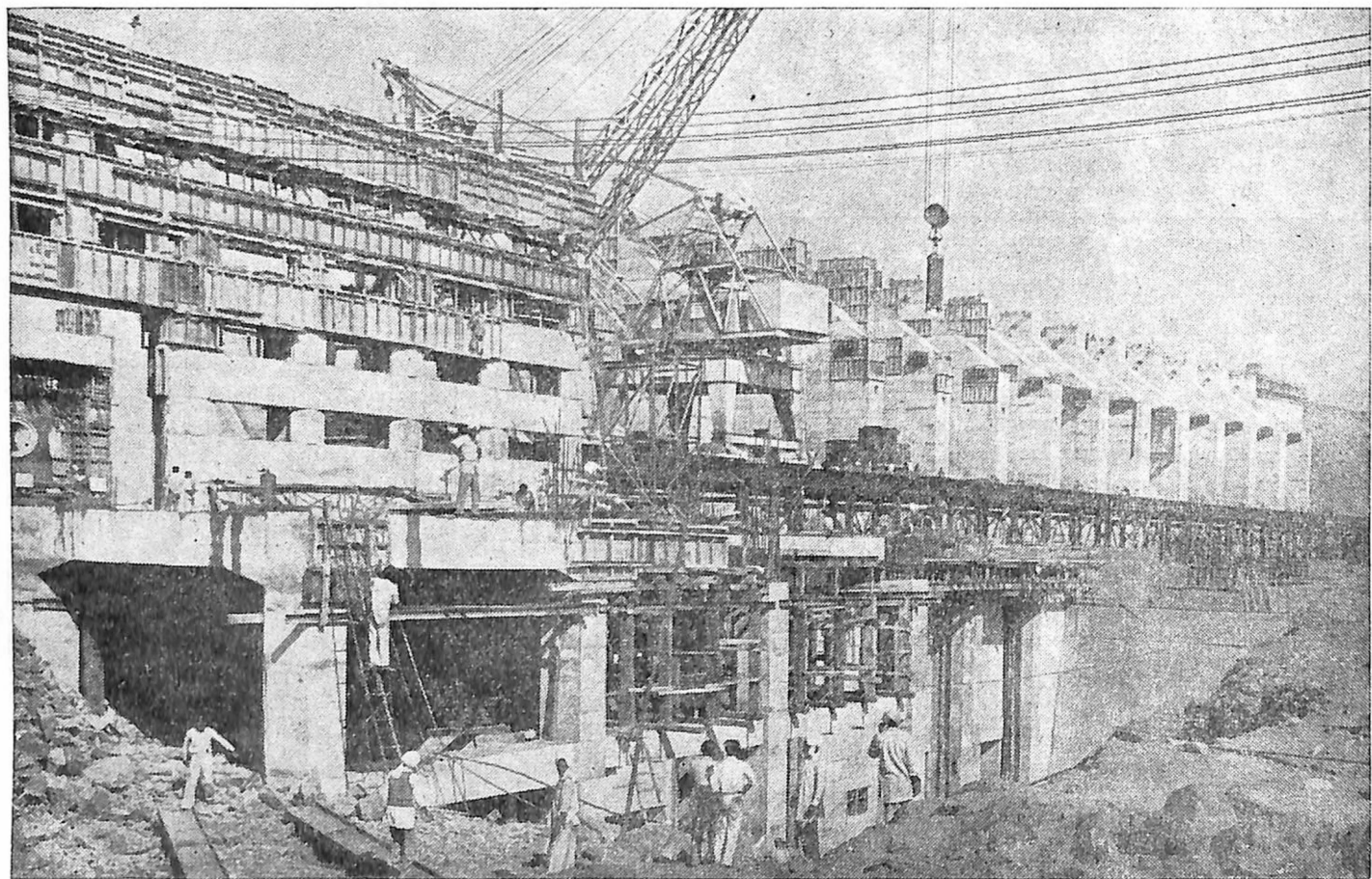


Figure 22. PHOTOGRAPH OF PANCHET HILL DAM AND POWERHOUSE DURING CONSTRUCTION.

TABLE 28. ESTIMATED ANNUAL OPERATING CHARGES OF MAITHON HYDROELECTRIC STATION

(Salesable energy per annum—148 million kWh)
(In 100,000 rupees)

I. Capital outlay				
(a) Land	265 + 34	299		
(b) Dam and appurtenant work	1,069 + 136	1,205		
(c) Hydro installation	459 + 59	518	2,022.0	
II. Capital cost for power				
(a) Land (34%)	90 + 12	102		
(b) Dam and appurtenant works (34%)	363 + 46	409		
(c) Hydro installation	459 + 59	518	1,029.0	
III. Annual charges				
<i>Depreciation</i>				
(i) 0.116% of 409		0.47		
(ii) 1.35% of 518		6.99	7.46	
<i>Operation and maintenance</i>				
(i) 0.8% of 453		3.62		
(ii) 1.5% of 459		6.89	10.51	
Total working expense			17.97	
Interest @ 4¼% on (II) ..			43.73	
Total annual charge			61.70	

Unlike the Maithon geological formation, the bed-rock at Panchet is highly laminated, and has several faults and intrusions. Special foundation treatment has been necessary in the faulty areas, both on the powerhouse and damsite structures.

The powerhouse is a conventional type above-ground-structure, with a vertical draft tube of standard type, and is located downstream of the intake blocks on the right bank of the spillway channel. A natural depression of the rock formation in the area determined the location of the powerhouse and minimized the cost of excavating and concreting.

The powerhouse at present contains one 40,000 kW "Kaplan" unit with space for a future second unit of identical capacity. It is hoped that the normal load growth of the interconnected power system will require substantial peaking capacity; the second Panchet unit offers the most economical solution to this operation. Another advantage during the monsoon season is that both Panchet units will operate at full rated capacity, while the Bokaro thermal station will provide peaking service, hence conserving both fuel and operating expenses.

TABLE 29. CONSTRUCTION FEATURES AND BASIC COST DATA OF THE PANCHET HILL PROJECT

Date of commencement ..	November 1952
Scheduled date of completion:	
(a) Dam	September 1959
(b) Powerhouse ..	October, 1959
Catchment area	4,234 sq mi (10,966 km ²)
Dam:	
Type	Earth dam with concrete spillway
Length	22,155 ft (6,753 m)
Height above the:	
(a) Lowest riverbed	134 ft (41 m)
(b) Lowest level of foundation ..	167 ft (51 m)
Volume of dam:	
(a) Concrete	340,000 cu yd (260,000 m ³)
(b) Earth ..	6,930,000 cu yd (5,298,000 m ³)
Estimated life	75 years
Reservoir:	
Highest flood level (above MSL)	449 ft (137 m)
Area (to top of gates level, 445 ft or 136 m) ..	59 sq mi (152.81 km ²)
Storage capacity:	
(a) To highest flood level	.. 13.65 lakh acre ft (1,684 million m ³)
(b) To top of gates level	.. 12.14 " " " (1,497 " ")
(c) To normal storage level	.. 3.33 " " " (411 " ")
Reservoir level at 6 a.m. on 23 August 1960	.. 408.04 ft (124.36 m)
Spillway:	
(a) No. of gates	15
(b) Size of gates	41 ft × 40 ft (12.5 m × 12.2 m)
Power:	
(a) Installed capacity	40 MW
(b) Generation 6 months 1959-60	70.98 million kWh
Total expenditure incurred upto March 1960^a	
(a) Dam	Rs 14.52 crores
(b) Hydroelectricity	Rs 2.19 "
Estimated cost:	
(a) Dam	Rs 15.43 crores
(b) Hydroelectricity	Rs 3.71 "

^a Excluding overhead and general charges.

The project was completed and placed in commercial service in October 1959. A photograph during construction of the downstream side of the Panchet Hill dam and powerhouse is shown in figure 22. The construction features and basic cost data of project are given in table 29. Table 30 summarizes the estimated annual operating charges at the Panchet Hill hydroelectric plant.

TABLE 30. ESTIMATED ANNUAL OPERATING CHARGES—
PANCHET HILL HYDROELECTRIC STATION
(In 100,000 rupees)

I. Capital outlay			
(a) Land	235 + 30	265	
(b) Dam and appurtenant works	1,308 + 167	1,475	
(c) Hydro installation	371 + 47	418	2,158
II. Capital outlay for power			
(a) 28% of land	66 + 8	74	
(b) 28% of dam and appurtenances	366 + 47	413	
(c) Hydroelectric installation ..	371 + 47	418	905
III. Annual charges			
(a) Depreciation			
(i) .116% of 413		0.48	
(ii) 1.35% of 418		5.64	6.12
(b) Operation and maintenance			
(i) 0.8% of 432		3.46	
(ii) 1.5% of 371		5.56	9.02
Total working expenses			15.14
(c) Interest @ 4¼% on (II)			38.46
			53.60

The Bokaro thermal power plant

The important Bokaro thermal power plant is twelve miles downstream from the Konar project dam structure. In 1953, it was the largest single thermal plant of its type ever to be erected in India. It forms a major power producing link in the long-range electrical development plan for the valley and its interconnecting systems.

Throughout the dry months of the year the station operates at full rated capacity, supplying the bulk of the energy requirements for the Damodar grid. During the monsoon season, Bokaro operates on the peaks of the load-curve while hydro facilities provide the base-load requirements.

The Bokaro station now has at total installed capacity of 225,000 kW, its fourth and ultimate unit of 75,000 kW having been placed in service during August 1960.

The cooling water for the station is provided from Konar dam. Cooling or circulating water is diverted into the power station by means of a barrage across the Bokaro river near the thermal plant, with facilities for recirculating the water supply if necessary.

The station was designed to burn low-grade (about 6,000 BTU), high ash content (45%), coal. The fuel from the DVC's coalfield is delivered to the station by a 5.5mi aerial ropeway conveyor. For geological reasons, it was not feasible to erect the thermal station closer to the mine. Coal is conveyed by belt to the coal bunkers

from the stockpile. The bunkers have a storage capacity equivalent to about 3½ days' operation.

The boiler "make-up" water passes from the river through a treatment-coagulation and precipitation plant, from there it is pressure-filtered and given a carbonaceous zeolite softener treatment before entering the boilers.

The six steam generating units (boilers), capable of producing 400,000 lb of steam per hour, operate at 895 psig and a temperature of 910°F superheat. Each steam generator is equipped with 4 burners. Two coal pulverizers are provided per boiler, one feeds 2 lower burners and the other feeds the 2 upper burners. The station has been designed to operate on pulverized coal fuel only. Full automatic regulating equipment is employed throughout the boiler plant. The steam generator for the fourth station unit is rated at 800,000 lb/hr, and has comparable design characteristics.

For each of the turbo-generator units, steam is supplied from two boilers to a 50,000 kW, 85% power factor 58,824 kVA, 3,000 rpm generator. Plant generation is expected to total 820 million kWh annually. Each tandem compound double-flow turbine is directly connected to a 13,800 V hydrogen-cooled generator. The turbine surface-condensing type has 21 stages, and is designed for 850 psig, 900°F steam at the throttle with 5 extraction openings. The turbine exhausts to a 50,000 sq ft single pass cross flow condenser equipped with divided water boxes and a built-in cross-over valve making it possible to clean one half of the condenser tubes while the other half remains in service.

The fourth Bokaro unit is rated at 75,000 kW, and is identical in design to units at the Durgapur thermal plant (see detailed description of Durgapur units).

A night photograph showing the Bokaro thermal power station and barrage appears in figure 23. Table 31 gives additional basic capacity and basic data not appearing in the text. Table 32 gives the estimated annual operating charges of the Bokaro thermal power plant.

TABLE 31. BASIC CAPACITY AND COST DATA OF THE BOKARO THERMAL POWER PROJECT

Date of commencement	January 1950
Date of completion (except for the 4th generating unit)	1953
Date of completion of 4th unit ..	August 1960
Power:	
Installed capacity (4 units) ..	225 MW
Expected generation (4 units)	902 million kWh per annum
Generation — 1955-56	324 million kWh
1956-57	486 — do —
1957-58	887 — do —
1958-59	1,084.90 — do —
1959-60	1,142.80 — do —
Total expenditure incurred up to March 1960 ^a	
(a) 3 units	Rs 14.90 crores
(b) 4th units	Rs 3.66 "
Estimated cost	
(a) 3 units	Rs 14.94 "
(b) 4th unit	Rs 4.46 "

^a Excluding overhead and general charges.

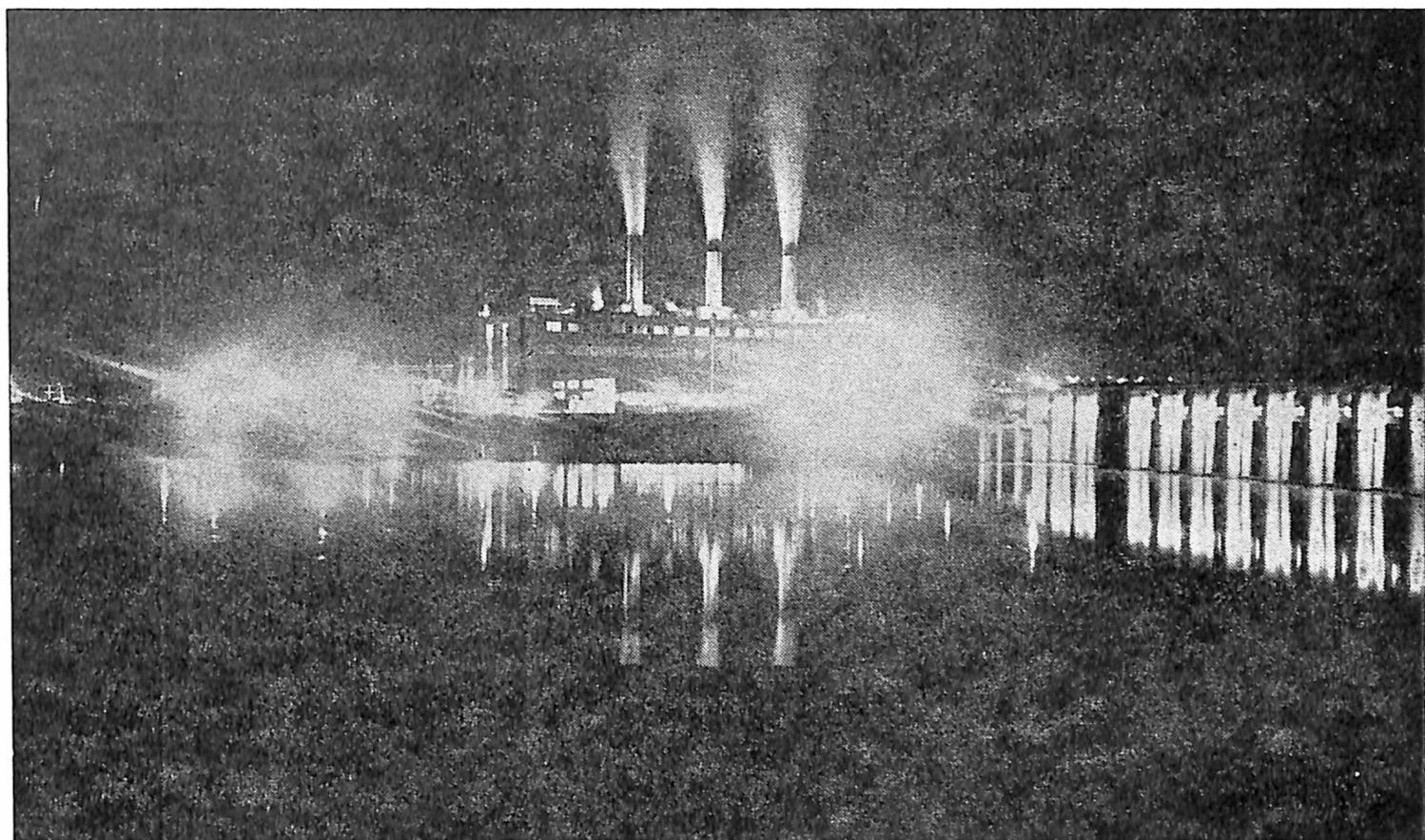


Figure 23. PHOTOGRAPH OF BOKARO THERMAL PLANT AT NIGHT.

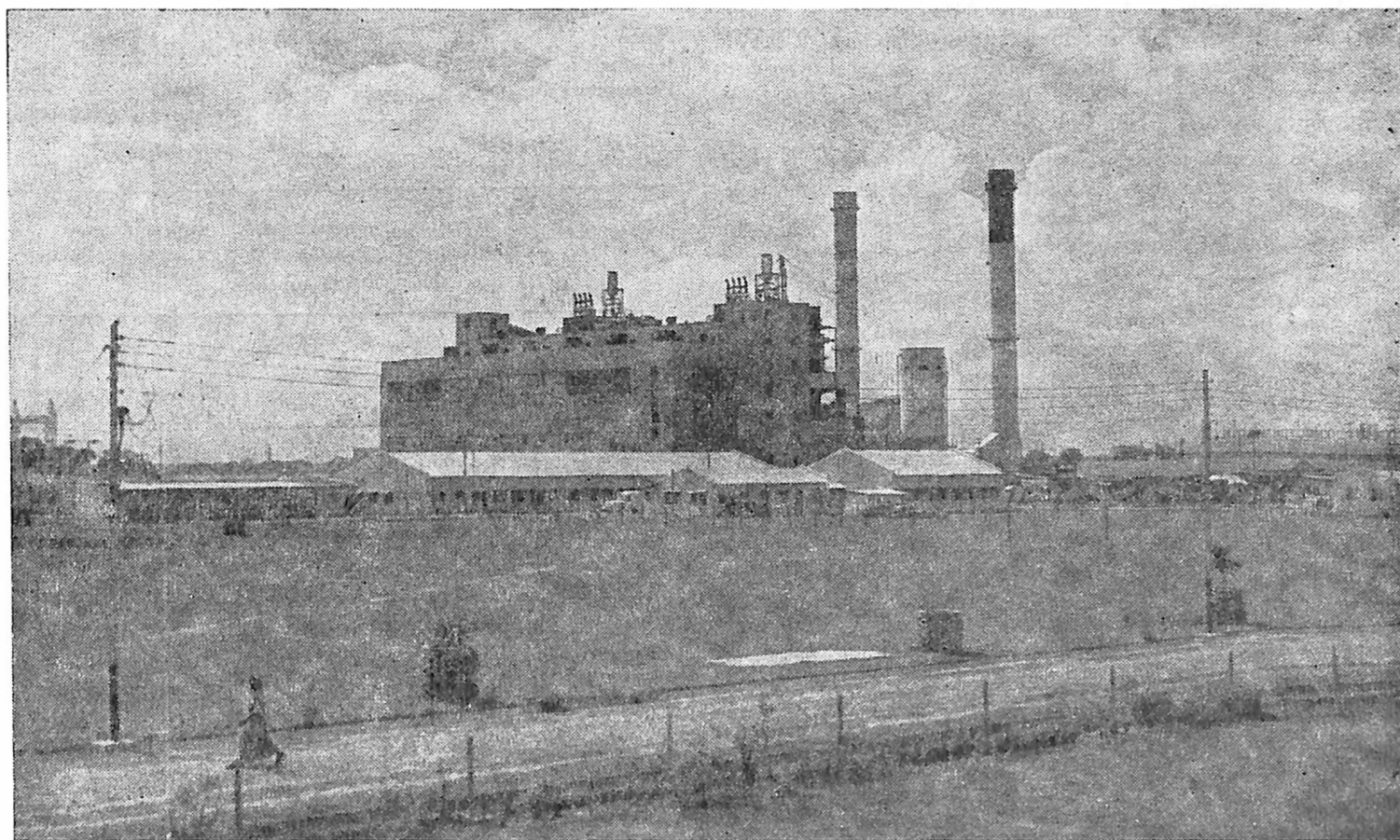


Figure 24. PHOTOGRAPH OF DURGAPUR THERMAL POWER STATION.

TABLE 32. ESTIMATED ANNUAL OPERATING CHARGES —
BOKARD THERMAL POWER PLANT

(In 100,000 rupees)

	3rd Unit	4th Unit	Total
I. Capital outlay			
(a) Plant and machinery	1,174.11	441.96	1,616.07
(b) Civil works	475.94	58.29	534.23
(c) Lands and roads	32.41	2.62	35.03
Total	1,682.46	502.87	2,185.33
II. Annual charges			
(a) Depreciation			
(i) 2.31% of I(a)	27.12	10.21	
(ii) 1.2% of I(b)	5.71	0.70	
Total	32.83	10.91	43.74
(b) Operation and maintenance 2% of 1,492 and 446 ..	29.84	8.92	38.76
(c) Fuel @ Rs 20/- per ton	76.42	38.21	114.63
Total working expenses ..	139.09	58.04	197.13
(d) Interest			
4% on 1,682.46	67.30	22.63	89.93
4½% on 502.87			
Total annual charges	206.39	80.67	287.06

The Durgapur thermal power plant

The two units at the Durgapur thermal plant are to be placed in service during early 1961; each is rated 75,000 kW, with an overload rating of 82,500 kW. The ultimate rating of the station, with a total of four units, is expected to total 400,000 kW. Figure 24 shows a photograph of the plant.

The steam generating plant of the "outdoor" type will initially contain two 800,000 lb/hr boilers operating at 1,475 psig, 1,005°F superheat. The calorific value of fuel is expected to run about 9,500 BTU/lb with 45% ash. About 30% of the fuel will be supplied from the adjacent steel plant coking ovens, and the remainder known as "middlings", from the steel plant's washery.

The general characteristics, including water supply, treatment plant and electric generation apparatus are very similar to those of the Bokaro thermal power station.

Table 33 provides pertinent data respecting estimated annual operating charges.

The Chandrapura thermal power plant

Ground was broken for the Chandrapura thermal power plant in mid-1959. The present planning envisions an ultimate capacity of 500,000 kW in 4 units of 125,000 kW each. The first two units are scheduled for operation in 1964/65. No further capacity additions have been sanctioned beyond this date. Figure 27, however, indicates the planning of additional generating units through the fourth five-year plan of operations.

TABLE 33. ESTIMATED ANNUAL OPERATING CHARGES —
DURGAPUR THERMAL POWER PLANT

(In 100,000 rupees)

I. Capital outlay			
(a) 25 years life	1,095.09		
(b) 40 years life	355.73		
(c) Land and roads	21.69		1,472.51
II. Annual charges			
(a) Depreciation			
(i) 25 years life @ 2.31% ..	25.30		
(ii) 40 years life @ 1.2% ..	4.27		29.57
(b) Operation & maintenance @ 2% of 1,306			26.16
(c) Fuel @ Rs 20 per ton			76.42
Total working expenses ..			132.11
(d) Interest @ 4½% of 1,472.57 ..			66.26
Total annual charges			198.37

Table 34 provides data on the scheduling of generating units and an estimate of investment costs. Table 35 shows the annual operating charges, including overhead depreciation and interest charges. The figures do not contain allocation of overhead charges.

TABLE 34. CONSTRUCTION SCHEDULE AND ESTIMATED CAPITAL COST
— CHANDRAPURA THERMAL POWER PLANT

Date of commencement	Unit I	1959
	Unit II	—
Scheduled date of completion ..	Unit I } Unit II }	1964/65
Power		
Installed capacity	(2 units)	250/280 MW
Expenditure up to 31 March 1960	Unit I Unit II	Rs 48.89 lakhs —
Estimated cost		Rs 28.16 crores

TABLE 35. ESTIMATED ANNUAL OPERATING CHARGES—
CHANDRAPURA THERMAL POWER PLANT

(In 100,000 rupees)

I. Capital outlay to date	3,175
II. Annual charges	
(a) Depreciation @ 2.03%	64.45
(b) Maintenance and operation @ 2% of 2,816	56.32
(c) Fuel @ Rs 20 per ton	127.37
Total working expenses	248.14
(d) Interest @ 4½% of 3,175	142.87
Total annual charges	391.01

The transmission grid

The Damodar Valley Corporation Act of 1948, Part III, Section 12 (b), among other things, stipulates that the functions of the Corporation shall be "the promotion and operation of schemes for the generation, transmission and distribution of electrical energy, both hydroelectric and thermal".

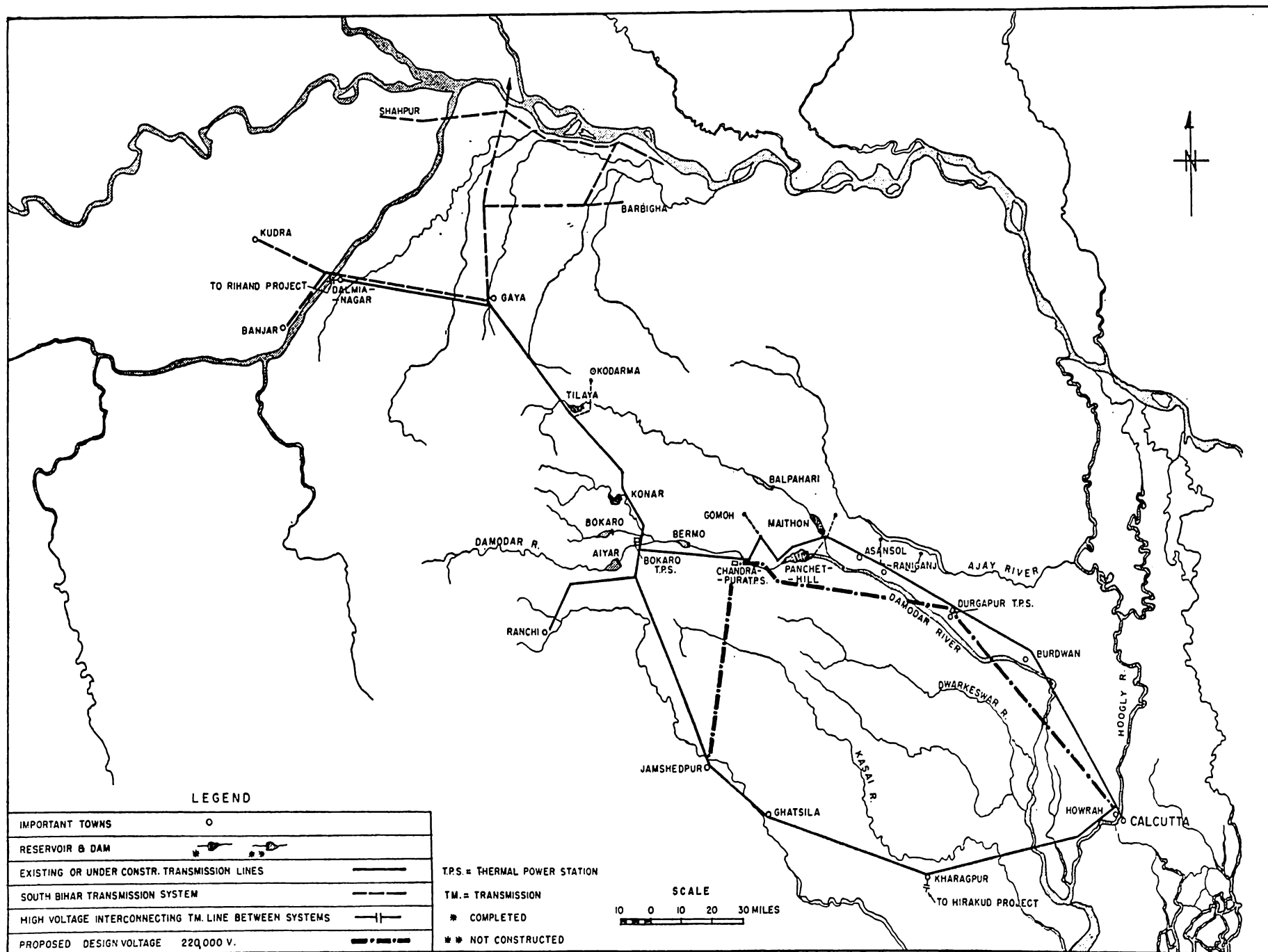


Figure 25. LOCATION OF HIGH VOLTAGE TRANSMISSION NETWORK.

One of the prime objectives of the development scheme was the transmission and distribution, to load centres, of hydroelectric and thermal electric power.

The grid substation installations have progressed at a more satisfactory pace than the erection of generating facilities, particularly in the case of hydroelectric developments. This accelerated programme, however, has been vitally important to meet pressing industrial demands, the requirements of the Calcutta Electric Supply Corporation and the new loads incurred by the electrification of the Eastern Railway system.

As at March 1959, there were 703 mi of 132,000 V lines completed, and another 216 mi of line under construction. Of the 33,000 V lines under construction, all 93 mi of line were completed on schedule.

At the beginning of 1959, construction of eight 132,000 V grid substations had been completed, and eight others were nearing completion. Of the fifteen 33,000 V receiving substations authorized, all were completed. The design sixteen 132,000 V grid substations have been standardized wherever practicable to conform to the "spread-out transfer type bus" operation.

At the Howrah substation, 3 outdoor-type hydrogen-cooled synchronous condensers, each with a rating of 20 MVAR, have been installed to ensure transmission system stability and voltage regulation to the services of the Calcutta Electric Supply Corporation and to the Eastern Railways. These units are capable of delivering a range of reactive power from 10 MVAR "lagging" to 20 MVAR "leading". The substation is also equipped with a 55 MVA 132,000/33,000/11,000 V stepdown transformer containing a tertiary winding of 11,000 V to supply service to the synchronous condensers and at 33,000 V to the Calcutta Electric Supply Corporation. A separate 20 MVA bank 132,000/33,000 V supplies the railway's demands.

Communication facilities have been vastly improved with the completion of the power-line-carrier communication system. Inter-communication services between all "Grid" substations throughout the 132,000 V system have greatly improved customer services. The carrier system also functions to operate distant relays, so that faulty sections can be isolated, an important feature in maintaining good public relations particularly when supplying large power customers such as the Calcutta Electric and others.

The DVC transmission system is by no means confined to an area within the Damodar valley. Under the "Act", the Corporation may, upon approval of the state government concerned, extend its transmission system to areas beyond the valley.

It has been found, throughout the world, that as expansion takes place, mutual operating and financial advantages accrue through the interconnexion of transmission facilities of one system with another. Officials of DVC have recognized these advantages and contemplate extending their transmission facilities to the Hirakud hydroelectric power project in Orissa, interconnexion to be

made at Kharagpur about 1962. The Hirakud project will have an installed capacity of 270,000 kW upon completion of its construction programme in 1961.

Another important interconnexion envisioned is the 132,000 V tie with the Rihand hydroelectric scheme in Uttar Pradesh. Present planning stipulates the installation of 225,000 kW at Rihand by 1962, to be increased ultimately to 300,000 kW. The tie with Rihand is to be made at the Barun substation near Dalmianagar. Another advantage of effecting these two interconnexions is that it provides a two-way service to the electrified Eastern Railway at Dalmianagar and at Kharagpur.

In view of the anticipated load growth resulting from a mushrooming of heavy industry, the Corporation is now pondering the construction of a super-high tension transmission system which in effect will serve as a backbone feeder to the 132,000 V grid. These plans as yet have not been crystalized although a voltage potential of around 220,000 V is under consideration. Arrangements are in progress for assimilating the entire DVC transmission system to an AC network "analyzer board" before final design plans are drawn up. It is proposed that the lines under consideration should extend from the authorized Chandrapur thermal power plant to the Durgapur thermal power plant, and thence to the power system of the Calcutta Electric Supply Corporation near Calcutta. Another line is proposed from the Chandrapura thermal power plant to Jamshedpur, where there are large steel industries.

Phase shifting transformers will be installed at strategic points throughout the transmission grid.

At the end of the second five-year development period, it is estimated that plant investment for transmission and distribution facilities will approach 2,000 lakhs. Details of capital investments in transmission equipment are shown in table 36. Table 37 summarizes the fixed, operating and maintenance charges for transmission plant at the end of the second five-year development plan. Location of the transmission network appears in figure 25. A typical 132 kV substation and outgoing transmission line is shown in figure 26.

TABLE 36. ESTIMATED CAPITAL INVESTMENT CHARGES —
TRANSMISSION AND SUBSTATION PLANT
(In 100,000 of rupees)

	Transmission line	Substation	Total
I. Capital outlay			
132 kV	935	784	1,719
33 kV	56	319	375
25 kV	—	109	109
Additional works for Chandrapura	32	139	171
Total	1,023	1,351	2,374
Additional overhead and audit charges	130	168	298
Total	1,153	1,519	2,672

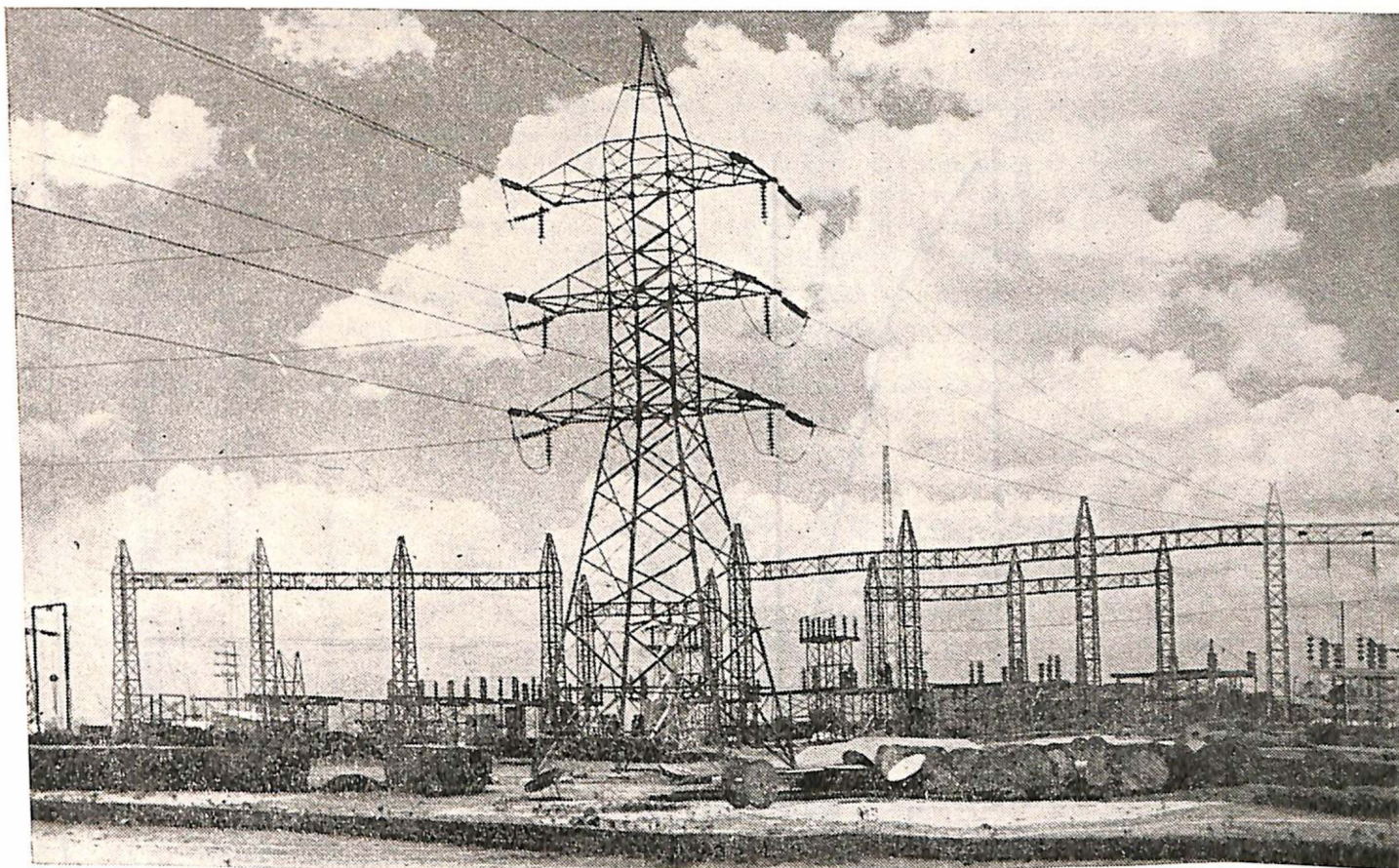


Figure 26. PHOTOGRAPH OF LOYABAD 132 KV SUBSTATION AND OUTGOING TRANSMISSION LINE.

TABLE 37. ANNUAL OPERATING CHARGES — TRANSMISSION PLANT
(In 100,000 rupees)

I. Depreciation			
1.06% of 1,153	12.22		
1.75% of 1,519	26.58	38.80	
II. Maintenance			
2% of 2,874		47.48	
Total working expenses ...		68.28	
III. Interest			
4% on 1,797	71.88		
4½% on 875	39.38	111.26	
Total annual charges		197.54	

The power system operations

The completion of Panchet Hill with its 40,000 kW of hydroelectric capacity in 1959 brought the total installed capacity for authorized hydroelectric facilities to 104,000 kW. After adding 172,500 kW from the Bokaro thermal plant (rated 15% overload), the total rated capacity is 276,500 kW. The system is further reinforced by an emergency tie-in with the 60,000 kW thermal plant of the West Bengal Coke Oven Division; this capacity, however, is not regarded as an assured supply and is therefore omitted in the calculations. Load requirements on the DVC system for 1960 reached a peak of 340,000 kW.

Power capacity-wise, year 1960, afforded a brighter outlook. In August 1960, Bokaro's fourth unit was placed in service to add 82,500 (includes overload rating) kW of rated capacity to the system. Early in 1961 two additional units of 82,500 kW each will be brought into service at the Durgapur thermal plant. These additions bring the total rated capacity for the system to 524,000 while the forecast of load requirements through 1961/62 is 485,000 kW.

In 1961, two inter-system transmission ties will be completed, one connecting the Hirakud project and the other the Rihand project. While the rated line capability of these two interconnexions is placed at 100,000 kW, only 60,000 kW is considered available for interchange service, and is not regarded as a dependable supply in the DVC system.

In 1964/5, the new Chandrapura thermal station will add 250,000/280,000 kW of capacity for commercial service, bringing total installed capacity to 804,000 kW. Thereafter, based on present load forecasts (as at January 1961) (see figure 27), and provided the proposed thermal units are authorized, there will be ample rated capacity available to meet load requirements through 1970.

The heavy industrialization of the area, plus the electrification of the Eastern Railways is, in a large measure, responsible for the present scheduled expansion of facilities to meet power and energy requirements.

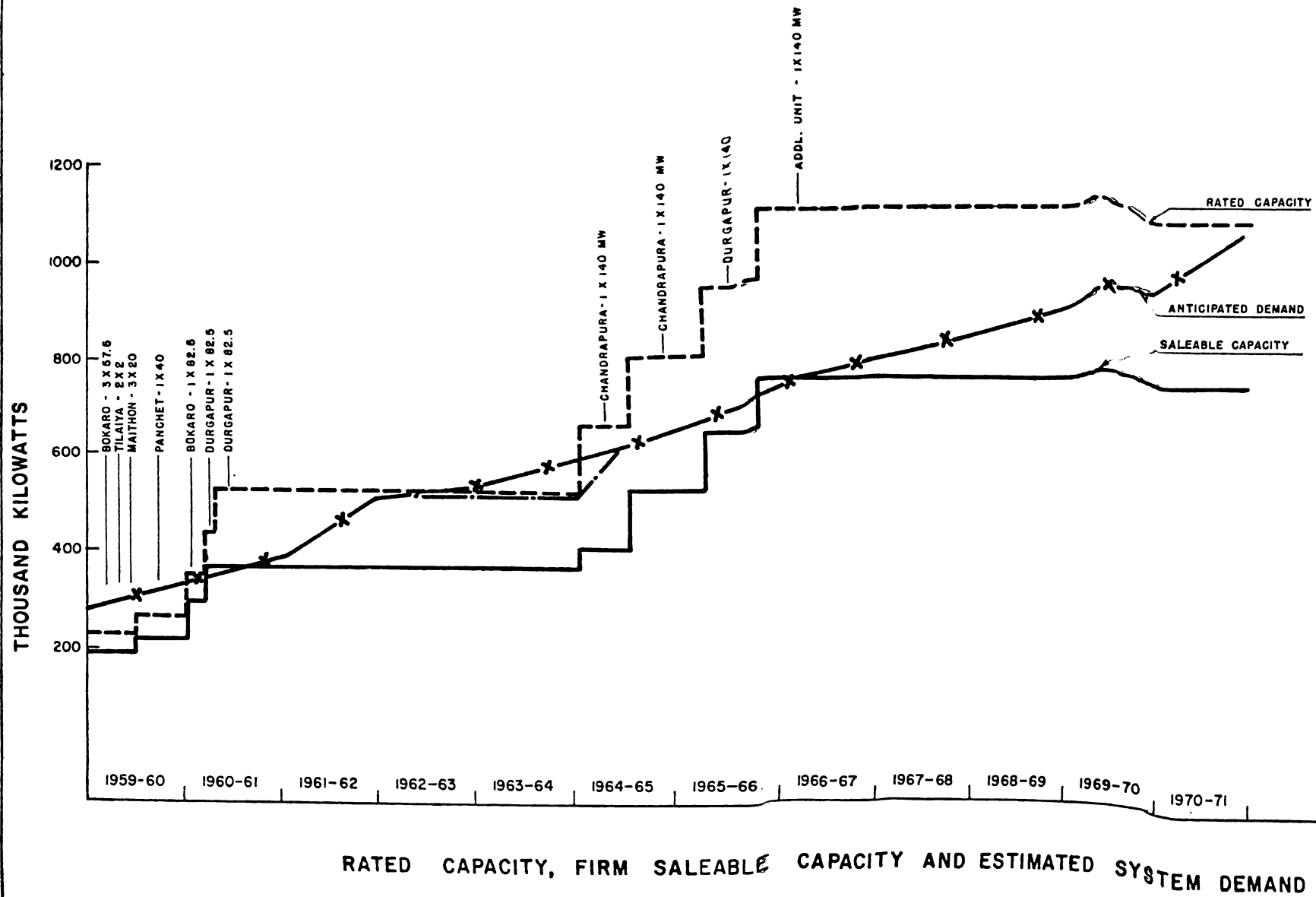


Fig. 27

Figure 27. ANTICIPATED POWER DEMAND AND SYSTEM CAPACITY.

Foremost in the matter of industrial expansion is the steel industry. Large crucible plants are either now in operation or in stage of construction at Jamshedpur, Asansol, Durgapur and Rourkela. Another large crucible plant is shortly to be constructed at Bokaro. The anticipated output of these plants is expected to be approximately 6.5 million tons of pig-iron in 1960, and is to increase to 10 million tons during the third five-year development plan.

The open-cut copper mines at Ghatsila, the mica mines in Bihar, the coal-mining operations at Jharia and Raniganj, the cement works at Sindri and, the aluminium fabrication mill near Asansol are all heavy consumers

of electric energy. Other industries being supplied from the DVC power system are copper smelting, fire-clay and ceramics, steel rolling mills, cotton mills, paper mill, locomotive works, glass works, fertilizer and a much broader range of minor chemical establishments. In addition, 17 towns with populations in excess of 10,000 inhabitants receive electric service. For the year 1959, DVC had a system load factor of 76%. The diversity factor was approximately 1.15%.

Some idea of the system load characteristics may be obtained from an examination of a typical daily winter-time load curve (figure 28), and another typical one of a summer month (figure 29).

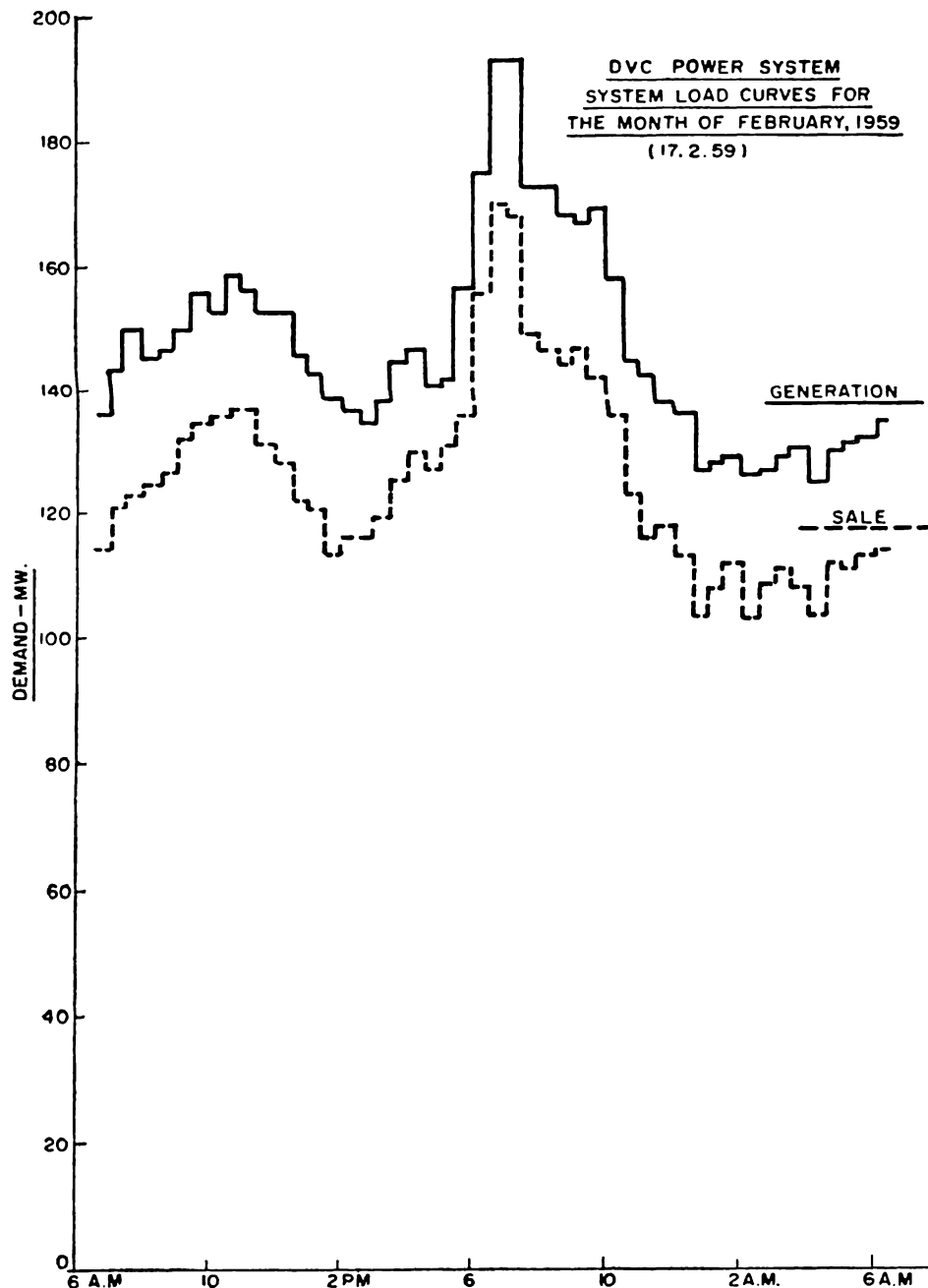


Figure 28. SYSTEM LOAD CURVE FOR MONTH OF FEBRUARY 1958.

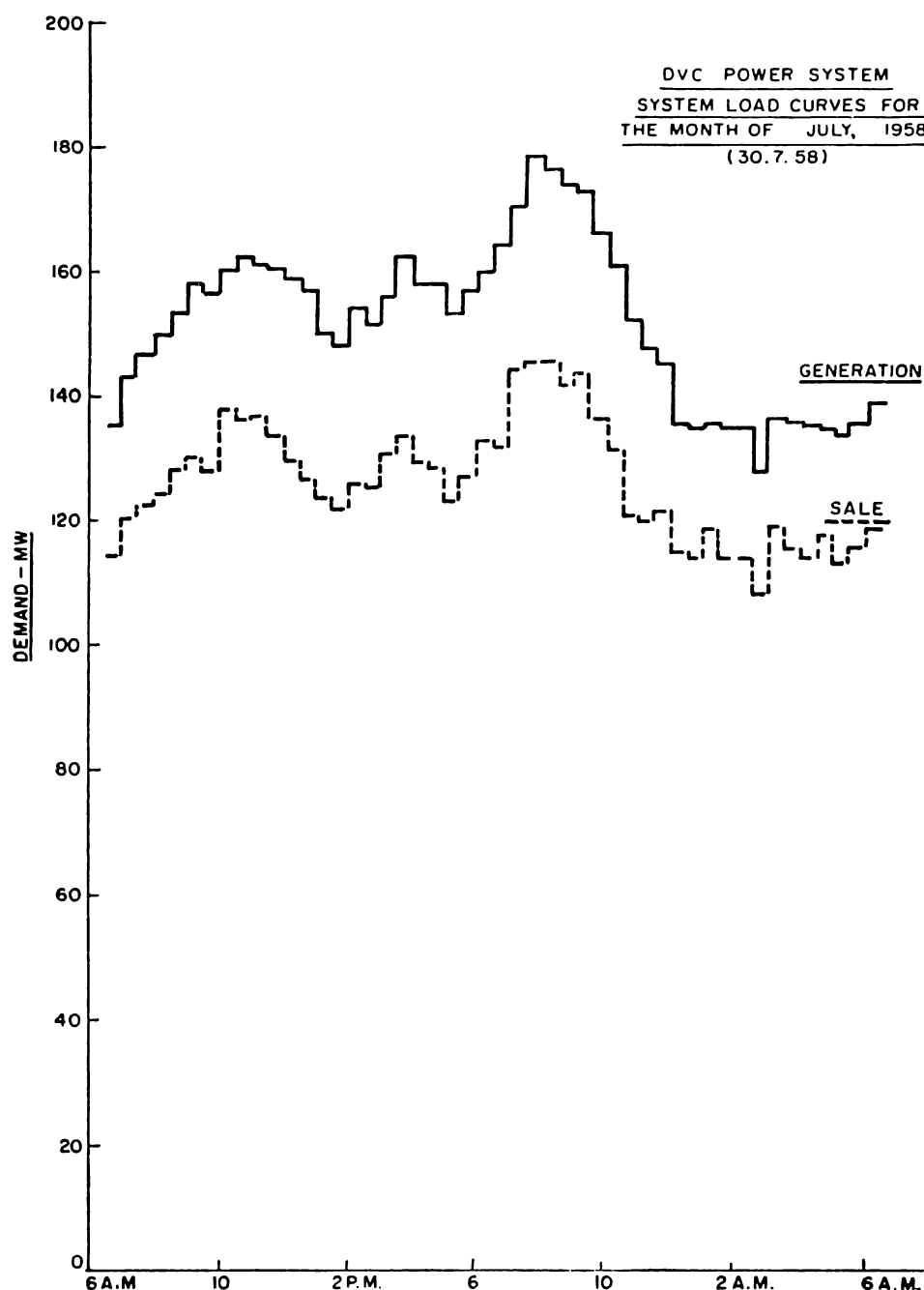


Figure 29. SYSTEM LOAD CURVE FOR MONTH OF JULY 1958.

These curves clearly show the system's high load factor characteristics, the customary valley of the early morning hours, the mid-morning industrial swing, the tapering off during the midday period and the usual peak of the evening hours. These characteristics are very well defined on the curve showing February's short-day fluctuations. These curves also illustrate the proportion of sales to the total power generated. For a system that distributes power and energy on a wholesale basis, the loss of energy occasioned by transmission and transformation of potential appears unreasonably high.

The sanctioning of new capacity additions is not reckoned beyond 1963. The capacity-cum-load curves

(figure 27), for the second and third five-year development period, reveal a startling deficiency in saleable generating capacity, commencing early in 1961. This deficiency is even more acute if it is realized that every hydro-wheel, every steam turbine and every electric generator must be available to meet load demands. Of prime importance in scheduling dependable operating capacities is the loading of the equipment. The question then arises whether it is practical to assume that thermal units can be operated continuously at 15% above capacity rating. Records at the Bokaro thermal plant disclose that Bokaro's 50,000 kW generators have been operating continuously at 62,000 kW or 24% above the manufacturer's rating. While it is

perhaps incumbent upon the operating department to provide the best service possible with the equipment available, it is a dangerous practice to operate equipment continuously at these excessive overloads. Not only is the continuity of service in jeopardy but the physical life of the units is shortened. Moreover, thermal plants in particular require greater maintenance and boilers turbines, and accessory equipment require overhaul because of the rigorous service they are subjected to. On a system which is already deficient in operating capacity, it becomes even more difficult to find time to remove units from service long enough to undertake proper overhauls. The desired frequency of inspections is given in a review of the "overhaul and repair schedule charts" for the DVC system, 1959, 1960 and 1961 (figures 30, 31, 30).

In the case of hydro operations, there is more freedom for removing units from service for inspection and overhaul, since in the dry season the station may be operating on a part-time schedule. In the case of thermal plants, capacity can be released from service more readily during the monsoon, when the hydro plants furnish base load requirements; it is on this premise that the "overhaul" schedules were prepared.

The relationship of net saleable power supply in the DVC system to the anticipated system load demands, bearing in mind availability of equipment and overhauls, is given in table 38.

TABLE 38. RELATIONSHIP OF MAXIMUM LOAD FORECAST TO SALEABLE NET, MAXIMUM POWER SUPPLY, 1959-1961
(In 1,000 kilowatts)

Item	1959	1960	1961
Maximum load forecast demand ..	309	436	601
Maximum net available capacity ..	197 ^a	352 ^a	352 ^a
Net power deficiency	— 112	— 84	— 249

^a Average maximum for year; see figures 30, 31, 32.

Electric service

The DVC Act provides that electric service, with the consent of the state government concerned, may be extended even beyond Damodar valley.

The marketing of electric power and energy is supplied almost entirely on a wholesale-for-resale basis, except in the case of direct sales to large industries which take service at not less than 33,000 V.

For the first time in the history of DVC, sales for the year 1958-1959 exceeded one billion kilowatt hours. Gross revenues totalled Rs 476.69 lakhs; after deducting operating and maintenance expenses, including depreciation and interest, net annual revenue amounted to Rs 54 lakhs. Sales for 1959-1960 are placed at 1.31 billion kWh; after deducting all operating expenses, including interest, depreciation and interest during construction, a net surplus of Rs 165 lakhs was realized.

Actual and projected revenues and operating expenses of the DVC electric system for the second development period are shown in table 39.

It will be noted that, beginning with the year 1958-59, power operating reflect a profit of 1.34% on the capital invested. The division of capital investment in electric facilities is shown in table 40.

TABLE 39. DVC POWER SYSTEM OPERATIONS — ACTUAL AND PROJECTED REVENUES AND EXPENSES FOR THE SECOND DEVELOPMENT PERIOD
(In 100,000 rupees)

Particulars	1956-57	1957-58	1958-59	1959-60	1960-61 ^a
Capital in use (at the beginning of the year)	2,546	3,047	3,996	4,539	6,035
k Wh sold (million)	420	807	1,087	1,312	1,564
Revenue	200	349	477	616	750
Annual working expenses	138	210	262	264	350
Net receipt	62	139	215	352	400
Percentage of net receipts (%) ..	2.45	4.57	5.37	7.76	6.63
Interest	— 100	— 122	— 161	— 187	— 294
Net surplus	— 38	17	54	165	136
Net surplus (%) ..	—	0.57	1.34	3.63	2.25

^a Projected.

TABLE 40. DIVISION OF CAPITAL IN USE ON ELECTRIC PROPERTIES (AT THE BEGINNING OF THE YEAR)
(In 100,000 rupees)

Particulars	1956-57	1957-58	1958-59	1959-60	1960-61
Bakaro, thermal ..	1,673	1,675	1,689	1,696	1,682 4th unit from Sept 1960
					206 (50%)
Tilaiya, hydro	175	175	185	186	178
Maithon, hydro	—	257	877	956	964
Panchet, hydro	—	—	—	321	705 From Oct 59
Konar dam					410
Transmission and distribution ..	698	940	1,245	1,380	1,584
Durgapur thermal plant	—	—	—	—	306 (25%)
Total	2,546	3,047	3,996	4,539	6,035

Surplus earnings from electric operations, as provided in the DVC Act of 1948, are re-invested in the property and charged to capital account. Funds that otherwise would have been supplied by the three government parties are appropriately deducted. If, however, a deficit occurs in any one year of operations, and capital funds are required, the three parties are obligated to provide sufficient funds for the maintenance of the construction programme.

Depreciation reserves, like the disposition of "earned surpluses", are also re-invested in the physical electric property and charged to capital account, thereby relieving the three governments from having to advance the equivalent funds. This approved policy will continue until April 1963, when a permanent depreciation reserve fund will be established. All depreciation reserves previously re-invested in electric properties shall then be reimbursed to the depreciation reserve account out of earned surpluses.

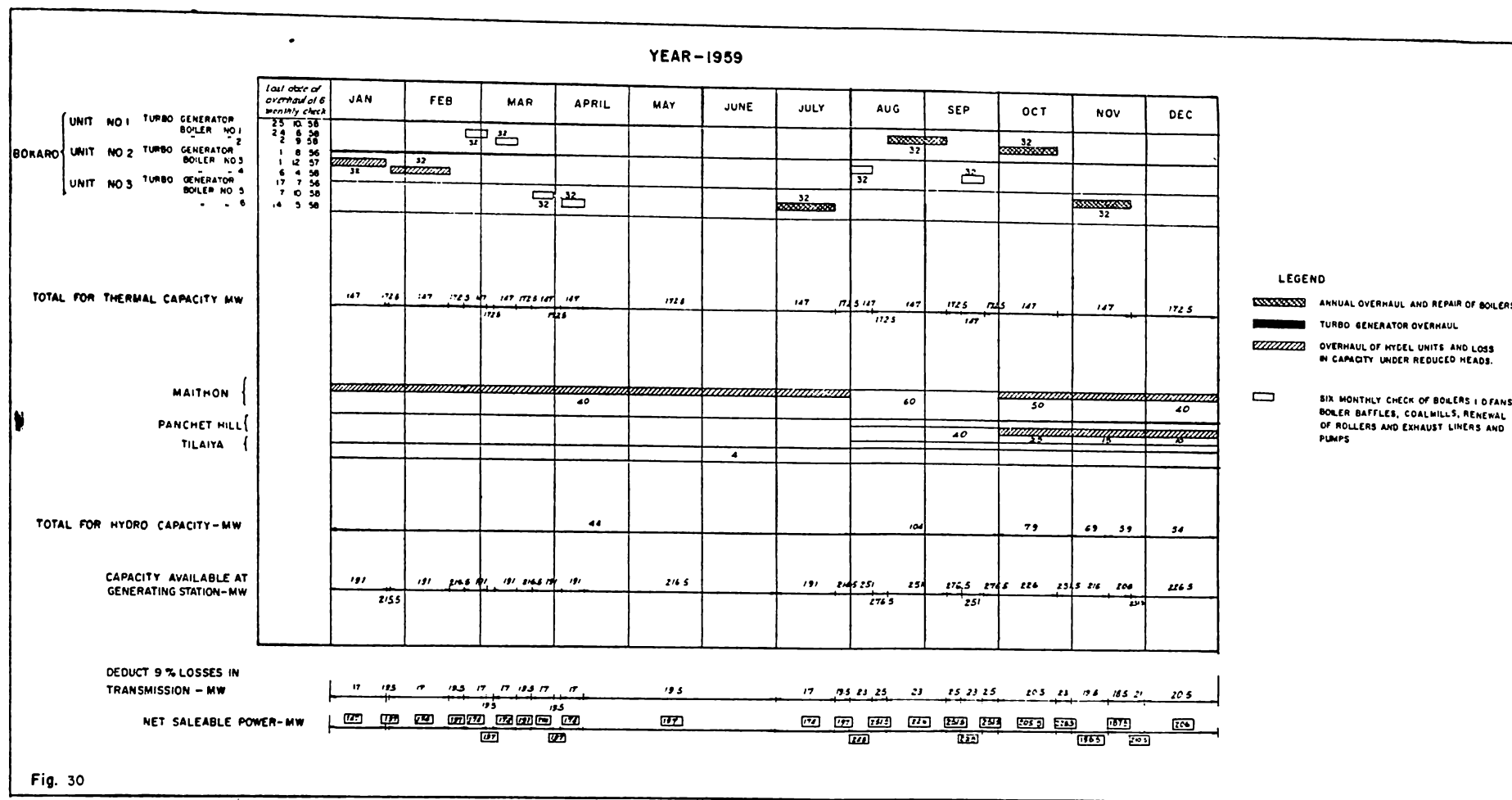


Figure 30. CHART INDICATING OVERHAUL SCHEDULE FOR 1959.



Figure 31. CHART INDICATING OVERHAUL SCHEDULE FOR 1960.



Figure 32. CHART INDICATING OVERHAUL SCHEDULE FOR 1961.

A schedule of depreciation rates applicable to electric properties is given in table 41.

TABLE 41. DEPRECIATION RATES APPLICABLE TO ELECTRIC FACILITIES

Plant classification	Life (years)	Depreciation rates ^a
Thermal power plants		
Plants and machinery	25	2.31
Civil works	40	1.20
Hydroelectric power plants		
Dam and appurtenances	100	1.16
Hydro equipment and machinery ..	35	1.35
Transmission and distribution system		
Transmission lines	40	1.06
Substations	30	1.75

^a Salvage value is assumed to be 10% of capital cost. Rate calculated by 3.5% "compound interest method".

TABLE 42. FINANCIAL FORECAST OF REVENUE OF ELECTRIC PROPERTIES^a

Item	In crores of rupees
Capital outlay	120.45
Gross receipts	14.37
Annual expenses	7.28
(1) Depreciation	1.92
(2) Maintenance & depreciation ..	2.24
(3) Fuel	3.12
Net revenue (before interest deduction)	7.09
Percentage of net revenue to total investment	5.89%
Interest on capital	5.24
Net surplus after allowing for interest	1.85
Percentage of net surplus	1.54%

^a Including only construction sanctioned through 1963.

It is anticipated that, by the end of the third five-year development period (April 1966), all electrical construc-

tion sanctioned so far will have been completed. Hence, surplus earnings accruing from electric operations thereafter will revert to the three government parties. A financial forecast of electric operations after 1966 is shown in table 42.

Operating and maintenance expenses have been arbitrarily established to reflect actual expected conditions on the DVC system once full development has been achieved. Table 43 shows the various percentages used in arriving at the anticipated expenses that appear in the consolidated statement.

TABLE 43. RELATIONSHIP OF OPERATING AND MAINTENANCE EXPENSES TO CAPITAL INVESTMENT

Plant classification	Percentage of construction cost
Thermal power plant	2.0
Hydroelectric power plant	1.5
Dam structures	0.8

Table 44 provides a consolidated statement and breakdown of electric power system operations, including fixed charges.

Rate tariffs and contracts

Rate tariffs, applicable to the DVC system, are of the conventional two-part demand and energy type.

This form of rate structure differs somewhat from other rate forms commonly in effect among the electric utility systems in that the "demand charge" is a preferential levy, calculated to cover the fixed charge expense against the original investment in the property. The charge is intended to include interest on the investment, depreciation, insurance and taxes, if the latter is collectable item. The "energy charge" is a variable-scale charge which is intended to cover expenses of labour, fuel, lubricants, the normal maintenance of equipment in the over-all operations of the property and administrative overhead.

TABLE 44. CONSOLIDATED STATEMENT OF DVC POWER SYSTEM OPERATIONS, INCLUDING FIXED CHARGES AT THE END OF SECOND FIVE-YEAR DEVELOPMENT PLAN^a
(In 100,000 rupees)

Item	Capital outlay incl. over-head and audit	Depreciation	Operation and maintenance	Fuel	Total (working expenses)	Interest on capital	Total annual charges
I. Thermal plants							
Bokaro (150 MW)	1,682	32.83	29.84	76.42	139.09	67.30	206.39
Bokaro (75 MW)	503	10.91	8.92	38.21	58.04	22.63	80.67
Durgapur (150 MW)	1,473	29.57	26.12	76.42	132.11	66.26	198.37
Chandrapura (250 MW)	3,175	64.45	56.32	127.37	248.14	142.87	391.01
II. Hydro plants							
Tilaiya (4 MW)	178	0.91	1.64	—	2.55	7.12	9.67
Maithon (60 MW)	1,029	7.46	10.51	—	17.97	43.73	61.70
Panchet Hill (40 MW)	905	6.12	9.02	—	15.14	38.46	53.60
Konar dam	428	0.48	3.05	—	3.53	17.12	20.65
III. Transmission and distribution	2,672	38.80	47.48	—	86.28	111.26	197.54
Total	12,045	191.53	192.90	318.42	702.85	516.75	1,219.60

^a Reflects only operation of plant facilities thus far sanctioned.

Each consumer, upon taking electric service, is required to enter into a *bona fide* agreement under prescribed service conditions and for a stipulated period of time and at rates corresponding to the type of service required. A reproduction of the standard form of contract now in effect is shown in appendix III.

Contingent upon current rate schedules for electric service now in effect, a gross revenue of Rs 1,443 lakhs (US\$68.5 million) is anticipated after full development of the electric property is accomplished. It is expected this will produce a net surplus of Rs 164.38 lakhs or 1.31% of the total invested in the property, after meeting interim charges against depreciation, reimbursement

and interest during construction; any surpluses will thereafter revert to the three participating governments on a pre-determined basis.

There are two general-type rate tariffs in effect,⁴ namely, (1) service to industrial consumers who have no generation stand-by equipment, and who take service at 33,000 V and (2) consumers with generating capacity which operates in parallel with the DVC system and receive service at 33,000 V.

The tariff applicable to industrial consumers for high tension service at 33,000 V who have no generating capacity is as follows:

⁴ NP = Naya Paise; 100 NP to 1 rupee.

Tariff "A"

Demand charge

First 5,000 kVA	675 NP per kVA per month (US\$1.42)
Next 20,000 kVA	600 " " " " " (US\$1.26)
Excess over 25,000 kVA	575 " " " " " (US\$1.21)

plus

Energy charge

All energy @ 2.7 NP per month (US\$0.0057)

Coal cost adjustment

The rate per kWh is deemed to be based on an average cost of 40 NP per 1,000,000 BTU of fuel delivered at the bunker of the DVC's generating stations or generating stations from which DVC purchases power. In the event, at any time or times during the continuance of agreement, of a rise or fall in the cost to DVC of

fuel delivered as aforesaid, the rate per kWh will be increased or reduced as the case may be by 0.006 NP for each 1% variation in the cost of fuel 1,000,000 BTU.

The cost of high tension service to industrial consumers who own and operate generating capacity in parallel with the DVC system is based on tariff "B" as follows:

Tariff "B"

790 NP per kVA per month (US\$1.66)

Demand charge plus

All energy @ 2.2 NP per month (US\$0.0046)
Same as clause in Tariff "A"

Energy charge

Coal clause

Surcharge for 11 kV Supply

A surcharge of 5% on the demand and energy charge of Tariff "A" is made for service delivered at 11 kV. The same fuel clause applies.

Special tariffs are, from time to time, negotiated

whenever service conditions provide material advantages between the parties. Typical of these circumstances is the tariff for service to the Calcutta Electric Supply Co., at Calcutta, West Bengal.

Demand charge 875 NP per kVA per month (US\$1.84)
plus

Energy charge 1.25 NP per kWh (US\$0.0026)
A special tariff is also in effect for service rendered to the Tata Iron & Steel Co. Ltd. at Jamshedpur, Bihar:

Demand charge 875 NP per kVA per month (US\$1.84)
plus

Energy charge 1.9 NP per kWh (US\$0.0040)

Coal clause Same as Tariff "A"

Chapter VI

THE REHABILITATION OF PEOPLE FROM SUBMERGED LANDS

The four reservoir dams and the thermal plant at Bokaro eliminated 69,000 acres of land, of which a little over half had been classed as arable. It also displaced 93,000 people from 4,500 homes in 302 villages.

In the Parliament, during discussion of the DVC Bill, great emphasis was placed on the importance of amicably resettling the people that had been uprooted from the inundated reservoir lands.

Under the Land Acquisition Act, these people were given a choice of accepting cash in compensation for their land or a new home and land on which to continue their agricultural pursuits.

The Corporation too was deeply sympathetic of the "lot" of the people who were shorn from their ancestral heritage. In an effort to alleviate rising scepticism among the people, DVC set out to construct four types of homes as a trial, each designed to satisfy certain prescribed family requirements. Homes were laid out in a rectangle around a large village square. Plots varied from 50 x 100 ft to 100 x 100 ft. Trees bordered the streets and storm drains marked each lane. In some villages artesian wells were strategically located while in others pucca brick cisterns were constructed. New primary schools, community centres and temples were erected. Figure 33 is the plan of the village of Bachhai, which is typical.

Bachhai was one of the old villages that underwent remodelling to accommodate displaced families of the bottom lands of the Tilaiya reservoir. Figure 34 is a scene in the old village of Bachhai before rehabilitation. Figure 35 illustrates the new Bachhai village and the types of homes constructed. Figure 36 is a typical community centre seen in any newly constructed village; similarly, the windmill driven deep well in figure 37.

It soon became evident that a fair price for their old fields would not be enough to assure the economic future of the people. It was essential to give them land whose yields would be comparable to that of their former holdings. The participating governments agreed that people displaced by DVC engineering works should be given land for land and house for house, and should be provided better living amenities. But land was scarce. Development of new farm lands seemed to be the only solution. The equipment and tools were available at the nearby Tilaiya damsite. With this objective in view, 6,579 acres of land were reclaimed for the displaced farmers. Surprisingly, the cost of reclaiming these waste lands was no more than the purchase price of land had

any been for sale, i.e. at slightly under Rs 900 per acre (US\$42.60). New fields were allotted on the basis of their old crop-producing capacity, consisting usually of three compact tracts—home sites, upland plot and paddy land instead of 20 or more small scattered tiny plots typical of former times.

The four trial houses that were built soon brought much criticism of DVC, they lacked roominess and loft space, windows seemed unhygienic and they were alleged to have many other shortcomings. As a result, DVC compromised by designing three intermediate houses. The largest had three rooms, including two fair sized verandahs front and rear; the smaller house had two rooms with small front and back verandahs. Figure 38 illustrates design details of the three houses of which 56 were finally constructed at Bachhai village.

In general, the homes were built of sun-dried bricks; foundation walls and the two top layer of outer walls were of pucca brick (kiln dried) and cement mortar. The centre walls (of mud brick) were coated with gunited cement in a proportion of 1:6 cement: sand, 3/8" thick to protect against deterioration during the monsoon season. The doors and windows were of sal wood and the rafters of sal logs. The wood was given special treatment against white ants and borers. The roof was covered with a locally made tile. The verandahs with their concrete benches afforded adults a comfortable place to sit and the children a place to play in the light. The interior was equipped with shelves and niches to keep utensils off the floor. Each kitchen was equipped with a chimney to carry out the cooking smoke. The low cost of these walls was an added feature of this type of home, being about 4 annas per square foot or US\$0.05. The cost of constructing the three popular types of houses and more recently classes 4 and 5 are shown in table 45 including comparison of costs for similar homes located in other villages. These costs exceeded the actual cost of acquisitioned houses by two and a half times.

TABLE 45. COMPARISON OF COSTS FOR CONSTRUCTING HOUSES
(In rupees)

	<i>Bachhai vilage</i>	<i>Other villages</i>
Class I	6,615	8,625
Class II	3,438	4,800
Class III	2,671	3,628
Class IV	1,719	2,520
Class V	1,200	1,535

While the rehabilitation of the Bachhai village in general was a success, other undertakings in the Tiliya area failed. Most people accepted the new land holdings but refused to move into the new villages provided for them. Before long, many of the people were either abandoning their place of abode or tearing it down to better accommodate their way of life; chimneys were considered unhealthy, and people died during the winter months of gas fumes because there was no way for the smoke from heating pots to escape. Later on, it became the DVC's policy to ascertain in advance what the people preferred, i.e. a cash settlement or compensation in form of a house and land on which to cultivate crops. The temperament pattern of the people from the Tilaiya reservoir area did not change appreciably among the families removed from the bottom lands of the three remaining reservoirs.

Many elected to take cash compensation for the surrender of their ancestral homestead to build a house more to their liking, others took cash which was soon dissipated. Twice the Assembly of the West Bengal

government endeavoured to re-colonize these unfortunate people from the streets of Calcutta onto the farmlands but without appreciable success.

Almost 92% of the people chose cash settlements in preference to accepting land for land and home for home. The remaining families took cash compensation to build homes for themselves and some even elected to do their own reclaiming. The large majority of houses that were abandoned were eventually turned over to the Bihar government. The total cost of acquiring project lands including the rehabilitation of the people as at March 1960 totalled Rs 6.44 crores (US\$13.5 million).

Table 46 shows a composite of the corporation's efforts to improve the lot of nearly 100,000 persons.

It can be concluded that the time-table for meeting construction schedules was not in harmony with the transmigration of the uninstructed masses living in the river bottom lands. Had earlier attention been given to the traditions of these people, such as orientation gatherings etc. it is believed the percentage electing to receive cash payments would probably have been surprisingly reduced.

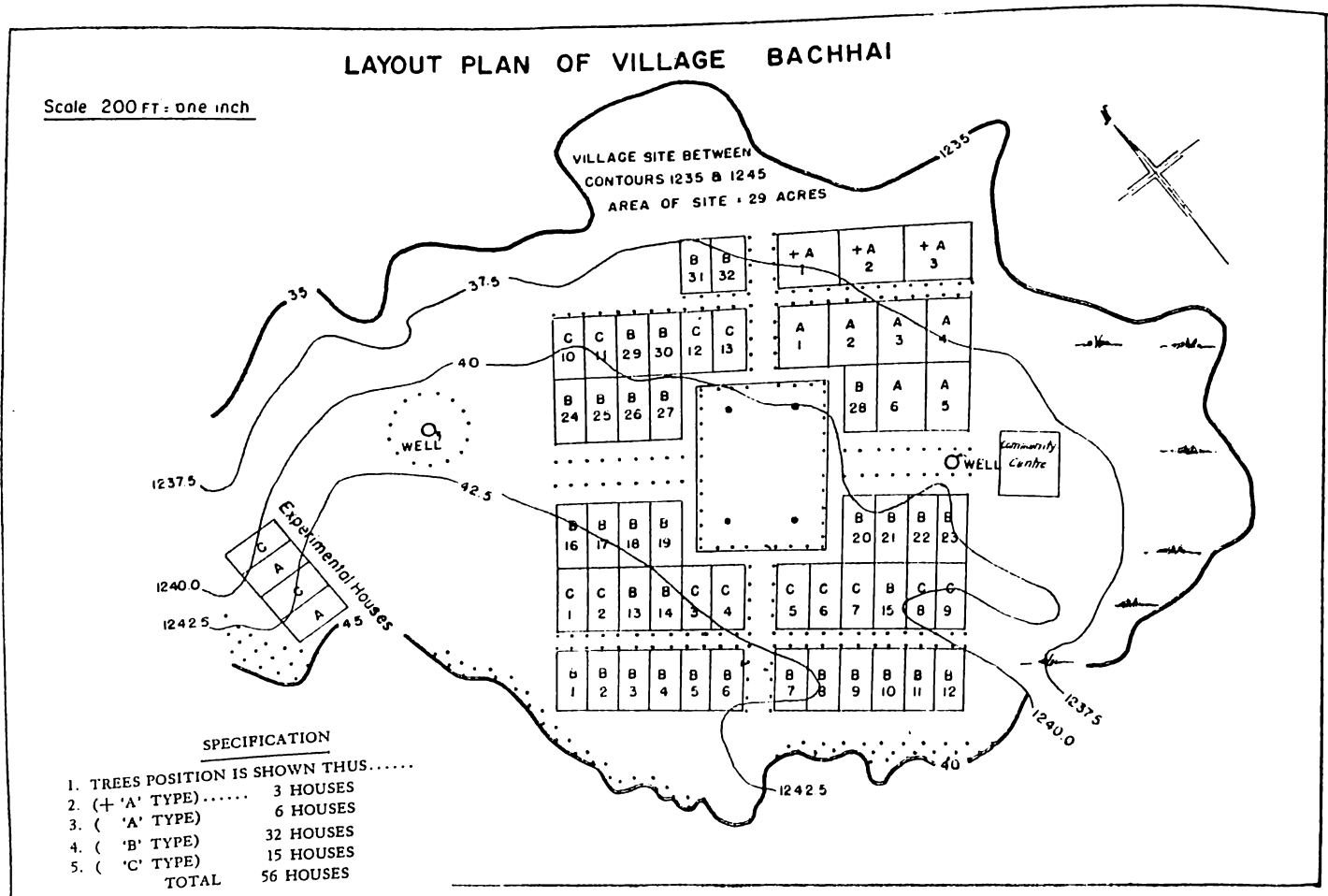


Figure 33. LAYOUT PLAN OF VILLAGE BACHHAI.



Figure 34. PHOTOGRAPH OF THE OLD VILLAGE OF BACHHAI.

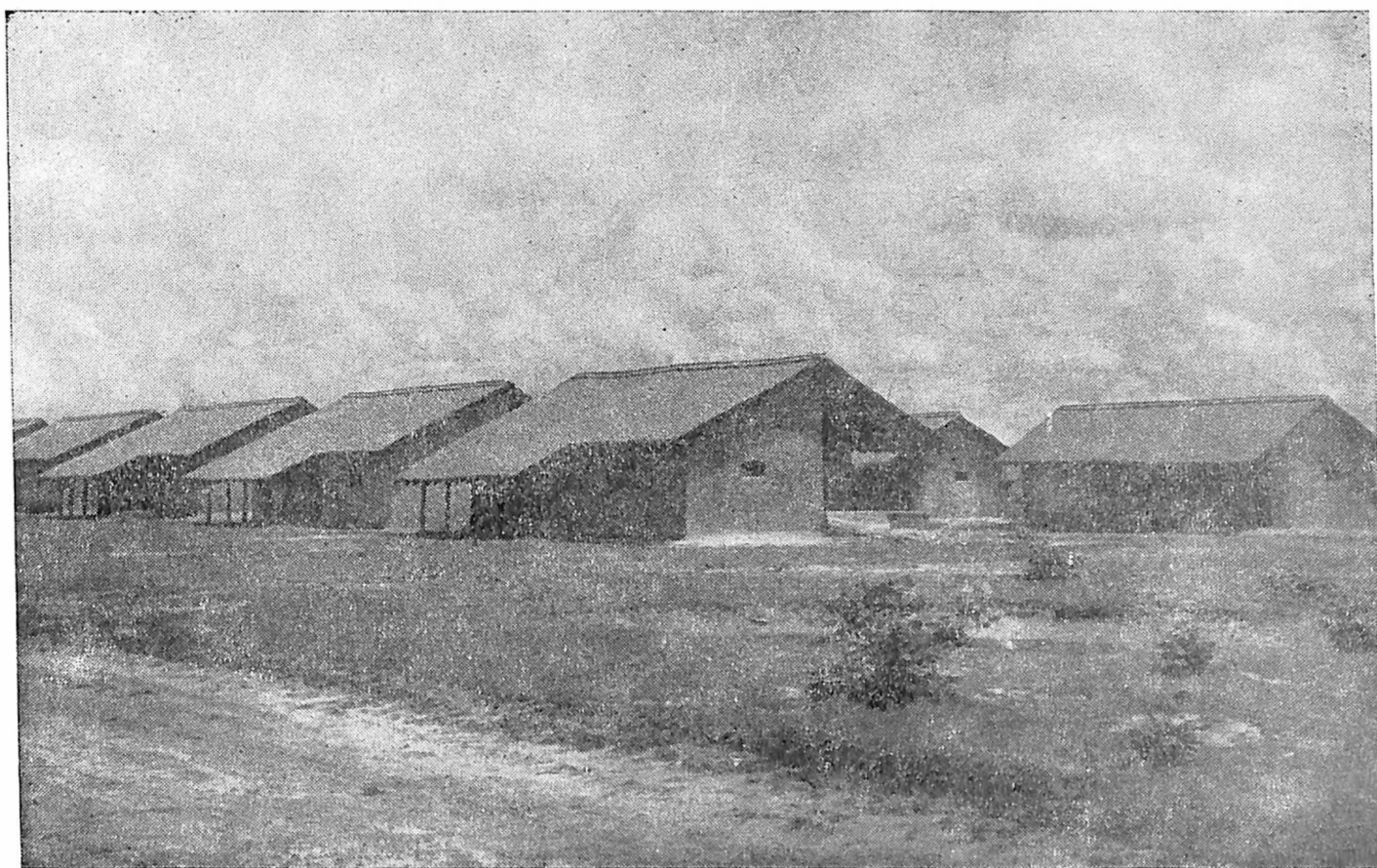


Figure 35. PHOTOGRAPH OF THE NEW VILLAGE OF BACHHAI.



Figure 36. PHOTOGRAPH OF A TYPICAL COMMUNITY CENTRE.

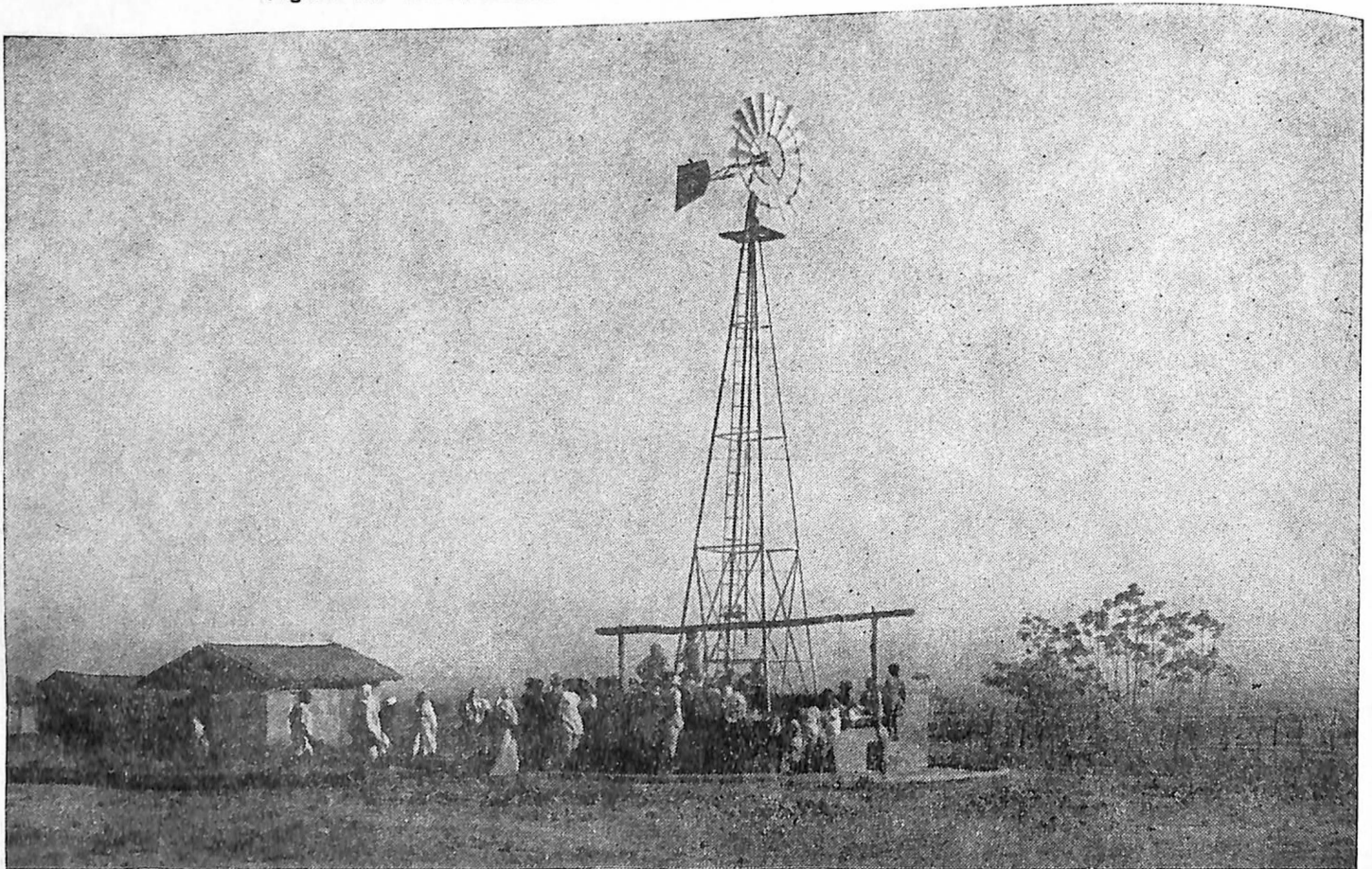


Figure 37. PHOTOGRAPH OF A TYPICAL WINDMILL DRIVEN DEEP WELL.

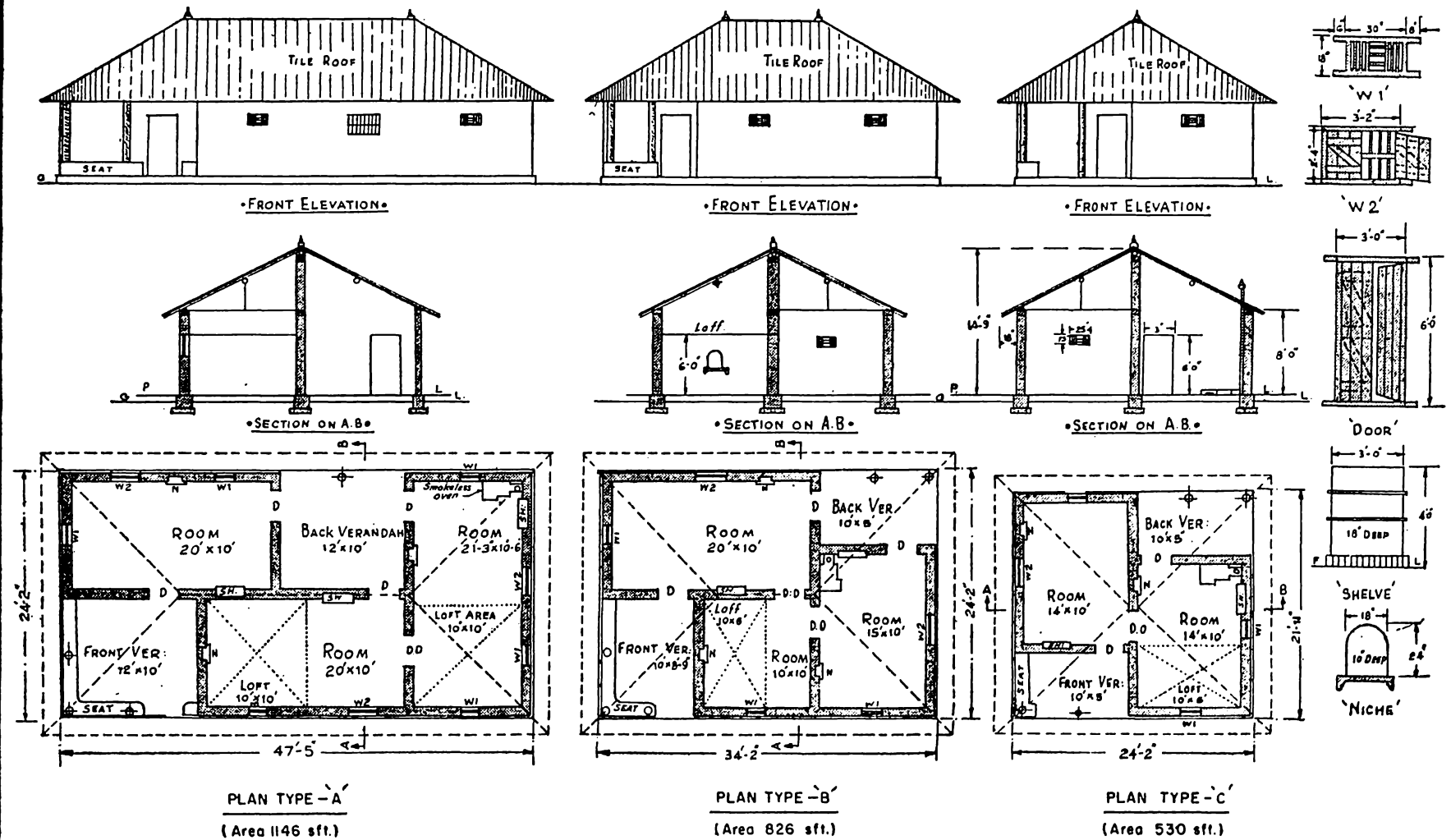


FIG. 38

Figure 38. DESIGN OF VILLAGE HOUSING.

TABLE 46. REHABILITATION STATUS OF FAMILIES FROM SUBMERGED AREAS OF DVC

Project	Total land area acres	Arable portion acres	Villages involved No.	Families affected No.	Persons displaced No.	Houses involved No.	D V C Compensation by cash		D V C Compensation by resettlement	
							Arable land acres	Houses involved No.	Arable land acres	Houses involved No.
Tilaiya	16,107	7,902	56	2,691	16,120	629	2,114	500	5,788	129
Konar	6,672	2,115	27	1,218	5,747	118	1,335	118	780	
Bokaro barrage (thermal plant) . .	1,185	538	3	371	1,697	59	448	59	90	
Maithon . .	26,176	15,803	86	5,211	28,030	1,588	11,468	1,538	145 ^a	
Panchet Hill	19,046	9,735	130	10,339	41,461	2,119	9,735	2,119		
Total	69,186	36,093	302	19,830	93,055	4,513	25,100	4,384	6,803	129

^a Land chosen by the displaced person in the Jamtara area is being reclaimed by the government of Bihar on behalf and at the cost of DVC.

Chapter VII

SOCIAL AND ECONOMIC PLANNING

General

Item (f) of Section 12 of the DVC Act refers to "the promotion of public health and the agricultural, industrial and general well-being in the Damodar Valley and its area of operations".

In defining the corporation's powers, there appears to have been a combination of objectives. Engineering works were of prime importance on the one hand while on the other Section 12 (f) refers to the "economic and general well-being" of the area. Again in Section 45 (i), an annual report was required, making specific reference among other items to "sanitation and public health measures" and "economic and social welfare of the people". Obviously these duties constituted an agreed delegation of government powers to the Corporation, although conflicting opinions resulted in a re-definition of its function by the Rau Committee of 1953 as follows:⁵

"We are of opinion that the normal functions of a corporation should include only such essential ancillary activities of a beneficent nature, as are obligatory on the project, such as those intended to mitigate the hardships caused to the people directly affected by the project, as resettlement of displaced people, keeping shore lines or reservoirs free from malarial larvae, etc. Thus, malaria control measures along the reservoir shores would be a legitimate charge on the project as malaria is the direct result of the creation of the reservoirs. Such measures all over the valley, however, would be outside the

scope of the project and, therefore, beyond the functions of the Corporation. Most of the functions of the Corporation listed in sub-section 12 (f) of the Act form part and parcel of the social welfare activities of the State concerned and may equally well be handed over to State Governments. But there is an advantage in making the Corporation act in consultation with the Governments concerned responsible for them because such activities may have to be organized on a regional basis. While, therefore, we are of opinion that they need not necessarily be beyond the purview of the Corporation, each such scheme should be undertaken only after it has been specifically sanctioned by the Central Government; it should, however, be open to a State Government to entrust any such work to the Corporation for execution in order to take advantage of the special facilities available to the Corporation in the area. For such works, the State Government would naturally provide the funds".

As a result, nearly all social and allied activities have been transferred to the participating governments. For example, the participating governments, in 1957, decided that DVC need not have a programme for the development of cottage industries, and this work was turned over to the state governments concerned, as was the lock factory at Tilaiya and the central finishing workshop at Maithon to Bihar state. In April 1959, the West Bengal government agreed to take over the cold storage plant at Kanainatsal, the spun pipe factory at Durgapur. The maintenance and operation of canals will probably be taken over by the West Bengal government in the course of 1961.

⁵ Inquiry Committee set up by the Government of India.

TABLE 47. PER CAPITA EXPENDITURE ON SOCIAL SERVICES IN THE DVC AREA ^a
(1953-54 constant prices; in 100,000 rupees)

Item	Lower valley (West Bengal)					Upper valley (Bihar)				
	1953-54	1954-55	1955-56	1956-57	1957-58	1953-54	1954-55	1955-56	1956-57	1957-58
1. Public health and hygiene	0.12	0.14	0.13	0.15	0.33	0.36	0.62	0.37	0.60	0.35
2. Education	0.70	1.23	1.06	0.90	0.93	0.34	0.36	0.49	0.96	1.19
Primary	0.40	0.46	0.34	0.23	0.22	0.11	0.03	0.14	0.49	0.67
Secondary	0.19	0.50	0.46	0.44	0.47	0.14	0.23	0.22	0.20	0.20
Agricultural	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.06	0.06
Industrial	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.03	0.09	0.09
Special	0.06	0.06	0.06	0.05	0.06	0.02	0.02	0.02	0.05	0.08
General	0.01	0.17	0.16	0.15	0.15	0.05	0.06	0.05	0.07	0.09
3. Labour and social welfare ...	0.01	0.01	0.01	0.01	0.01	0.53	0.85	0.97	1.12	0.80
4. Buildings for education, medical and public health	0.04	0.07	0.09	0.16	0.09	0.05	0.06	0.16	0.19	0.07
5. Total	0.83	1.38	1.20	1.06	1.27	1.23	1.89	1.99	2.87	2.41
6. Community development and national extension service	0.20	0.62	0.62	0.78	0.80	0.32	0.62	1.76	1.70	1.90
TOTAL of (5) and (6) ...	1.03	2.00	1.82	1.84	2.07	1.55	2.51	3.75	4.57	4.31

^a Compiled by Prof. S. B. Rangnekar from official sources.

In 1950, a National Planning Commission was created for the express purpose of unifying planning on a national scale. This action relieved DVC of continuing its social and economic activities which were taken up by the appropriate governments and combined with their respective programmes. It is of interest to note the extent to which Bihar and West Bengal are extending social activities. Table 47 shows the *per capita* expenditure on social services in DVC area. It will be observed that in the West Bengal District of the DVC, education is given the topmost priority (average Rs 0.96 out of the total *per capita* outlay of Rs 1.83), while in the Bihar districts of DVC, priority is accorded to labour and social welfare (averaging Rs 0.86 out of a total *per capita* of Rs 1.83).

Malaria

At one time the incidence of malaria was exceedingly high throughout the valley. Because of the socio-economic deterioration of the villagers and its effect on the pre-development programme, malaria had to be tackled expeditiously on a broad front. Moreover, development of any river system with multiple-purpose objectives might indirectly favour the incidence of malaria; for example, the creation of reservoirs and the accompanying borrow-

pits provide ideal breeding places for the various species of anopheline (malaria) mosquito.

DVC has established its own malaria control organization, and work is concentrated in each of the reservoir areas and the irrigation canals. Malaria control of the actual irrigated area is the responsibility of the National Malaria Control Programme of West Bengal.

As a means of instituting effective malaria control and discouraging the breeding of mosquitos in the irrigation canals and paddy fields, a malaria laboratory was established at Burdwan. This laboratory has been highly instrumental in reducing the incidence of malaria. Table 48 shows the percentage of malaria cases to total of all cases for the DVC reservoirs or barrage projects.

TABLE 48. PROGRESS OF ANTI-MALARIA WORKS

Place	Percentage of malaria cases to total cases					
	1950-51	1952-53	1954-55	1956-57	1957-58	1958-59
Tilaiya	2.7	0.8	1.1	0.2	0.01	0.00
Konar	9.09	2.1	0.5	0.03	1.5	0.40
Durgapur ...	—	2.5	0.9	0.04	—	0.00
Bokaro	4.8	2.2	0.4	0.08	0.02	0.01
Maithon	34.3	5.8	0.3	0.04	0.01	0.08
Panchet	—	1.6	0.3	0.12	0.14	0.09

Chapter VIII

FINANCIAL ADMINISTRATION

Functions and duties of the Financial Adviser

Under the Act, the Financial Adviser is appointed by the Government of India, and his functions and duties have been laid down in the DVC Act and the rules framed thereunder.

The functions and duties of the Financial Adviser are summarized below:

- (i) The Financial Adviser shall advise the Corporation on all matters affecting revenue and expenditure.
- (ii) The Financial Adviser shall have the right to attend every meeting of the Corporation but shall not have the right to vote. He shall have the right to refer to the Corporation any matter which, in his opinion, ought to be brought to its notice.
- (iii) The Financial Adviser shall be responsible for the manner in which the "annual" and "financial" statements are prepared and the accounts of the Corporation are maintained and made available for audit.

The Financial Adviser has two assistant financial advisers and the requisite number of subordinate staff. All financial matters are scrutinized by the Financial Adviser before they are presented to the Corporation, and he has to examine cases both from the points of view of financial propriety, availability of funds and observance of financial regulations.

The Financial Adviser is not responsible for the day-to-day maintenance of accounts. His supervision over the accounts of the Corporation broadly consists of seeing that the accounts are maintained correctly and that the progress of expenditure is commensurate with the amount provided for in the budget estimates of the Corporation. In fact, the Financial Adviser occupies an important position in the financial administration of the Corporation and his advice is generally accepted by the Corporation. In the event of disagreement, the Financial Adviser has the right, established by convention, to bring matters to the notice of the Government of India.

Source and disposition of appropriated funds

Under the Damodar Valley Corporation Act, the three participating governments, namely the Government of India and the governments of West Bengal and Bihar are to supply funds for completion of the projects under-

taken by the Corporation. As the Corporation has to pay interest on the capital provided by the three participating governments, funds are demanded from them quarterly so as to minimize interest charges. The funds thus supplied by the three governments are deposited in the Reserve Bank of India. Receipts are also credited to the Reserve Bank of India. Money is drawn out by cheque. Allotment of funds is made on the basis of projects or schemes sanctioned by the three participating governments. The present standing of funds drawn from the three participating governments are—Central, Rs 31.47 crores; West Bengal Rs 76.14 crores and Bihar Rs 25.16 crores, a total of Rs 132.77 crores as at August 1959. The projects undertaken by DVC came within the over-all planning of India as a whole.

Returns

Until all the projects authorized are completed and brought into commercial operation and actual expenditure is determined, an accurate financial return cannot be indicated. Moreover, the cost of the dams has been allocated on a tentative basis. The financial returns are based on estimated expenditure and receipts. The return on the power system is based on further developments as far as it can be envisaged. At present, the Corporation pays 4.5 per cent interest on borrowed capital. However, the Government of India has since decided that, in respect of funds drawn up to 31 March 1958, interest will, with effect from 1 April 1958, be charged at 4 per cent for power projects and 3 per cent for other projects.

Method of amortization

The question of amortization does not arise in the case of the Damodar Valley Corporation under the DVC Act. The participating governments supply the requisite funds, and profits and losses on each of the three main objectives, namely, irrigation, power and flood control, are to be shared by them in proportion to the capital supplied by each government for each objective. In calculating profit and loss, account is taken of working expenses, depreciation, reserve and other funds, and interest payable on capital.

Application of depreciation method and policy of investment

The sinking fund method is to be adopted for the purpose of depreciation. Until the construction phase is

over and the works are brought into commercial operation, the money earmarked for depreciation, as well as receipts, are utilized for capital expenditure in order to minimize interest charges on borrowed capital. The participating governments are required to pay only the net amount of capital expenditure. Under section 39 of the DVC Act, a revenue account will be opened from the year 1963-64, when the amount set apart for depreciation, etc. will be adjusted and invested in such manner as may be determined by the Central Government. Until the revenue account is opened, a proforma account is kept to arrive at the net profit or loss.

Taxes or their equivalent

The Corporation is liable, under the Act, to pay any taxes on income levied by the Government of India in the same manner and to the extent as a private company.

Accounting methods and system of budgeting

The accounting structure has been prescribed by the Government of India. The Corporation is empowered to introduce detailed heads and changes in the form of the accounts in consultation with the Comptroller and Auditor General of India. In addition to the financial accounts, the Corporation has introduced cost accounting and workshop accounting along recognized commercial lines. At the end of the year, the Corporation prepares a balance sheet in the form prescribed by the Government of India. The form of budgeting has also been prescribed by the Government of India, and is in line with normal budgeting procedure.

Allocation of capital

The Act prescribes that the total capital expenditure chargeable to a project is to be allocated between three main objectives. Sums spent on other authorized objectives, such as afforestation, soil conservation, etc. are treated as common expenditure to be shared by the three governments in equal proportion. The governments of Bihar and West Bengal are responsible for the capital cost of the works constructed exclusively for irrigation in their respective states, and share the balance of the capital cost under irrigation in proportion to their guaranteed annual off-takes of water for agricultural purposes. The total amount of capital allocated to power is shared equally by all the three participating governments. Capital up to Rs 14 crores allocated to flood control is shared equally by the Central Government and the government of West Bengal, and the excess, if any, is the exclusive liability of West Bengal. Each participating government is to provide its share of the capital on the dates specified by the Corporation, and in case of default the Corporation has the power to raise a loan with the consent of the Government of India to make up the deficit at the cost of the government concerned. Profit and loss is to be determined in respect of each of the three main objectives,

and, except for flood control, is to be distributed between the three participating governments in proportion to their respective shares in the total capital cost attributable to each objective. The capital provided by each participating government is not repayable, but carries interest at rates fixed by the Central Government.

Owing to the financial stringency throughout India during the early years of DVC, allocation of funds could not always be counted upon and often fell short of budget approvals. Later on, supplemental appropriations became available and greatly eased the strain on the construction programme.

One serious handicap concerned the import of heavy construction and electrical equipment. The acute shortage of dollars between 1949 and 1951 made it extremely difficult to procure necessary plant and equipment from the United States. However, the situation improved after April 1950, when the Government of India negotiated a loan of \$18.5 million from the World Bank for the construction of the Bokaro-Konar transmission project. Again in January 1953 the Government obtained a loan of \$19.5 million from the World Bank for the Maithon, Panchet Hill and the irrigation project in West Bengal. Later on, the Government of India surrendered \$9 million of the \$19.5 million sanctioned, since it was decided to utilize its sterling balances to meet the sterling portion of the expenditure covered by the loan. A third loan of \$25 million from the World Bank was approved in July 1958 for the purchase and installation of the fourth unit at Bokaro Thermal Station and the new Durgapur 150,000 kW thermal station.

There is always present the "inquisitive public" wanting to know how much will the venture cost and will the returns, if any, warrant the investment?

The Preliminary Memorandum on the scheme of Unified Development of the Damodar River dated August 1945 envisaged that flood control, irrigation and power, if constructed as single purpose projects, would cost about 74.5 crores of rupees (\$156 million). If, however, the total cost of the reservoirs and dams required in the unified development were allocated in proportion to the costs of reservoirs and dams which would have been required for the separate development, assuming a contingency of 15%, the over-all cost would be 55 crores of rupees (\$116 million). Of this amount Rs 14 crores would have been allocated to flood control, Rs 13 crores to irrigation and Rs 28 crores to power.

It is of interest to note that, up to the end of March 1960, a sum of Rs 141 crores had been already invested in the DVC project. This should not be taken to indicate that the DVC spent Rs 141 crores on works which could be constructed for Rs 55 crores. The DVC project was later integrated with the over-all development programme of the country and the original scheme has undergone considerable modifications and extensions. Table 49 indicates the changes and the estimated cost of the construction projects already sanctioned.

TABLE 49. AMENDMENTS AND MODIFICATIONS OF THE ORIGINAL SCHEME

Original scheme		Sanctioned so far	Estimated cost (engineering) Rupees (crores)
I. Power projects			
Bokaro thermal plant	150 MW	225 MW	60.60
Durgapur thermal plant	—	150 MW	
Chandrapura thermal plant	—	250 MW	
Hydro plants	200 MW	104 MW	8.83
	350 MW	729 MW	
Transmission lines	150 mi	1,251 mi	23.74
Substations	5	44	93.17
II. Irrigation			
Headworks	Diversion weir (no specification)	Concrete barrage (2271' long and 38' high)	3.56
Canals (length)	not specified	1,550 mi	15.08
Concrete structures	not specified	2,141	
New irrigable area	540,000 acres	753,000 acres	
III. Navigation canal	nil	85 mi	4.59
IV. Dams	8	4	
Storage capacity	47 lakhs AFT	29 lakhs AFT	41.70
Total			158.10

Table 50 indicates the total actual expenditure of DVC to end of the second plan period.

TABLE 50. ESTIMATED CAPITAL INVESTMENT UP TO END OF SECOND FIVE-YEAR PLAN PERIOD
(Actual expenditure up to 30 March 1960)
(Figures in crores of rupees)

Item	Estimated expenditure to 31 March 1961	Actual to 31 March 1960
Construction projects including navigation	120.98	113.52
Afforestation, soil conservation, agricultural development, public health and sanitation	2.52	2.14
Overhead and audit charges	3.33	2.98
Interest on capital	36.31	29.92
Ancillary services	2.16	2.11
	165.30	150.67
Operation and maintenance		
Working expenses	13.78	9.70
Receipts from sale of power and misc. irrigation receipts	27.20	19.68
Net expenditure	151.88	140.69
Allocation		
Power	82.32	76.01
Irrigation	42.23	39.43
Flood control	19.24	18.36
Subsidiary objects	8.09	6.89
Total allocation	151.88	140.69

A distressing feature of the DVC Act is the provision for payment of interest to the participating governments, since this had led to over-capitalization. Table 50 indicates that the total estimated expenditure of Rs 151.88 crores to end of 31 March 1961 includes interest

amounting to Rs 36.31 crores, which works out to 31%. As interest is payable half-yearly, funds have to be drawn from government for payment of interest obligation to government with the result that every time such funds are drawn to meet interest payments they become capitalized. Interest is compounded semi-annually. Strictly speaking, no payment takes place, but the procedure involves an artificial inflation of the capital account, with adverse repercussions on the revenue account.

The four dams, the three hydro plants and the Bokaro thermal power plant are already in operation. The Durgapur power plant has been commissioned early in 1961. The Durgapur barrage was completed in 1955, and began supplying water for kharif irrigation in 1956. The work on the canal system was completed in July 1959, but the floods of October 1959 caused serious damage to the canal structures, involving an expenditure of about Rs 82 lakhs on restoring the damages to the irrigation and the navigation canals. The work is in progress and is to be completed by July 1962, when the navigation canal is to go into operation. The work on the Chandrapura power plant with the associated transmission lines is to be completed some time in 1964/65, and the plant will go into full operation possibly in 1964/65. All transmission lines and substations, except those associated with the Chandrapura thermal power plan will be completed by 1962/63.

Benefits

In arriving at an appraisal of direct and indirect benefits it should be borne in mind (water sales being incidental) that only investments in power and irrigation features produce direct cash benefits. Investment in flood control works yields no income, but over the years prevents the loss of life, property and thus saves huge sums of

would help substantially to reduce the interest charges by as much as Rs 48.0 lakhs, and will consequently reduce the deficit of Rs 66.0 lakhs in the irrigation account to Rs 18.0 lakhs per annum. Under Section 37 of the DVC Act, the annual deficits on the irrigation and flood control accounts will be met by the state governments—in this case the burden will fall almost entirely on West Bengal. Taking the irrigation and flood control sections together, the deficit will be Rs 94.0 lakhs, even after the betterment levy is wholly collected. It is, therefore, of the utmost importance that the West Bengal government should commence collecting the betterment levy before 1963-64, when it is obligatory under Section 39 for the Corporation to open its revenue accounts.

This indicates a deficit of Rs 77 lakhs per annum, which may be reduced to Rs 66 lakhs on full development in 1954/55 (see table 54).

Irrigation benefits

Reckoned in terms of cash receipts, the irrigation account will not pay its way unless water rates are increased and the possibilities of industrial and domestic water are fully exploited. If, however, the indirect benefit in the form of additional crops is taken into account, the investment may be said to be sound. Table 52 shows the annual additional yield of crops and their value.

TABLE 52. ANTICIPATED ANNUAL WEALTH FROM NEWLY IRRIGATED LAND

Crop classification	Rupees (crores)
Kharif	7.53
Rabi	4.95
Jute	3.60
Total	16.08

Electric power

There is an acute shortage of electric power throughout the valley, and the Central Water and Power Commission has estimated the growth of power demand in the region to be 125,000 kW every year for the next seven years. It is, therefore, essential that at least one thermal unit of 125,000 kW is installed every year. The Corporation has submitted proposals for additional plants during the third five-year plan period, in addition to those already sanctioned.

Development work

The Corporation is required, under Section 12 of the Act, to undertake certain development activities, such as afforestation, soil conservation, public health, agricultural, industrial, economic and general well-being in the Damodar valley and its area of operation. Such expenditure is treated as common expenditure, divisible equally between the three participating governments. It is also authorized, under Section 21, to establish, maintain and operate laboratories and research stations and farms for conducting experiments, research, etc. The expenditure incurred on this account up to the end of 1955-56 was Rs 125 lakhs. Table 53 indicates the expenditure incurred on this account to end of 1959/60, and estimated expenditure during the year 1960/61, the last year of the second five year plan period.

TABLE 53. DEVELOPMENT EXPENDITURES DURING THE SECOND FIVE-YEAR PLAN PERIOD

(In 100,000 rupees)

Item	Actual to 31 March 1960	Estimate 1960/61	Total to 1960/61
Afforestation	32.46	10.50	42.96
Soil conservation	84.10	9.96	94.06
Land use	39.86	7.05	46.91
Agricultural development ..	29.19	7.48	36.67
Industrial development ...	13.10	0.12	13.22
Research station	0.82	0.54	1.36
Public health and sanitation	14.41	2.65	17.06
Total	213.94	38.30	252.24

The participating governments have decided to restrict such development to activities directly connected with the proper maintenance of reservoirs and canals, agricultural demonstrations, pisciculture and small industries for utilization of power. Any further development activities in the third five-year plan period will be restricted to such amounts as the three participating governments are able and willing to release for such purposes. The Corporation has, however, submitted proposals for expenditures amounting to Rs 250 lakhs on afforestation and soil conservation.

Financial forecast

Section 39 of the DVC Act states that, "for a period not exceeding 15 years from the establishment of the Corporation, if the Corporation runs in deficit, the interest charges and all other expenditure shall be added to the capital cost and all receipts shall be taken in reduction of such capital cost". This 15-year period expires in 1963/64, when it is obligatory on the part of the Corporation to open revenue accounts under each of the three main objectives. It was anticipated in 1958 that the Chandrapura power plant would be commissioned in 1962/63, so that the Corporation would earn an over-all surplus during that year. As, however, there was considerable delay and difficulty in concluding the supply contract with the equipment manufacturers, there is no prospect of the earlier hopes being fulfilled. As far as can be foreseen at present, the two units will probably be commissioned in 1964/65. Table 54 indicates that there will be an over-all deficit in 1962/63, which will continue until 1965/66, when the Chandrapura thermal power plant will be in full operation. Formal revenue accounts will, therefore, be opened in 1963/64:

TABLE 54. FORECAST OF REVENUE BEGINNING 1962/63
(In 100,000 rupees)

Item	1962/63	1963/64	1964/65	1965/66
Power	+114	+117	+122	+185
Irrigation	— 85	— 77	— 66	— 66
Flood control ..	— 73	— 76	— 76	— 76
Net	— 44	— 36	— 20	+ 43

The deficits under irrigation and flood control, with effect from 1963/64, will be recoverable from the participating governments (mainly from the government of

West Bengal), while the surplus on the power account will be shared by the three governments in equal proportions.

In 1962/63, depreciation arrears in the power account will aggregate Rs 6.00 crores (or Rs 6.77 crores with interest @ 3½%), and will be a first charge on the profits before there can be any question of their distribution between the three participating governments, which, will, however, be relieved of the interest charges of Rs 373 lakhs on the power capital aggregating 87.12 crores, and also of the need to find further capital for normal expansion of new power plants after 1964/65. With the surplus

accruing after 1962/63, depreciation and reserve and other funds will be created under Section 40 of the DVC Act.

Details of operating revenues (receipts) and general expenses, including interest, depreciation, overhead, operating and maintenance costs for the three object features are shown in tables 55, 56 and 57 respectively.

TABLE 56. IRRIGATION OPERATION REVENUES AND EXPENSES
(In 100,000 rupees)

Receipts	1962-63	1963-64	1964-65	1965-66
Kharif	78	85	85	85
Rabi	6	9	15	15
Industrial use ...	20	25	30	30
Miscellaneous	5	5	5	5
Total	109	124	135	135
<i>Expenditure (Operation and maintenance)</i>				
Canals	41	44	44	44
Dams	11	11	11	11
Depreciation	5	5	5	5
Interest	137	141	141	141
Total	194	201	201	201
Deficit	85	77	66	66

Note: Based on water rates @ Rs 10/- per acre for kharif and Rs 15/- per acre for rabi irrigation.

TABLE 55. FLOOD CONTROL DEFICITS
(In 100,000 rupees)

	1962/63	1963/64	1964/65	1965/66
Capital in use	1,890	1,961	1,961	1,961
Receipts	—	—	—	—
<i>Working expenses</i>				
Interest	59.0	62.0	62.0	62.0
Depreciation of dams	2.27	2.27	2.27	2.27
Maintenance and operation of dams	11.75	11.75	11.75	11.75
Deficit	73.02	76.02	76.00	76.00

TABLE 57. POWER OPERATING REVENUES AND EXPENSES
(In 100,000 rupees)

Item	Up to end of	Second plan period					Third plan period				
	1955/56	56/57	57/58	58/59	59/60	60/61	61/62	62/63	63/64	64/65	65/66
1. Installed capacity (MW)	—	154	174	214	364	479	479	479	479	604 ^a	729 ^a
2. Capital in use (crores)	—	25.46	30.47	39.96	45.39	60.35	85.59	85.89	87.12	113.51	120.45
3. Gross receipts	321	200	349	477	616	750	994	994	1,007	1,273	1,437
4. Working expenses:											
Maintenance and operation ...	230	93	162	206	204	284	390	390	392	482	536
Depreciation	81	45	48	56	60	66	122	122	125	177	192
Interest on capital	196	100	122	161	187	264	368	368	373	492	524
Total (4)	507	238	332	423	451	614	880	880	890	1,151	1,252
5. Net Surplus (+)	—	— 38	+ 17	+ 54	+ 165	+ 136	+ 114	+ 114	+ 117	+ 122	+ 185
Deficit (—)	—	—	—	—	—	—	—	—	—	—	—
Accumulated surplus/deficit ..	—186	—224	—207	—153	+ 12	+ 148	+ 262	+ 376	+ 493	+ 615	+ 800

^a It is assumed that the first unit of the Chandrapura thermal power plant will be in operation in 1964/65, and the second unit in 1965/66.

ORGANIZATION AND ADMINISTRATION

The Corporation as a policy-making functional body

Serious consideration had been given to whether the Corporation should be a policy-making or functional type organization.

A functional organization is one in which a member of the Corporation also serves as head of a division, for instance, the engineer-member would usually be the Chief Engineer of the Corporation, the finance member would head up the financial and accounting divisions, etc. The policy-making organization on the other hand applies itself generally to policy matters, administration and to making the Corporation a going concern.

DVC was established as an autonomous Corporation to frame its own plans and programmes subject to the Central Government's right to regulate policy decisions and to exercise certain powers of laying down rules on specific matters (see sections 48, 59 and 60 of the Act). There has been no change in its "terms of reference" since it was originally established.

The DVC Act of 1948 vested the Corporation with a high degree of autonomy insofar as it concerned organization and management. This freedom of action also encompassed wide latitude in matters of administration. The Central Government only reserved itself the authority to appoint the Financial Advisor.

It was the first time in Indian history that a public corporation had been created. The underlying reason for its creation was to free it of departmental interference, financial controls and the red tape inherent in the official form of administration, preventing flexibility of operation, efficiency and enterprise.

The Act conferred upon the Corporation the authority "to do anything which may be necessary or expedient for the purpose of carrying out its functions under the Act".

On passage of the Act the Corporation established a nucleus organization to plan and design engineering works. Some of personnel selected were transferred from the Central Technical Power Board. Of prime importance was the creation of an engineering team headed by a capable chief engineer, although the selection of the latter did not take place until December 1950, when Mr. A. M. Komora was appointed. In early 1950, a Board of Consultants was engaged. This Board consisted of Mr. L. F. Harza, President, Harza Engineering Company, United States, Mr. S. O. Harper, former Chief Engineer of the United States Bureau of Reclamation; Mr.

Venkatachari, Chief Engineer to the government of Madras; later on in the year Mr. Kanwar Sain, member of the Central Water and Power Commission of India became the fourth member.

The Tilaiya dam was the first project to be undertaken with local forces headed by a construction supervisor, Mr. Fergusson of the United States. In February 1950, Gruner Bros., a Swiss firm was appointed Consulting Engineer for the Konar project, and in May 1950 a contract for the construction of the Konar dam was awarded to Hind Construction Ltd. and Patel Engineering Co. Ltd. The construction of the transmission lines and substations was undertaken departmentally with local force. The Bokaro thermal plant was engineered by the Kuljian Corporation of the United States.

Qualifications of members of the Corporation, Executive Secretary and Financial Adviser

Qualifications of the three corporation members were not laid down on the basis of actual detailed job descriptions. However, it was stipulated that no one could become a member of the Corporation if they (i) had a financial interest in contracts which related to the performance of services to the Corporation and (ii) or was a member of the Central or state Legislature.

In general, it was understood that a member was expected to possess the highest integrity, incorruptibility, high intelligence and a clear concept of economic development in India along modern scientific lines, especially in the industrial and agricultural field; alignment of economic life on a co-operative basis, and a fairly wide experience in national affairs.

The qualifications of the Financial Adviser and the Secretary are not specifically provided for in the Act. In general, candidates for these positions are selected on the basis of their education and background experience. The conditions of service of the members of the Corporation, the Financial Adviser and the Secretary are regulated by the rules framed by the Central Government.

Office of the Chief Executive Officer

The office of the Secretary and General Manager is at Calcutta, which was chosen mainly because of its excellent communications and the possibility of easy contact with banks, trade centres and one of the participating governments.

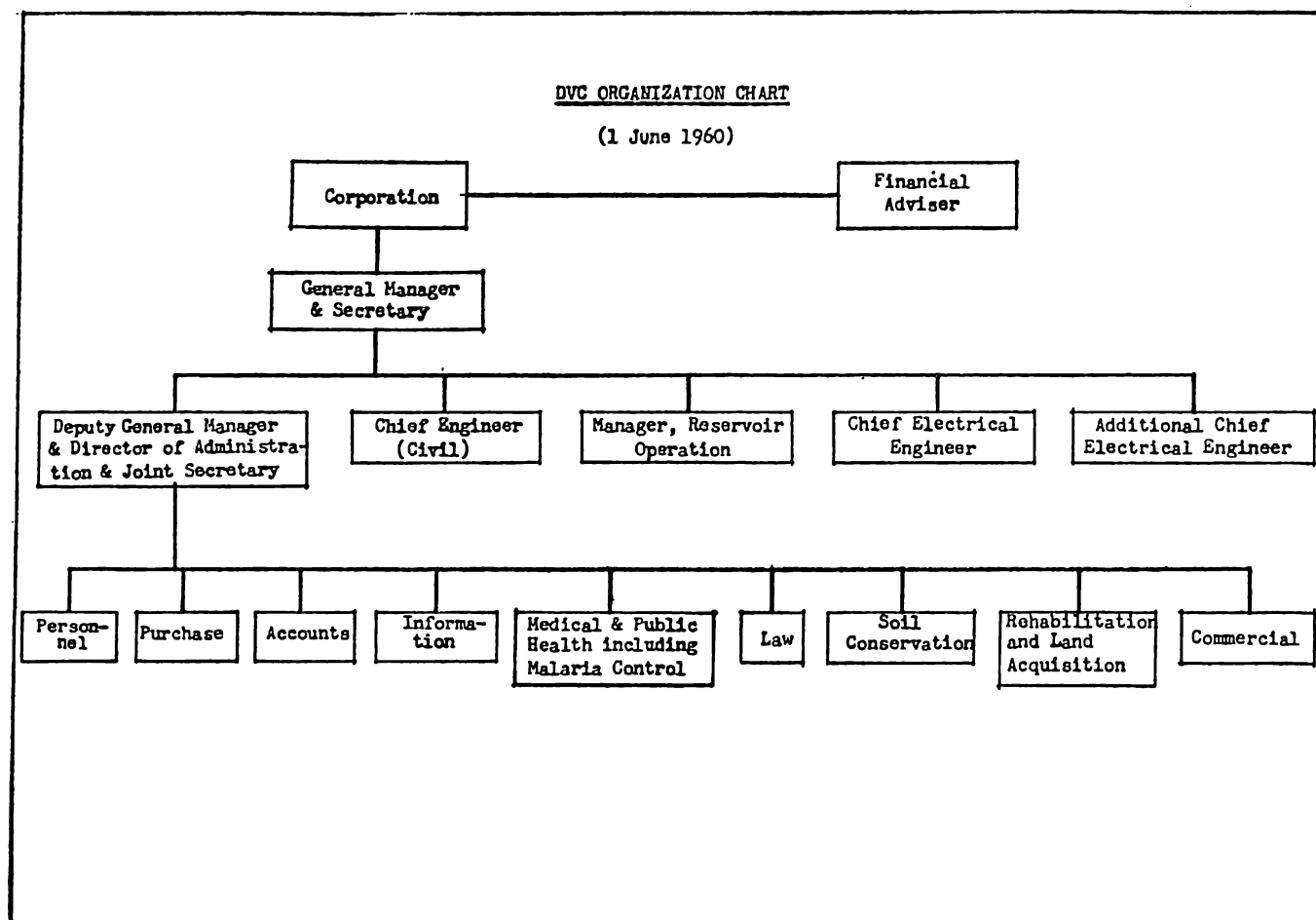


Figure 39. CORPORATION'S ORGANIZATION CHART.

An examination of the corporations organization chart (see figure 39), shows that five major officials report directly to the Secretary namely the Director of Administration and Joint Secretary, the Chief Engineer (Civil), the Chief Electrical Engineer (Operation) the Additional Chief Electrical Engineer and the Manager of Reservoir Operations.

The post of Director of Administration and Joint Secretary, with headquarters at Calcutta, was created in July 1957. Its function is to relieve the Secretary of day-to-day administrative details. Under the Director of Administration and Joint Secretary there are nine subordinate offices, namely, Personnel, Purchase, Accounts, Information, Medical and Malaria Control, Law, Soil Conservation, Rehabilitation and Commercial.

Figures 40 to 49 give in greater detail the organizational structure of the Corporation.

The Civil Engineering Department

The Chief Engineer (Civil), with headquarters at Maithon, is the Director of the Department of Civil Engineering (see figure 40).

More than two years elapsed after the establishment of DVC before a Chief Engineer was appointed. During the interim period, a Board of Engineers was in charge of

various engineering activities. This arrangement was not altogether satisfactory, and the confusion resulted in constructional delays and entailed unnecessary cost. Later, a Board of Consultants was called in to give advice on design and construction.

The principal concern of the Civil Engineering Department is the planning, designing and construction, as well as operation and maintenance, of dams, barrages, canals and other civil works. The Barrage and Irrigation Project is under the direct charge of a Deputy Chief Engineer (see figure 41) while the maintenance and operation of the dams are under the direct charge of a Superintending Engineer with headquarters at Maithon. This Department also operates a number of Service Organizations, such as the Mechanical and Fabricating Workshop, the Motor Maintenance Workshop, the Field Engineering Service Division and the Disposal Organization.

The chief office consists of three subordinate offices, namely, Superintending Engineer in charge of Planning and Design, Superintending Engineer (Dam Circle) and Officer in charge of the workshop.

The Electrical Department

The Chief Electrical Engineer (Operation and Maintenance) is stationed at Calcutta. He is assisted by two Deputy Chief Electrical Engineers, one in charge of

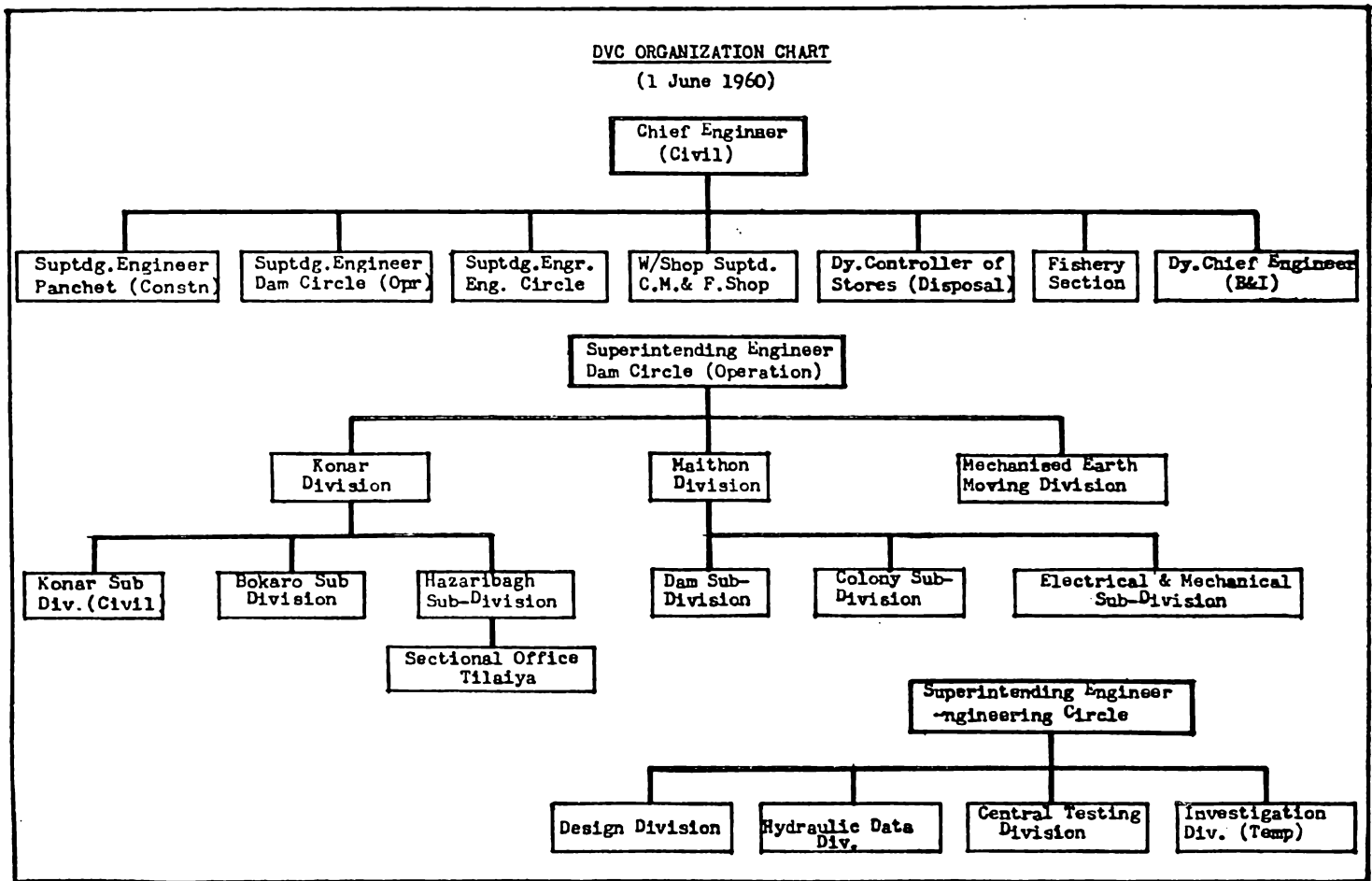


Figure 40. ORGANIZATION CHART, OFFICE OF CHIEF ENGINEER.

generation, with headquarters at Calcutta, and the other in charge of transmission with headquarters at Maithon. This Department functions through four subordinate offices, three of which are responsible for power generation, power transmission, and engineering and planning; the fourth is called the Central Relay, Mobile and Laboratory Division. Figure 42 shows the organizational chart of the Chief Electrical Engineer.

The Additional Chief Electrical Engineer (Construction), with headquarters at Calcutta, is responsible for engineering, planning and construction of power houses and transmission lines. He is assisted by a Deputy Chief Electrical Engineer stationed at Calcutta. Figure 43 shows the organization of the Additional Chief Electrical Engineer (Construction).

The Personnel Department

The Personnel Department is responsible for personnel management and administration of the Corporation. Its headquarters are at Calcutta.

The Department is concerned with the recruitment and termination of employees, and transfers and promotion. It maintains personnel records, conducts a training programme, promotes safety measures and sponsors welfare and social activities.

Employees of the Corporation are classified under the following categories (1) regular (permanent), chargeable to establishment (2) work-charged (monthly rated) and (3) muster roll (daily rated) chargeable to specific work.

At the height of construction activities, there were almost 25,000 employees on the DVC payroll. The construction work was accomplished almost entirely with departmental employees.

By the beginning of 1960, almost all authorized construction had been completed, and employment dipped to almost 21,000 workers. Most of these employees are engaged in the operation and maintenance of the completed projects.

Many of the people who were laid off have since been given work on projects in other areas, these numbered about 4,000.

Many of the technical staff were originally engaged on a contract basis with terms extending for as long as three years. As construction activities drew to a close, contracts were tendered for shorter periods. This, however, was considered a temporary measure pending the establishment of a permanent organization. Job descriptions for each permanent position are contemplated.

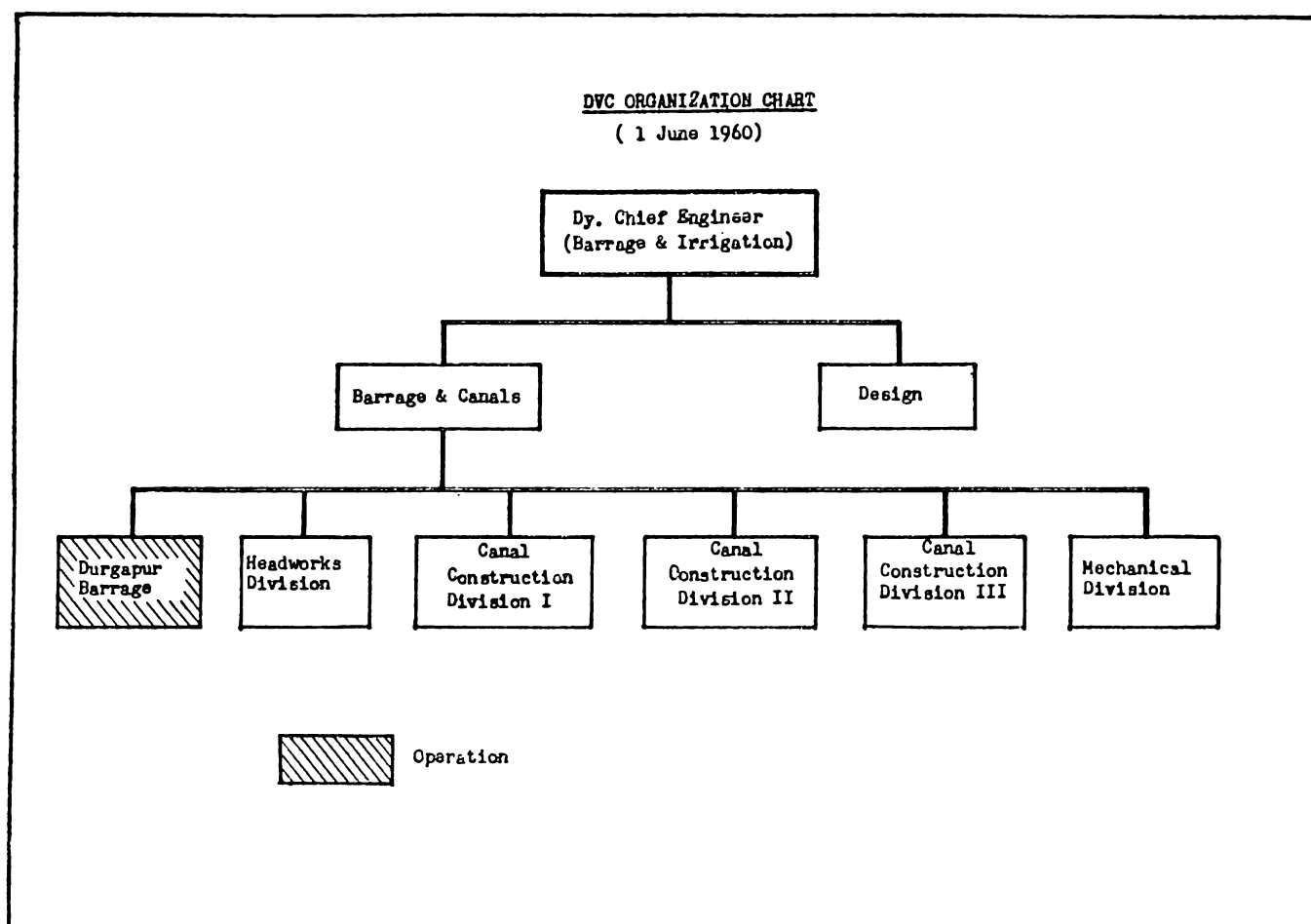


Figure 41. ORGANIZATION CHART, OFFICE OF DEPUTY CHIEF ENGINEER FOR BARRAGE AND IRRIGATION.

Each employee on the regular payroll earns annual and sick leave. Annual leave with full pay is accrued on the basis of 1/11 of the period the employee is on duty each year. One can accumulate such leave up to 180 days, with maximum time off not exceeding 120 days. Sick leave is accumulated at the rate of 20 days each year. For extended illnesses, salaries continue at the full rate for 120 days and at half rate up to 240 days.

Employees remuneration, benefits and pensions

The scale of pay of the various officers and staff is fixed on the basis of the responsibilities and duties attached to each post. The Corporation generally follows the scale of pay sanctioned by the Government of India in respect of their own employees, with such minor changes as may be considered necessary to meet local conditions of service. Employees are entitled to the benefits of the Contributory Provident Fund. Under this scheme, each employee is required to subscribe a minimum amount of $6\frac{1}{4}\%$ of the salary received. Each month, the Corporation subscribes a sum equal to $8\frac{1}{3}\%$ of the basic payroll including compound interest on the total amount. The money thus collected is invested in government securities. The Corporation is now considering the advisability of introducing a pension scheme for its permanent staff.

Each employee is covered in case of injury while actually employed by the Workmen Compensation Act of India of 1923 (Section VIII of 1923).

The Personnel Officer, in co-operation with the Reporting Officer of each department, makes a confidential character and work assesment report of each employee. Forms PL/F-1; PL/F-2; PL/F-3 and PL/F-4 are used as appropriate and appear in the appendices IV, V, VI and VII.

If the performance of an employee is unsatisfactory, he or she is given reasonable opportunities to overcome the deficiency. Before final action is taken, he or she is placed in another division, and the report of the head of that division is taken into account. If the Reporting Officer confines the report along generalities no action is taken against the employee. The employee has the right of appeal to the Corporation. If the employee is dissatisfied with work conditions and the environment, efforts are made to arrange his or her transfer to some other position.

Safety measures adopted by DVC

DVC does not employ a safety engineer as is customary in many projects. However, work is carried out under the direction of the Personnel Department through two agencies in the field. Safety standards, prescribed by the ILO and the Labour Commissioners of the Government, are followed. These are communicated to the Construction Engineers first for adoption, and then followed up by the other agency, namely, the local Welfare Organizations, which are headed by Welfare Officers.

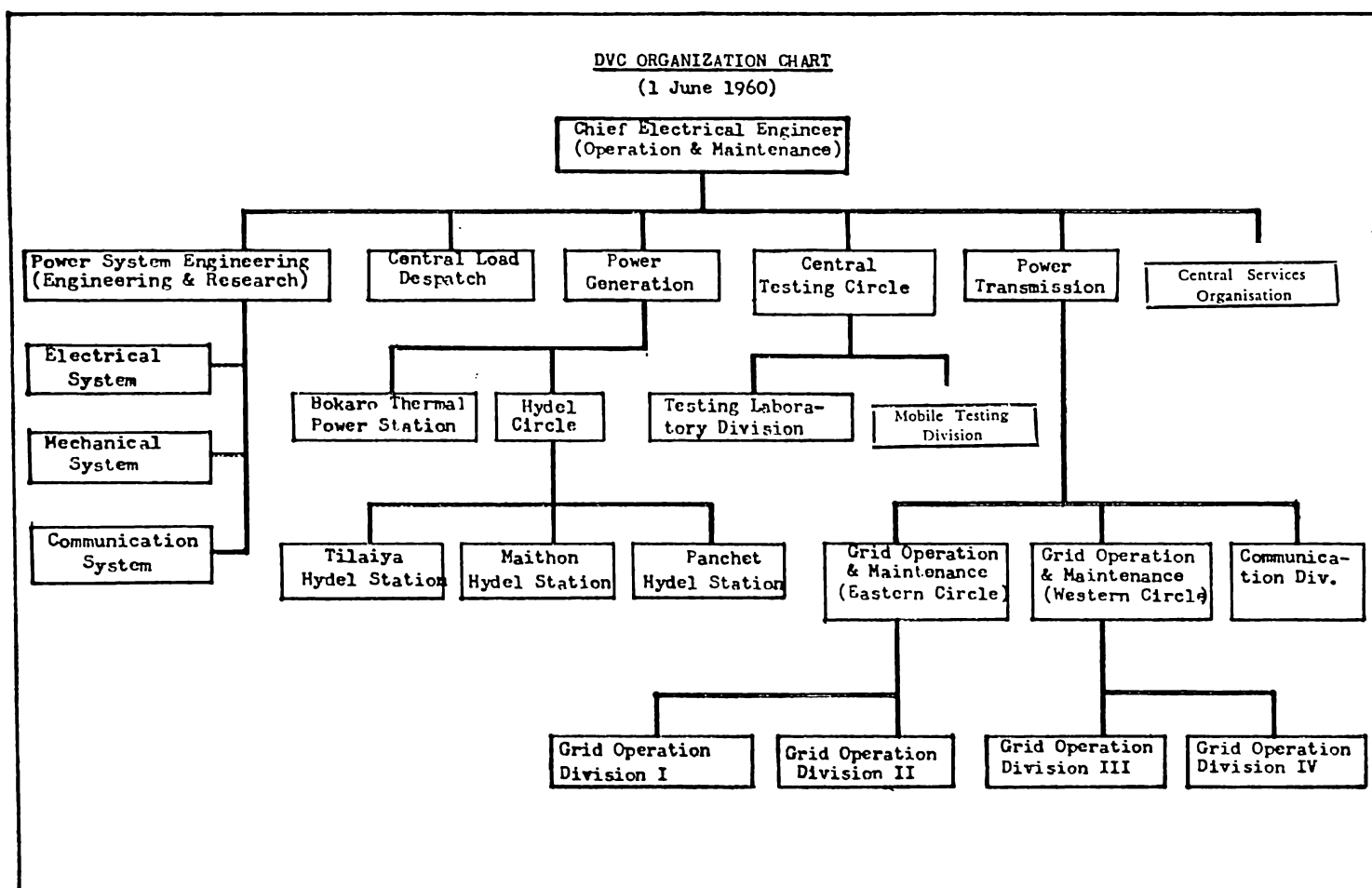


Figure 42. ORGANIZATION CHART, OFFICE, OF CHIEF ELECTRICAL ENGINEER FOR OPERATION AND MAINTENANCE.

The number of accidents, including minor accidents, during the last 3 years were 96 in 1957/58, 105 in 1958/59 and 95 in 1959/60.

Figure 44 shows the organizational structure of the Corporation's key staff, the Director of Personnel, Controller of Purchase and Stores.

School and welfare facilities

The Corporation has established accredited school facilities for the children of its employees. At Bokaro, a basic school and high school is functioning. Basic and primary schools have also been established at the Maithon, Panchet Hill and Durgapur projects.

The training programme

The Personnel Department is responsible for the training programme, and its activity's are divided into three categories, namely, (i) the training of DVC's own personnel in DVC, (ii) the training of DVC personnel under outside agencies, including training abroad, and (iii) the training of outsiders, including foreigners, in DVC.

(i) DVC has comprehensive training schemes for its engineers, technicians, operators and accounts personnel, who are regular employees and apprentices. Specific syllabuses and courses are followed. Although the apprentices enjoy

many of the facilities of DVC employees, their employment in the regular DVC service is conditional on the successful completion of their training. Examinations are held on completion of each training course, and successful candidates are promoted.

(ii) Under the second category, DVC participates in the different technical assistance programmes offered by national and international agencies, and sponsors, from time to time, its employees for training abroad under the auspices of these programmes. Besides, DVC also has its engineering personnel trained by the suppliers and manufacturers of equipment (particularly electrical) in foreign countries. If the necessary facilities are available in the country, DVC arranges for the training of its personnel by such firms.

(iii) Under the third category, DVC provides postgraduate training to recent engineering graduates. The Government of India handles their selection and posting to DVC. DVC also receives undergraduate engineering students for training. Technicians and mechanics trained in the different trade schools in the country are accepted for in-plant training by DVC. Employees of different state governments and projects in the country, such as engineers, soil scientists and accountants, are received and given training in the various plants and offices of DVC. Foreigners also

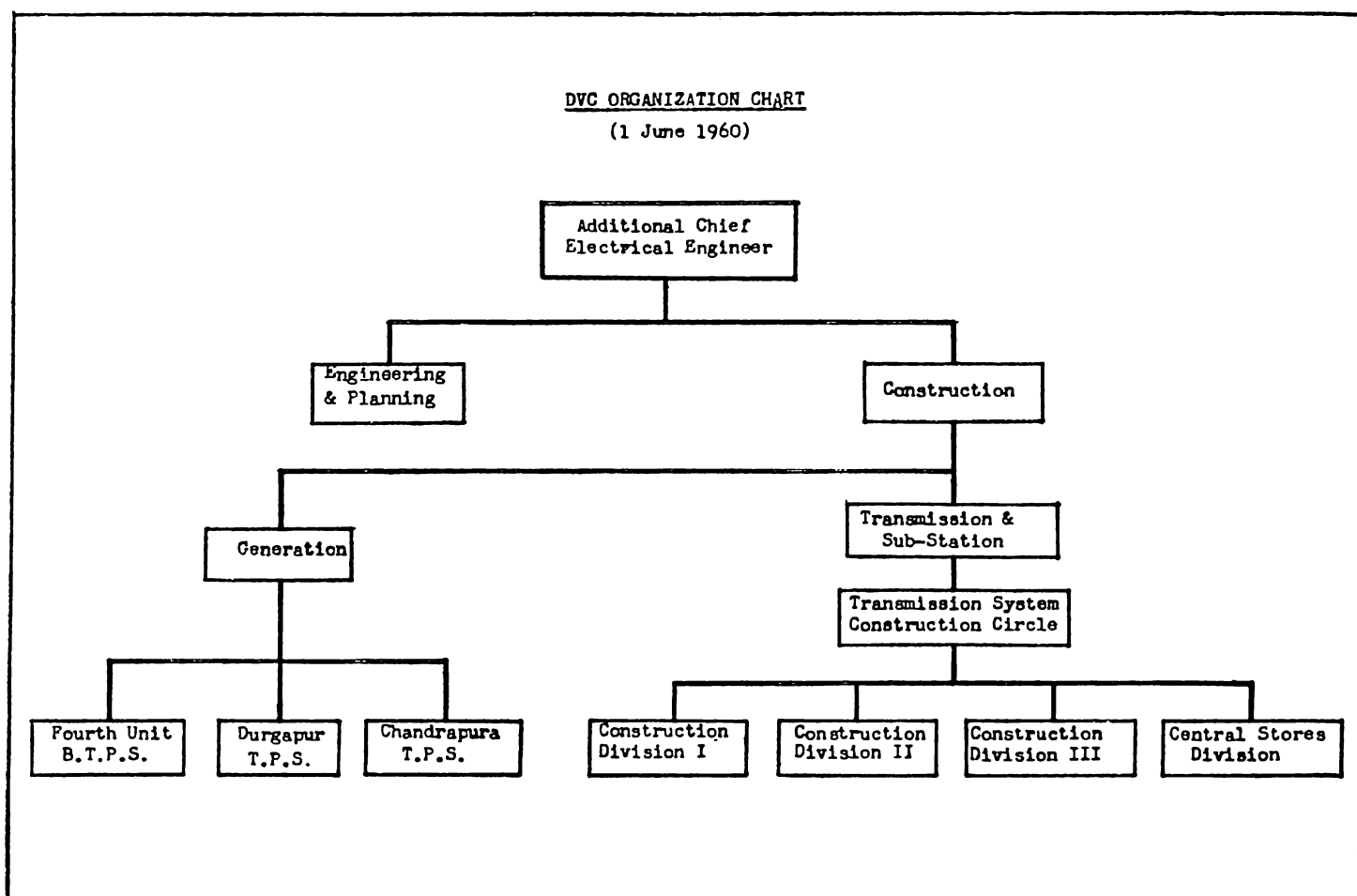


Figure 43. ORGANIZATION CHART, OFFICE OF ADDITIONAL CHIEF ELECTRICAL ENGINEER.

come to India for study and training, sponsored by international organizations. DVC provides all facilities for training under this category and the cost is borne by the sponsoring authorities.

All trainee personnel sent to a foreign country are required to enter into a contract with the Corporation as a guarantee for the investment made. Trainees whose expenses are chargeable to foreign assistance programmes are required to enter into a 3-year contract; those sent abroad at the expense of the Corporation are required to enter into an agreement for five years. As at March 1960, 75 trainees had been sent abroad for specific training. Of this number, five had breached their contracts and of this five, three had reimbursed the Corporation for its expenditures; the remaining two have had suits filed against them by the Corporation.

The Accounting Department

The Chief Accounts Officer has his headquarters at Calcutta, where the consolidated accounts of the Corporation are maintained (see figure 45). In 1950, accounting work was decentralized, and branch offices were established at Bokaro, Maithon, Tilaiya, Hazaribagh and Konar. A Personal Ledger Account is held in the Reserve Bank of India, at Calcutta, whence funds are transferred to the treasuries, depending on the requirements of the Field

Accounts Offices. Every officer authorized to incur expenditure out of the Corporation's funds was placed in account with one of these field accounts officers, who function as treasury officers, internal auditors, accounting officers and general advisors to the Executive Officer placed under their accounts jurisdiction.

The Financial and Works Accounts of the projects and units are maintained by the field accounts officers who prepare a monthly classified account of the transactions of their office for submission to the Chief Accounts Officer at Calcutta. The latter officer then compiles a consolidated account of all accounting activities (including his own), and submits the statement to the Corporation at the end of each month. By March 1960, the Accounts Department had disbursed and accounted for a sum of Rs 379 crores (US\$800 million). (Rs 141 crores on Capital account and Rs 238 lakhs on other accounts).

Government rules which apply to accounting procedures are being adhered to as far as practicable, consistent with requirements of the administration. Statutory audit is conducted by an officer of the Indian Audit and Accounts Department, with headquarters at Calcutta, and is assisted by Branch Audit Officers stationed in the field.

Another function of the Central Accounts Office is to maintain the employees' "Contributory Provident Fund Account". The balance credit of the fund on 30 March

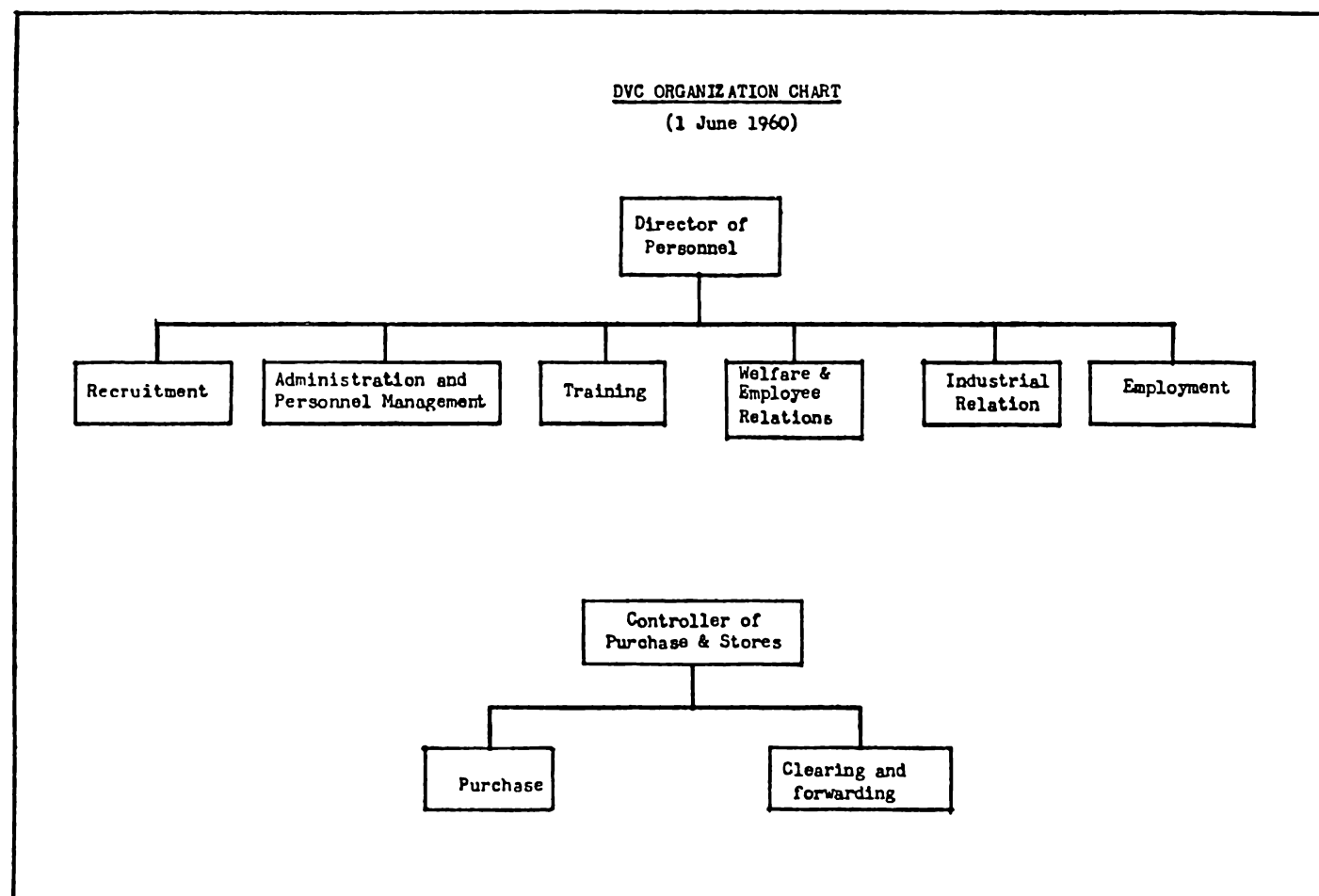


Figure 44. ORGANIZATION CHART, OFFICE OF DIRECTOR OF PERSONNEL; CONTROLLER OF PURCHASE AND STORES.

1960 was Rs 122.60 lakhs, of which Rs 109.54 lakhs (US\$ 2,300,000) has been invested in government securities.

Cost accounting

During the early period of construction, a cost accounting system was introduced. Owing to the difficulty of reconciling accounts maintained under the engineer's classification and that adopted in the "works account", a new classification of accounts was instituted in November 1954. The system now successfully employed is the uniform classification of accounts promulgated by the United States Federal Power Commission of 1935 and adopted by both private and public utilities throughout the United States, TVA and the United States Bureau of Reclamation.

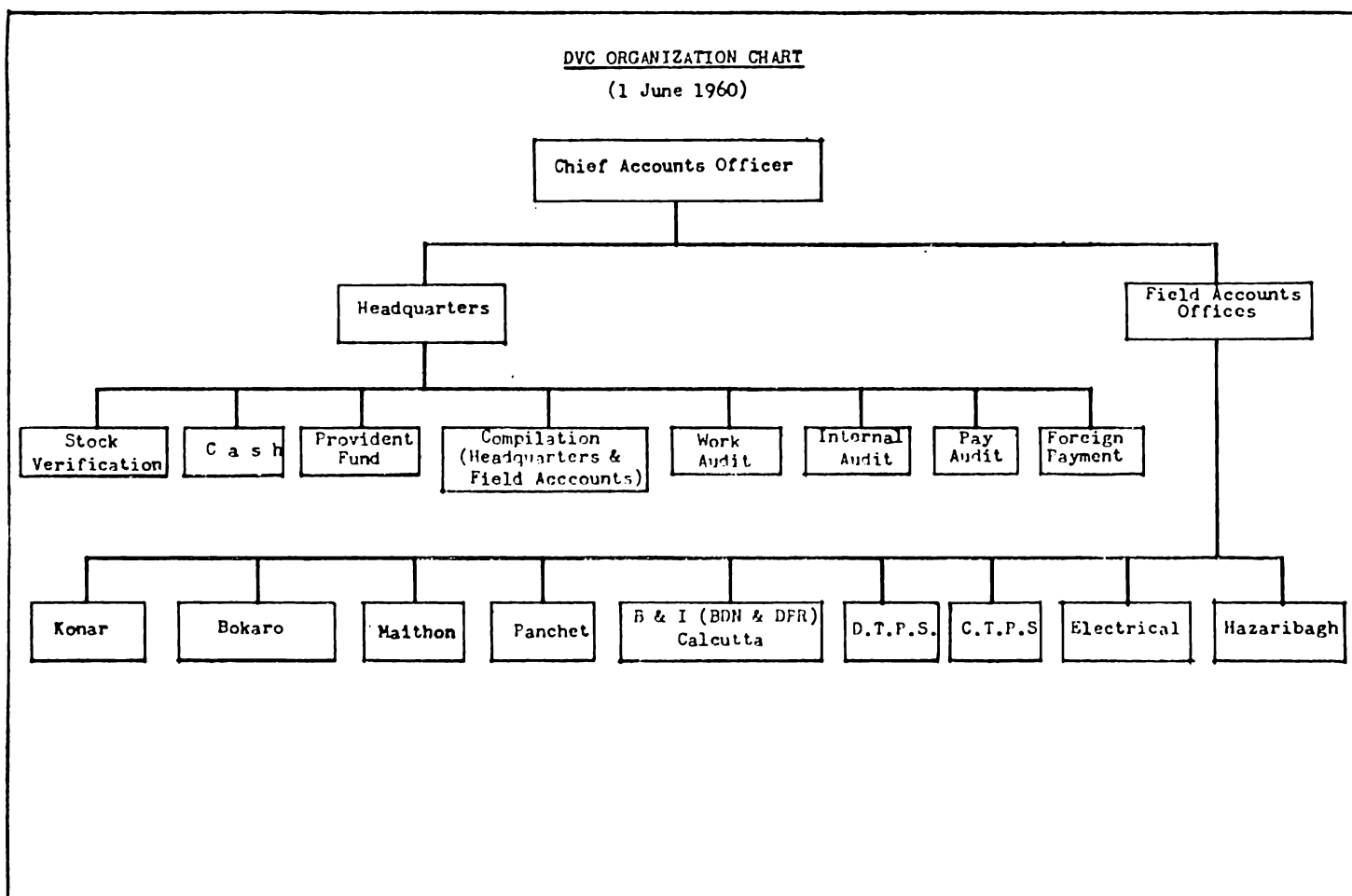
The Purchase Department

The Office of Controller of Purchases and Stores was created immediately after the inception of DVC. Its headquarters are at Calcutta. Originally, it was decided to utilize the Central Purchase Organization of the Government of India. However, it was soon realized that the Corporation's objectives could not be implemented if it had to depend on the government organization. A compromise was eventually worked out, enabling the

Corporation to avail itself of the services of the central purchasing agency whenever possible, and when the delivery period was longer than 6 months and the monetary value exceeded Rs 50,000, but ensuring that full advantage be taken of the "rate contract" system.

Purchase requisitions for stores and equipment are placed by the various departments with the Purchase Branch. Purchases not exceeding Rs 10,000 are circulated among suppliers on the approved list of the Corporation; orders from Rs 10,000 to Rs 100,000 are publicly advertised in the Indian Trade Journal; for orders exceeding Rs 100,000, public notification is given to the Indian Trade Journal and leading newspapers in Calcutta, Delhi, Bombay and Patna to secure competitive bids. For orders exceeding Rs 200,000, Corporation approval is required. Upon receipt of bids to furnish certain commodities, comparative statements are prepared and, assuming equal circumstances, the order is placed with the lowest bidder; otherwise there must be adequate justification for any departure prior to placement of order.

The Purchase Department maintains a "clearing" and "forwarding" section to facilitate imported supplies from docks as well as local suppliers for subsequent shipment to work sites. Insurance sections form a part of this organization.



Figures 45. ORGANIZATION CHART, OFFICE OF CHIEF OF ACCOUNTS.

The Purchase Department also maintains a "screening committee" to scrutinize purchase orders for spare parts to ensure against duplication and other stocking (see figure 44).

The Information Department

The Chief Information Officer has his headquarters at Calcutta and is helped by an Assistant Information Officer (see figure 39). A Public Relations Officer is attached to the Information Department, which is also situated at headquarters. In the field, there are two assistant Public Relations Officers with offices at Maithon and Bokaro.

The Information Department is responsible for the dissemination of information concerning Corporation activities through various mediums, such as press conferences and release films, photographs, charts, models, periodicals and public gatherings.

The primary duty of the Public Relations' personnel is to maintain healthy relations with the clients of DVC, to conduct tours of "press parties" and other official visitors, and to co-operate in every way with the Information Chief to make the Department both the sounding-board and the spokesman of the Corporation.

The Medical Department

The Chief Medical Officer, with headquarters at Calcutta, is responsible for hospital and dispensary service and for malaria control (see figure 46). DVC has established four well-equipped hospitals at Maithon, Bokaro, Panchet Hill and Durgapur. Each hospital has an average of twenty beds, and is equipped with ambulances. It also operates eleven dispensaries; these are located at Calcutta headquarters, Tilaiya, Konar, Bokaro, Maithon, Panchet Hill, Durgapur, Kanainatshal, Sonamukhi and Bermo Colliery. A photograph of the Bokaro hospital is shown in figure 47.

Since the establishment of the Medical Department, there have been no epidemics of infectious diseases or malaria among the labouring group. Inoculations and vaccinations are given against cholera, smallpox and typhoid.

The Soil Conservation Department

The headquarters of the Soil Conservation Department are at Hazaribagh in Bihar. The office reports directly to the Director of Administration and Joint Secretary.

A detailed description of the functions of the office is given earlier in this text. The Department's organizational chart is shown in figure 48.

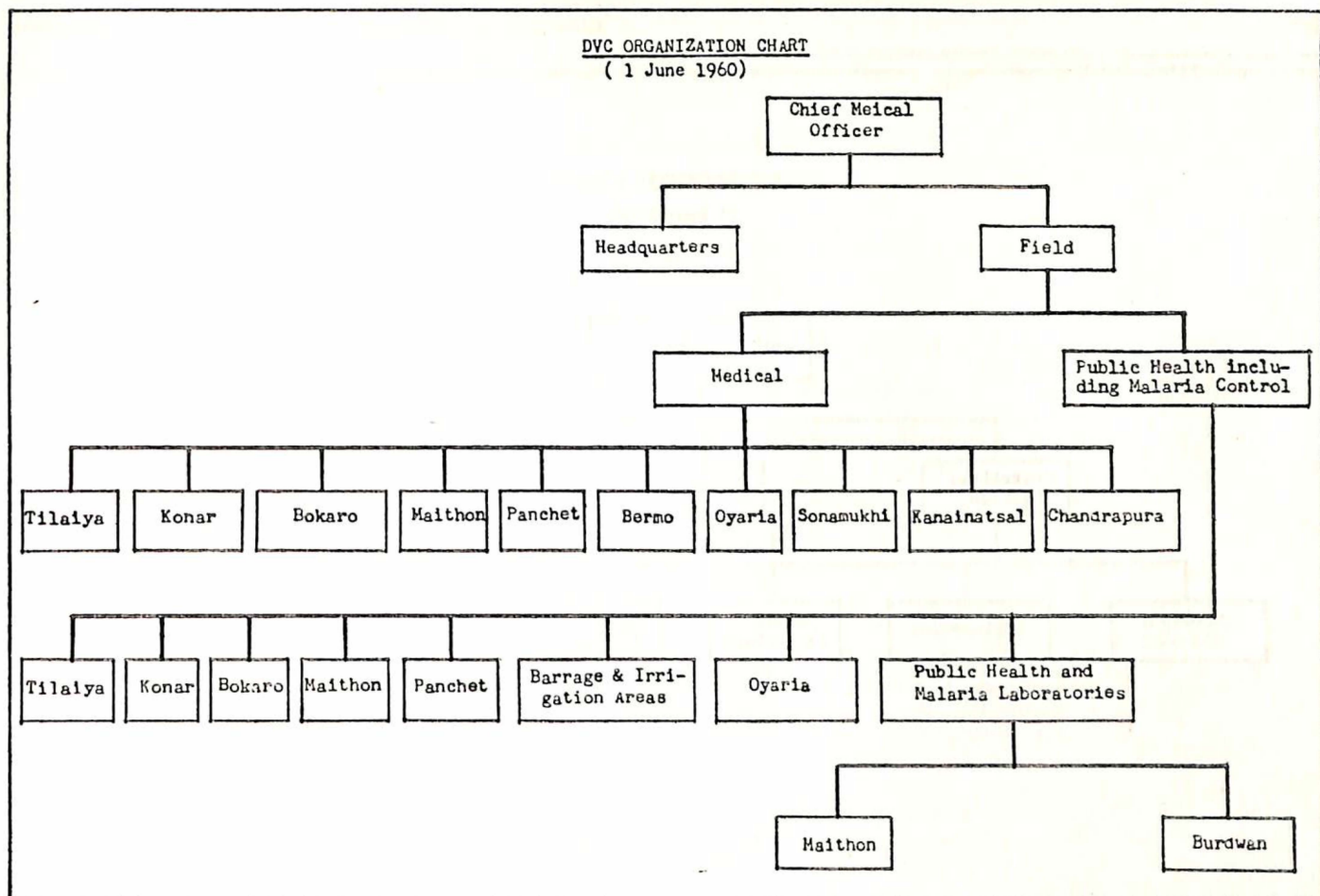


Figure 46. ORGANIZATION CHART, OFFICE OF MEDICAL OFFICER.

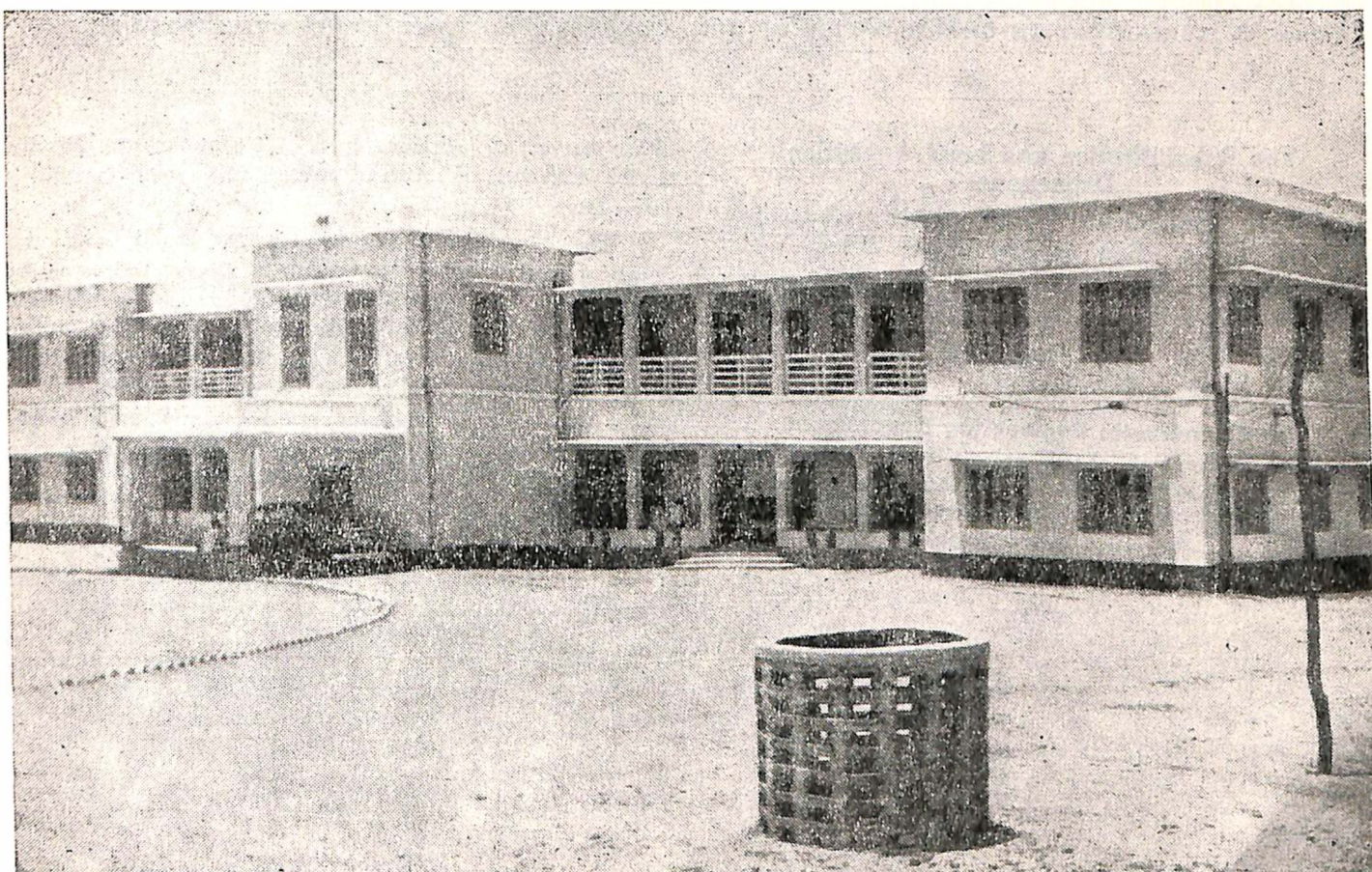


Figure 47. PHOTOGRAPH OF BOKARO HOSPITAL.

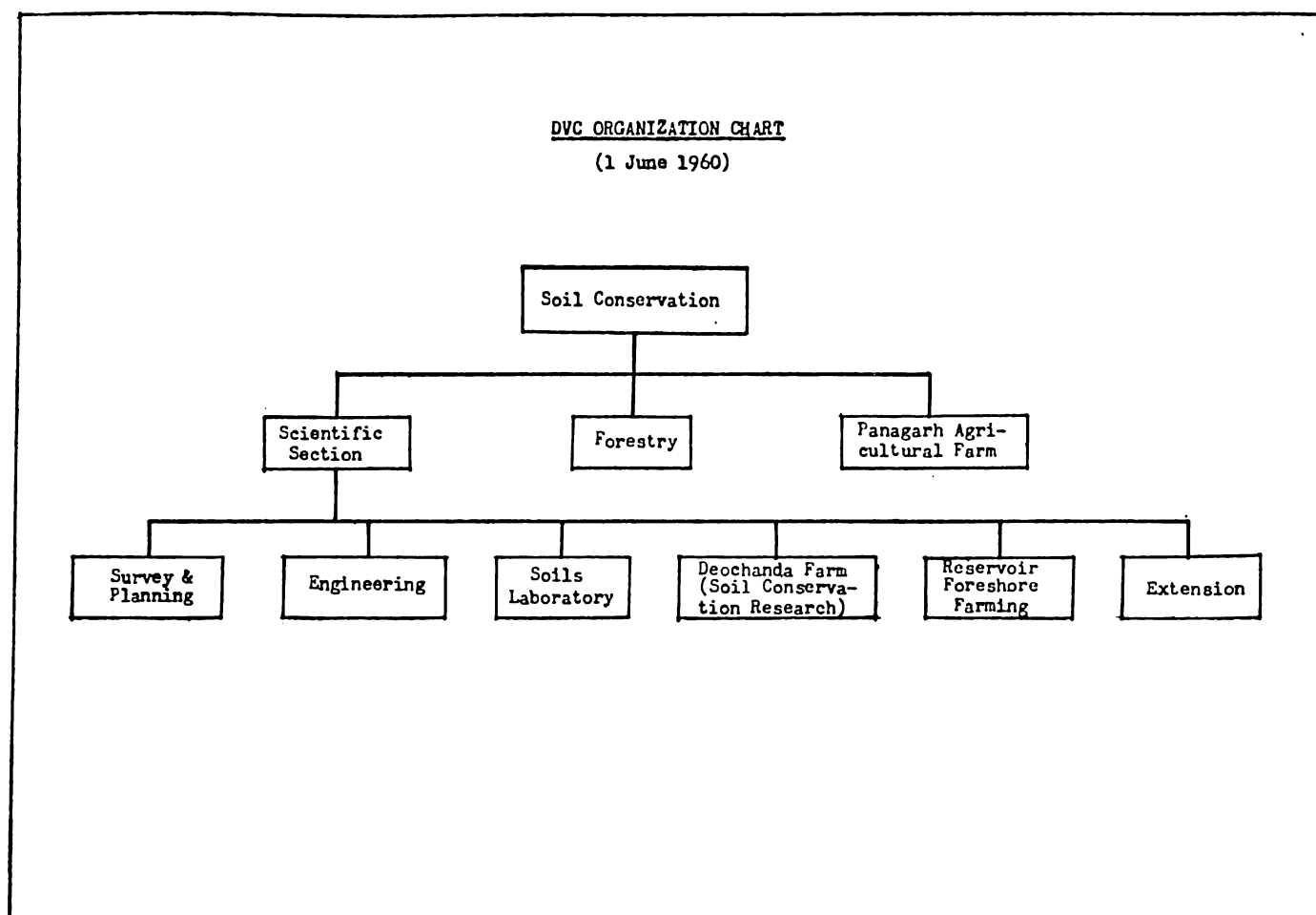


Figure 48. ORGANIZATION CHART, OFFICE OF SOIL CONSERVATION AND LAND UTILIZATION.

The Rehabilitation and Land Acquisition Department

The Rehabilitation and Land Acquisition Department has offices at Hazaribagh, Bihar. The Department reports directly to the Director of Administration and Joint Secretary (see figure 49).

The duties and functions of this office were described in an earlier chapter.

The Commercial Engineering Department

The Office of the Commercial Engineer is at Calcutta. At one time the office came under the Chief Electrical Engineer, but has since been separated because

of the amount of work involved. It now reports directly to the Director of Administration and Joint Secretary (see figure 39).

The Department is primarily concerned with the design of rate structure for the sale of power to customers of DVC; it also negotiates power contracts for the sale and purchase of electric power, conducts market studies to determine future load growth, supervises preparation of monthly billings and power accounting statistics. It is also responsible for functional control of cost engineering, functional control of power system operations, and makes budget estimates of anticipated revenues and plans for the effective utilization of generating capacity.

DVC ORGANIZATION CHART

(1 June 1960)

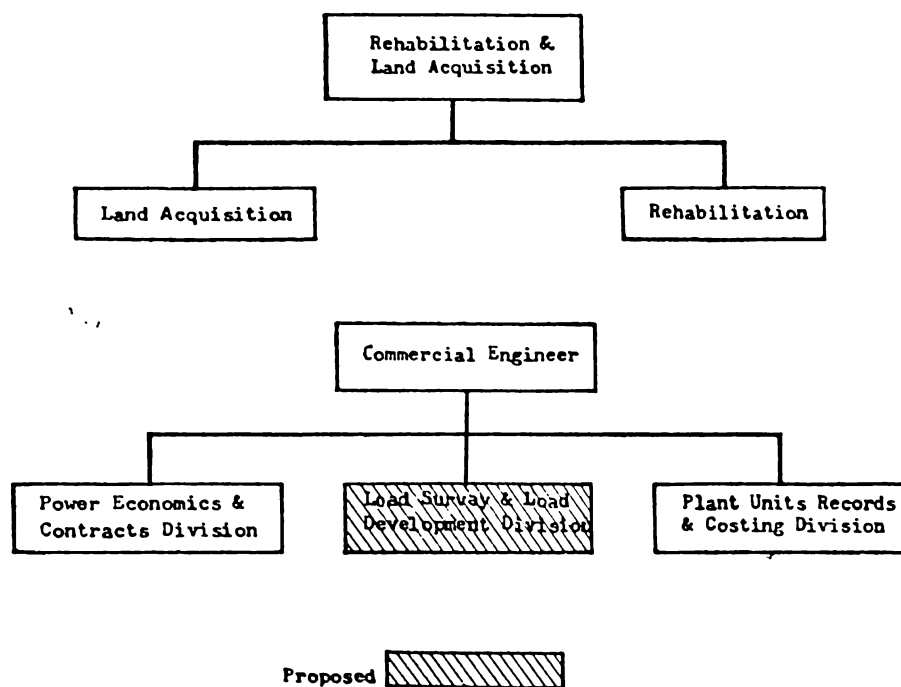


Figure 49. ORGANIZATION CHART, OFFICE OF REHABILITATION AND LAND UTILIZATION.

Chapter X

SUMMARY

Conclusions and recommendations

The Damodar project was conceived at the close of the Second World War amid famine, flood and frustration, and encountered many obstacles. There was an acute shortage of dollars, and technical personnel was scarce and difficult to attract from abroad. Heavy construction equipment was needed but so was a credit standing.

It was common knowledge that the Damodar valley was a vast storehouse of minerals and that the potential for water resource development was equally impressive. Then, too, there was the common objective—flood control.

The legislative bodies in the states of Bihar and West Bengal and that of the Central Government were enthusiastic of the prospects of ushering in an era of progress, production and prosperity for the valley, but just how to spread three months of rainfall over twelve was a problem of most vital concern throughout India.

Wide acclaim greeted passage of the Act creating DVC. Subsequently, however, criticism came to be levelled at the Corporation. For example, the unreasonable delay in designating a Chief Engineer, the fact that, at Tilaiya, one man's influence governed structural design, the Konar project legal fiasco which, after a period of eight years, still remains in litigation awaiting a court award, the postponement of adequate flood protection to the lower valley, the waiving of recovery of penalties for consumers that delayed payment of bills for power services, are but a few of the matters criticized.

It should be remembered that the Damodar Act represented a number of compromises on many issues between the Central and the two state governments, each jealous of their own particular interests. There included, for example, resettlement of displaced persons, land acquisition procedures to be followed, irrigation benefits and industrial expansion, Bihar's right to appoint a representative to the Corporation Board, Bengal's contention regarding construction priorities, and allocation of project costs and the Central Government's contribution to flood control were just a few of the many situations demanding arms-length agreement.

Although modelled on the Tennessee Valley Authority Act, the DVC Act did not follow it completely because there was a unanimous desire to bring it into harmony with Indian conditions and requirements, so that some of the essential provisions of the Tennessee Act

had to be deleted. To amend the DVC Act, either the legislatures of Bihar and West Bengal must pass appropriate resolutions under Article 252 (1) of the constitution or by an Act of Parliament with reference to entry 56 of the Union List "that the regulation and development of the Damodar Valley under the control of the union is expedient in the public interest".⁶

In the early days of DVC's existence, much resentment was expressed among the critics in the "legislatures" of the DVC Act. In the Lok Sabha, the Corporation was condemned as a "roving public benefits society" while some other state legislators felt that the Act had created a "state within a state".⁷

It was apparent the Corporation could not function efficiently in the face of an administrative impasse, and such could only be avoided by evolving a *modus operandi* agreeable to all concerned within the framework of the Act.

During the past ten years there has been continuing dissatisfaction among the participating governments. While admitting that the Corporation's autonomy should not be jeopardized, these governments nevertheless insist that they should be associated more closely with the activities of DVC without interfering in its day-to-day operations. On the other hand, the Corporation contends that its rights should be respected and its obligations recognized. It also takes the view that the three governments, in effect, are shareholders in the Corporation, and that the Corporation is their "managing agency".

On matters of policy, under Section 48 of the Act, the Central Government now issues such directives as are considered pertinent and necessary. It can however be said that the *modus operandi* has fostered better understanding between the Corporation and the three governments, yet present operations differ from the role of "welfare agency" as was originally portrayed by the framers of the Corporation. Even as recently as March 1959 at the participating government's conference, the question was raised whether the DVC Act should be amended. Unfortunately, these conflicts of interest continue to haunt DVC's operations.

It is, of course, recognized by all that the primary function of the Corporation is technological river valley

⁶ Report of the Damodar Valley Inquiry Committee, Chapter VIII, Sec. 2.

⁷ Bihar Legislature, Assembly Debates, 11 October 1947.

development, and, with government consent, the development of areas adjacent to the valley. It is, however, impossible for a "going concern" functioning as a public utility to keep pace with regional expansion unless it is capable of collecting revenue it earns for services rendered; labour must receive wages, fuel must be purchased, and maintenance of equipment cannot be deferred without serious sacrifice of efficiency. Nor can the Corporation enlarge its production facilities without the financial assistance of the three participating governments. It may be argued that the Corporation can always seek outside financial assistance, but only at the expense of time; then too terms for amortizing such loans are stringent and the interest rate, by comparison, is high.

Failure on the part of the three governments to support the flood control programme has had far-reaching and devastating effects, particularly for the inhabitants of the lower valley. Ever since the inception of DVC, it was fully recognized that the completion of the four dams would not provide adequate flood protection in the lower valley. Notwithstanding repeated Corporation requests for funds for continuing project investigations of the Aiyar project, leading to its construction, the programme has been postponed each year. One of the reasons for delay was that any further expenditure on flood control measures had to be borne entirely by West Bengal. So far, West Bengal has been content to risk its luck with flood protection up to 650,000 cusecs, and not one million cusecs which the original Voorduin plan envisioned.

On 1 October 1959, history repeated itself and with more vengeance than had ever before been officially recorded; had it not been for the catchment of four dams in the upper basin, the estimated inflow into the lower valley would have been of the order of 800,000 cusecs. Now that irreparable damage has been done, the authorities once again are deliberating which reservoir site shall be selected for construction. Continued indecision, however, has the effect of postponing the completion date by 6 years before any site be brought into useful service. Had the DVC Act spelled out the obligation of states with respect to their participation in engineering works, which are considered vital to life and property, a great loss might have been averted. One thing has been observed as our experience in floods increase we may reasonably expect bigger and bigger floods as long as the flood potentialities of a basin are not exhausted.

Apart from flood control protection, additional power output is needed, as well as increased quantities of water supply for industrial and domestic purposes. Steel plants are heavy consumers of raw water, and a new steel plant at Bokaro is scheduled for completion during the third five-year plan.

The comments and suggestions below are the result of a study of the Corporation's activities, supported by a field trip throughout the Damodar valley. These suggestions are intended to be constructive and are offered

for the further consideration of the Corporation and government authorities.

1. Field investigations have disclosed the existence of 30 or more small damsites in the "upper" basin. These sites, lying in good arable areas, are considered feasible for developing irrigation projects. Only two projects have thus far been constructed. Continued postponement of land development will only intensify the erosion problems in the upper basin and reduce the useful life of the main stream reservoirs. Additional irrigation projects should therefore be considered, in view of the agricultural and other indirect benefits they would bring.

2. The second five-year plan provided for the reafforestation of 30,000 acres jointly with the state of Bihar. This target has almost been attained. Under the third five-year plan, 46,000 acres are to be reafforested through a joint undertaking. This worthy endeavour should be accelerated as rapidly as finances will permit. State governments are also urged to give greater consideration to the protection of forest lands and not permit destruction of forest in one area while large-scale replanting is carried out in another. Greater enforcement on the part of the state governments of regulations against the burning and cutting of timber should be vigorously pursued.

3. Flood control works do not produce direct earned income. The capital invested in these works is regarded as an insurance premium against loss of life and property. It is common practice in other countries to subsidize these capital expenditures. Nor is the operating agency required to pay interest on investments from which there is no earned revenue. This practice creates an erroneous and unfavourable public impression of the Corporation's financial operations, and results in the inflationary capital accounting procedure prescribed in Section 39 of the DVC Act.

It is suggested that the present practice of requiring interest payments on capital invested for flood control features be eliminated, and that the DVC Act should be amended accordingly.

4. An examination of the typical daily system load curves (figures 28 and 29) suggests the desirability of designing the second Kaplan unit at the Panchet Hill power plant to provide for a reverse power, pump storage operation. The scheme would increase the peaking capacity of the plant by 40,000 kW a valuable asset to system operations during the dry season, while the additional capital outlay would be exceedingly small. The seriousness of the system power shortage is clearly depicted in figure 27. This deficiency commences about March 1961 and will continue until the unit at Chandrapura is commissioned, some time in 1964/65. Although the increment of relief by comparison with the size of the thermal units would be small, the addition of 40,000 kW at this time nevertheless is appreciable, and would increase power revenue while only slightly increasing operating costs. The penstock and pit for this unit have already been completed. Efforts should therefore be made to complete the installation as early as possible.

5. The sanctioning of capacity addition in the past has not kept pace with load growth. The thermal units at the Bokaro plant have been obliged to operate as much as 24% above rated capacity. This practice should be discontinued since it not only lowers the fatigue factor of the units but results in shorter service life and greatly increases both capital and operating expenses.

6. The regular personnel of DVC number close to 5,000. The numerous employees contacted during the field visit appear to be well trained, industrious and dedicated.

Many of the key personnel have been trained abroad at corporation expense in administrative and technological fields. The housing facilities and working environment of the employees are patterned on modern lines. Employees and their families receive health benefits; they also receive retirement security, sick and annual leave accruals, and enjoy social and recreational facilities at DVC Community Centres. Recreational developments along the reservoir areas have recently been programmed; all these features are commendable and should be further implemented in keeping with orderly budgeting practices.

7. Planning of technological features leading to industrial development has been the prime objective of the Corporation. As industrial development approaches the point of saturation, perhaps by the end of the third five-year plan, efforts should be directed towards improving the living standards of the rural population through the extension of rural electric service within the DVC area. Electric service would raise the present standards of the rural living, and its many applications to farm innovations would promote the general comfort of a deserving class of inhabitants. Consideration should be given to amending the DVC Act to implement this objective.

Owing to the complex geographical area involved, it is difficult to delimit exactly the DVC service area that has been benefited as a result of the Corporation's construction activities during the past decade. In the first place, the bulk of the Corporation's capital investment is located within a small sector of the state of Bihar. But this area contains vast resources—minerals, water potential and, to a lesser extent, manpower. The pattern differs somewhat in West Bengal. In the sector occupied by DVC, nearly a million acres of agricultural land have a guaranteed irrigation service, the sprawling city of Calcutta is supplied with a sizeable block of electric power and large industrial plants are nearing completion in the vicinity of Durgapur. Another factor to consider is that the service area, by virtue of the Corporation's transmission system, extends far beyond the Damodar valley, into the states of Orissa and Uttar Pradesh. For instance, the transmission connexion into the state of Uttar Pradesh was established to provide electric power supply to operate the East Indian Railway System, and to effect a transmission tie with the Rihand hydroelectric project; the connexion into the state of Orissa was designed to interchange power with the Hirakud hydroelectric project in a rapidly expanding mineralized area. Figure 1 shows the mineral occurrences in this area.

In all four states, studies have been in progress to determine the economic impact on the areas resulting, not alone from DVC operations, but more particularly from the implementation of the many other schemes under the long-range development programme of the Central Government. In view of this amalgamated coverage, is it not possible to isolate and evaluate the economic impact brought about by a single factor, such as DVC. However, the many benefits secured and the progress made in the DVC service area during the last decade are quite evident.

Before the establishment of DVC, floods of the order of 350,000 cfs brought destruction and widespread suffering to the lower valley. Now flood control works give protection up to flood crests of 650,000 cfs. DVC dams in the 1958 flood prevented property damage in the lower valley to the extent of 50 crores (\$105 million) and in 1959 the loss of life and property from flood damage would have been far greater but for the four dams which held back a large measure of the flood onslaught.

In the lower valley crops generally failed one year out of every three. Agriculture was primarily based on subsistence farming, and there was little incentive for the farmer to increase crop production. Today nearly one million acres under cultivation are assured of a water supply for kharif (rice) planting and an additional 100,000 acres for rabi (vegetable) crops. New wealth accruing to the area from irrigation works is estimated at Rs 16 crores (\$34 million) annually. The taxing power of West Bengal has also been enhanced, and property owners, transport undertakings, merchants and the consumers each share in the benefits.

The construction of the 85 mi navigation canal from Durgapur to Calcutta eases the burden on the railways which were already taxed far beyond their carrying capabilities. The canal also provides a direct low-cost water route from large manufacturing industries in the vicinity of Durgapur and Burdwan to world shipping lines leaving the port of Calcutta.

The production of coal, iron, copper and other minerals now offer year-round employment to many thousands of people who had previously been seasonal workers, but for the most part heretofore depended on the land for their poverty existence. In the early years, two steel mills in the area produced less than a million tons of pig iron annually. Now, there are six modern installations with an expected ultimate output of 10 million tons annually.

During the days of heavy construction 25,000 people were given employment by DVC. Today nearly 5,000 people are gainfully employed on a permanent and highly satisfactory basis.

Electric power, so vital to industrial development, rose from 137,098 kW of capacity in 1943 to 524,000 kW in 1961. Planned additions at the end of the third five-year plan (1966) call for the ultimate installation of 1,084,000 kW exclusive of generation capacity in the Calcutta area. The annual increment in wealth from

direct and indirect benefits of this operation is calculated at about 25.0 crores of rupees (\$52.5 million), and might well double once full development is achieved.

The advent of DVC has also brought about construction of new roads, transport and communications facilities. Another important contribution concerns the health and welfare of this industrialized region. In the past the incidence of various diseases, particularly in lower valley, was high. Today, malaria, kalazar and other tropical diseases have virtually disappeared. Unsanitary conditions are being eliminated. Schools and vocational training centres are rapidly reducing illiteracy.

Increasing contacts with the outside world and infiltration of new ideas and concepts of a better way of life are but a chain reaction of the many direct and indirect benefits accruing to the inhabitants of the valley.

The monetary evaluation of the benefit-cost ratio of the Damodar valley's development is difficult for the reasons previously set forth. However, the benefits will outweigh expenditures many times if the Corporation is given reasonable freedom to achieve its basic objectives on a sound business principals, for the Damodar valley river scheme is another great milestone in India's march of progress.

Appendix I

DAMODAR VALLEY CORPORATION ACT

ACT No. XIV of 1948¹

An Act to provide for the establishment and regulation of a Corporation for the development of the Damodar Valley in the Provinces of Bihar and West Bengal.

WHEREAS it is expedient to provide for the establishment and regulation of a Corporation for the development of the Damodar Valley in the Provinces of Bihar and West Bengal;

AND WHEREAS in pursuance of section 103 of the Government of India Act, 1935 (26 Geo. 5, c. 2), resolutions have been passed by all the Chambers of the Provincial Legislatures of the said Provinces to the effect that certain matters dealt with in this Act which are enumerated in the Provincial Legislative List should be regulated in those Provinces by Act of the Dominion Legislature;

It is hereby enacted as follows:—

PART I INTRODUCTORY

1. **Short title, extent and commencement:** (1) This Act may be called the Damodar Valley Corporation Act, 1948.
(2) It extends to the Provinces of Bihar and West Bengal.
(3) It shall come into force on such date as the Central Government may, by notification in the official Gazette, appoint in this behalf.
2. **Interpretation:** In this Act, unless there is anything repugnant in the subject or context,—
(1) "Corporation" means the Damodar Valley Corporation;
(2) "Damodar Valley" includes the basin of the Damodar river and its tributaries;
(3) "member" means a member of the Corporation and includes the Chairman;
(4) "Participating Governments" means the Central Government, the Provincial Government of Bihar and the Provincial Government of West Bengal;
(5) "prescribed" means prescribed by rules made under section 59;
(6) "Provincial Government" means the Government of Bihar or as the case may be of West Bengal, and "Provincial Governments" means the Governments of Bihar and of West Bengal;
(7) "regulations" means the regulations made by the Corporation under section 60.

PART II

ESTABLISHMENT OF THE CORPORATION

3. **Incorporation:** (1) With effect from such date as the Central Government may, by notification in the official Gazette, appoint in this behalf, there shall be established a Corporation by the name of the Damodar Valley Corporation.

¹ The Act received the assent of the Governor General on the 27th of March, 1948.

- (2) The said Corporation shall be a body corporate having perpetual succession and a common seal, and shall by the said name sue and be sued.

4. **Constitution of the Corporation:** (1) The Corporation shall consist of a Chairman and two other members appointed by the Central Government after consultation with the Provincial Governments.

- (2) A person shall be disqualified for being appointed, or for continuing as, a member of the Corporation—

- (a) if he is a member of the Central or any Provincial Legislature; or
- (b) if he has, directly or indirectly, any interest in a subsisting contract made with, or in any work being done for, the Corporation except as a shareholder (other than a director) in an incorporated company provided that where he is a shareholder, he shall disclose to the Government the nature and extent of shares held by him in such company.

- (3) No act or proceeding of the Corporation shall be invalid by reason only of the existence of any vacancy amongst its members or any defect in the appointment of a member thereof.

5. **Conditions of service of members:** (1) Omitted by the Damodar Valley Corporation (Amendment) Act, 1957 (No. 59 of 1957).

- (2) The remuneration and other conditions of service of the members shall be such as may be prescribed.

6. **Appointment of officers and servants:** (1) The secretary and the financial adviser of the Corporation shall be appointed by the Central Government.

- (2) The secretary shall be the chief executive officer of the Corporation.

- (3) The Corporation may appoint such other officers and servants as it considers necessary for the efficient performance of its functions.

7. **Conditions of service of officers and servants:** The pay and other conditions of service of the officers and servants of the Corporation shall—

- (a) as respects the secretary and financial adviser, be such as may be prescribed; and
- (b) as respects the other officers and servants, be such as may be determined by regulations.

8. **Functions and duties of the financial adviser:** The functions and duties of the financial adviser shall be such as may be prescribed.

9. **General disqualification of all officers and servants:** No person who has directly or indirectly, by himself or his partner or agent, any share or interest in any contract, by or on behalf of the Corporation, or in any employment under, by or on behalf of the Corporation otherwise than as an officer or servant thereof, shall become or remain an officer or servant of the Corporation.

10. **Appointment of Advisory Committee:** Subject to any rules made under section 59 the Corporation may from time to time appoint one or more Advisory Committees for the purpose of securing the efficient discharge of the functions of the

Corporation, and in particular for the purpose of securing that those functions are exercised with due regard to the circumstances and requirements of particular local areas.

PART III

FUNCTIONS AND POWERS OF THE CORPORATION

General

11. Limits of Damodar Valley and area of operation:

(1) The Central Government shall, by notification in the official Gazette, specify the limits of the Damodar Valley.

(2) The Corporation shall carry out all or any of its functions and exercise all or any of its powers within the Damodar Valley.

(3) The Central Government may, after consultation with the Provincial Governments, by notification in the official Gazette, direct that the Corporation shall carry out such function and exercise such power in such other area as may be specified therein and the area so specified shall be called the "area of operation" of the Corporation.

12. Functions of the Corporation: The functions of the Corporation shall be—

- (a) the promotion and operation of schemes for irrigation, water supply and drainage,
- (b) the promotion and operation of schemes for the generation, transmission and distribution of electrical energy, both hydro-electric and thermal,
- (c) the promotion and operation of schemes for flood control in the Damodar river and its tributaries and the channels, if any, excavated by the Corporation in connection with the scheme and for the improvement of flow conditions in the Hooghly river,
- (d) the promotion and control of navigation in the Damodar river and its tributaries and channels, if any,
- (e) the promotion of afforestation and control of soil erosion in the Damodar Valley, and
- (f) the promotion of public health and the agricultural, industrial, economic and general well-being in the Damodar Valley and its area of operation.

Irrigation and water-supply

13. Provision for irrigation and water-supply: The Corporation may, with the approval of the Provincial Government concerned which shall not be unreasonably withheld, construct canals and distributaries and maintain and operate them:

Provided that the Provincial Government may, after giving notice and subject to the payment of fair compensation, take over the maintenance and operation of any such canal or distributary.

14. Rates for supply of water for irrigation: (1) The Corporation may, after consultation with the Provincial Government concerned, determine and levy rates for the bulk supply of water to that Government for irrigation, and fix the minimum quantity of water which shall be made available for such purpose.

(2) The rates at which such water shall be supplied by the Provincial Government to the cultivators and other consumers shall be fixed by that Government after consultation with the Corporation.

15. Rates for supply of water for industrial and domestic purposes: The Corporation may determine and levy rates for bulk supply and retail distribution of water for industrial and domestic purposes and specify the manner of recovery of such rates.

16. Supply of water to those whose supply has been stopped or reduced: If, with a view to operating its schemes, the Corporation has stopped or reduced the supply of water to any person for agricultural, industrial or domestic purposes which such person was, prior to such stoppage or reduction, enjoying by virtue of any prescriptive right the Corporation shall arrange such supply of water on the same terms as before.

17. Construction of dam, etc., prohibited except with approval of the Corporation: Save as otherwise prescribed, no person shall construct, operate or maintain in the Damodar Valley any dam or other work or any installation for the extraction of water without the consent of the Corporation.

Supply and generation of electrical energy

18. Supply and generation of electrical energy: Notwithstanding anything contained in the Indian Electricity Act, 1910 (IX of 1910) or any licence granted thereunder—

(i) No person shall without the permission of the Corporation—

- (a) sell electrical energy to any consumer in the Damodar Valley where the energy is taken by the consumer at a pressure of 30,000 volts or more;
- (b) transmit electrical energy in the Damodar Valley at a pressure of 30,000 volts or more;
- (c) generate any electrical energy at an installation having an aggregate capacity of more than 10,000 kilowatts in any part of the Damodar Valley lying to the north of a straight line drawn east to west passing through a point at latitude twenty-two degrees, fourteen minutes and forty-seven seconds and longitude eighty-seven degrees, fifty-one minutes and forty-two seconds except such portion of the municipal area of Burdwan as may lie to the north of such straight line:

Provided that nothing in sub-clause (c) shall apply to any person who was, at the commencement of this Act, generating electrical energy at an installation having an aggregate capacity of more than 10,000 kilowatts, so long as the capacity of such installation is not increased:

Provided further that nothing in sub-clause (c) shall apply to the power station installation of the fertiliser factory at Sindri having an aggregate capacity of 80,000 kilowatts so long as the capacity of such installation is not increased beyond 80,000 kilowatts.

- (ii) The Corporation may sell electrical energy to any consumer in the Damodar Valley but no such sale shall, except with the permission of the Provincial Government concerned, be made to any consumer requiring supply at a pressure of less than 30,000 volts.
- (iii) The Corporation may, with the permission of the Provincial Government concerned, extend its transmission system to any area beyond the Damodar Valley and sell electrical energy in such area.

19. Effect on existing licences: (1) Where any licence granted under the Indian Electricity Act, 1910 (IX of 1910), becomes inoperative wholly or partly by virtue of the provisions of section 18, the licence shall be deemed to have been revoked or modified so as to be consistent with those provisions.

(2) Where a licence is deemed to have been revoked under subsection (1), the Corporation shall purchase the undertaking of the licensee, and where a licence is modified under that subsection, the Corporation shall, at the option of the licensee, either purchase the undertaking or pay fair compensation to the licensee.

(3) The purchase price or the amount of compensation payable by the Corporation under sub-section (2) shall be such as may be agreed to between the Corporation and the licensee or, in the event of disagreement, as may be determined by arbitration.

20. Charges for supply of electrical energy: The Corporation shall fix the schedule of charges for the supply of electrical energy, including the rates for bulk supply and retail distribution, and specify the manner of recovery of such charges:

Provided that the Corporation may in any contract for bulk supply of electrical energy impose such terms and conditions including a retail rate schedule as it may deem necessary or desirable to encourage the use of electrical energy.

Other activities

21. Other activities of the Corporation: (1) The Corporation may establish, maintain and operate laboratories, experimental and research stations and farms for conducting experiments and research for—

- (a) utilising the water, electrical energy and other resources in the most economical manner for the development of the Damodar Valley,
- (b) determining the effect of its operations on the flow conditions in the Hooghly river,
- (c) making improvements in navigation conditions in the port of Calcutta, and
- (d) carrying out any other function specified under section 12.

(2) The Corporation may set up its own planning, designing, construction and operating agencies, or make arrangements therefor with the Participating Governments, local authorities, educational and research institutions or any person carrying on the business of an architect, an engineer or a contractor.

Powers

22. General powers of the Corporation: (1) The Corporation shall have the power to do anything which may be necessary or expedient for the purposes of carrying out its functions under this Act.

(2) Without prejudice to the generality of the foregoing provision, such power shall include the power—

- (i) to acquire and hold such movable and immovable property as it may deem necessary and to lease, sell or otherwise transfer any such property;
- (ii) to construct or cause to be constructed such dams, barrages, reservoirs, power houses, power structures, electrical transmission lines and sub-stations, navigation works, irrigation, navigation and drainage canals and such other works and structures as may be required;
- (iii) to prevent pollution of any water under its control and to take all measures to prevent discharges into such water effluents which are harmful to water supply, irrigation, public health or fish life;
- (iv) to stock its reservoirs or water courses with fish and to regulate or prohibit taking out fish from the water under its control;
- (v) to undertake resettlement of the population displaced by the dams, acquisition of land for reservoirs and protection of watersheds;
- (vi) to aid in the establishment of co-operative societies and other organisations for the better use of facilities made available by the Corporation;
- (vii) to undertake measures for the prevention of malaria.

23. Power to close roads and open spaces: (1) The Corporation may, after giving notice to the persons concerned or to the public generally,—

- (a) turn, divert or discontinue the public use of, or permanently close, any road or any part thereof, or
- (b) discontinue the public use of, or permanently close, any open space or any part thereof.

(2) Whenever the Corporation discontinues the public use of, or permanently closes, any road or open space, the Corporation shall pay reasonable compensation to every person—

- (a) who was entitled, otherwise than as a licensee, to use such road or open space or part thereof as a means of access, or
 - (b) whose immovable property was receiving air and light on account of such open space or part,
- and who has suffered damage—

(i) in any case falling under clause (a) from such discontinuance or closure and

(ii) in any case falling under clause (b) from the use to which the Corporation has put such open space or part.

(3) In determining the compensation payable to any person under sub-section (2), the Corporation may take into consideration any benefit accruing to such person from the construction, provision or improvement of any other road, or open space at or about the same time that the road or open space or part thereof, on account of which the compensation is to be paid, is discontinued or closed.

(4) When any road or open space or any part thereof, is permanently closed under sub-section (1), the Corporation may sell or lease such part of it as is not required for its purposes.

24. Powers under certain other enactments: (1) Notwithstanding anything contained in the Acts specified in column one of Part I of the Schedule, the Corporation may carry out all or any of the functions and exercise all or any of the powers of a Provincial Government in the Damodar Valley under the provisions of such Acts specified in column two thereof against each item of column one.

(2) Notwithstanding anything contained in the Acts specified in column one of Part II of the Schedule, any officer authorised by the Corporation may carry out all or any of the functions and exercise all or any of the powers of a Canal Officer-collector, or Forest Officer, as the case may be, in the Damodar Valley under the provisions of such Acts specified in column two thereof against each item of column one.

Co-operation and avoidance of submersion

25. Co-operation with other authorities to minimise inconvenience caused by submersion: The Corporation shall co-operate with the Participating Governments, railway authorities and local authorities and bodies, with a view to minimising the inconvenience likely to be caused by the submersion of roads and communications and shall bear the cost of any realignment thereof or resettlement of any population rendered necessary by such submersion.

26. Submersion of coal mines to be avoided by the Corporation: The Corporation shall make every endeavour to avoid submersion of coal or mineral deposits and shall co-operate with the coal mining industry and the bodies set up by the Participating Governments to ensure the maintenance of supplies of sand for stowing purposes in coal mines and in other ways to minimise the inconvenience to the coal mining industry.

PART IV

FINANCE, ACCOUNTS AND AUDIT

27. Expenditure till the Corporation is established: All expenditure incurred by the Central Government for and in connection with the establishment of the Corporation up to the date of its establishment shall be treated as the capital provided by the Central Government to the Corporation and such capital shall be adjusted between the Participating Governments in accordance with the provisions of sections 30 to 36.

28. Vesting of property in the Corporation: All property acquired and works constructed for the purposes of the Damodar Valley scheme before the establishment of the Corporation shall vest in the Corporation and all income derived and the Corporation.

29. Fund of the Corporation: (1) The Corporation shall have its own fund and all receipts of the Corporation shall be carried thereto and all payments by the Corporation shall be made therefrom.

(2) Except as otherwise directed by the Central Government, all moneys belonging to that fund shall be deposited in the Reserve Bank of India or the Agents of the Reserve Bank of India or invested in such securities as may be approved by the Central Government.

30. Liabilities of Participating Governments to provide capital to the Corporation: The Participating Governments shall, as hereinafter specified, provide the entire capital required by the Corporation for the completion of any project undertaken by it.

31. Payment by Participating Government on specified date: Each Participating Government shall provide its share of the capital on the dates specified by the Corporation and if any Government fails to provide such share on such dates the Corporation may raise loan to make up the deficit at the cost of the Government concerned.

32. Expenditure on objects other than irrigation, power and flood control: The Corporation shall have power to spend such sums as it thinks fit on objects authorised under this Act other than irrigation, power and flood control and such sums shall be treated as common expenditure payable out of the Fund of the Corporation before allocation under Section 33.

33. Allocation of expenditure chargeable to project on main objects: The total capital expenditure chargeable to a project shall be allocated between the three main objects, namely, irrigation, power and flood control as follows, namely:—

- (1) expenditure solely attributable to any of these objects, including a proportionate share of overhead and general charges, shall be charged to that object, and
- (2) expenditure common to two or more of the said objects, including a proportionate share of overhead and general charges, shall be allocated to each of such objects in proportion to the expenditure which, according to the estimate of the Corporation, would have been incurred in constructing a separate structure solely for that object, less any amount determined under clause (1) in respect of that object.

34. Capital allocated to irrigation: The total amount of capital allocated to irrigation shall be shared between the Provincial Governments as follows, namely:—

- (1) the Government concerned shall be responsible for the capital cost of the works constructed exclusively for irrigation in its Province; and
- (2) the balance of capital cost under irrigation for both the Provinces of Bihar and West Bengal shall be shared by the Provincial Governments in the proportion to their guaranteed annual off-takes of water for agricultural purposes:

Provided that the divisible capital cost under this clause shall be provisionally shared between them in accordance with their previously declared intentions regarding their respective guaranteed off-takes and any payments made accordingly shall be adjusted after the determination of the guaranteed off-takes.

35. Capital allocated to power: The total amount of capital allocated to power shall be shared equally between the three Participating Governments.

36. Capital allocated to flood control: The total amount of capital up to fourteen crores of rupees allocated to flood control shall be shared equally between the Central Government and the Government of West Bengal and any amount in excess thereof shall be the liability of the Government of West Bengal.

37. Disposal of profits and deficits: (1) Subject to the provisions of sub-section (2) of section 40, the net profit, if any, attributable to each of the three main objects, namely, irrigation, power and flood control, shall be credited to the Participating Governments in proportion to their respective shares in the total capital cost attributed to that object.

(2) The net deficit, if any, in respect of any of the objects shall be made good by the Governments concerned in the proportion specified in sub-section (1):

Provided that the net deficit in respect of flood control shall be made good entirely by the Government of West Bengal and the Central Government shall have no share in such deficit.

38. Payment of interest: The Corporation shall pay interest on the amount of capital provided by each Participating Government at such rate as may, from time to time, be fixed by the Central Government and such interest shall be deemed to be part of the expenditure of the Corporation.

39. Interest charges and other expenses to be added to and receipts taken for reduction of capital cost: For a period, not exceeding fifteen years, from the establishment of the Corporation, if the Corporation runs in deficit, the interest charges and all other expenditure shall be added to the capital cost and all receipts shall be taken in reduction of such capital cost.

40. Provision for depreciation and reserve and other funds: (1) The Corporation shall make provision for reserve and other funds at such rates and on such terms as may be specified by the Auditor General of India in consultation with the Central Government.

(2) The net profit for the purposes of section 37 shall be determined after such provision has been made.

41. Corporation's share in betterment levy by Provincial Governments: In the event of any betterment levy being imposed by a Provincial Government, the proportionate proceeds thereof in so far as they are attributable to the operations of the Corporation shall be credited to the Corporation.

42. Borrowing of money: The Corporation may, with the approval of the Central Government, borrow money in the open market or otherwise for the purposes of carrying out its functions under this Act.

43. Liability to pay Central taxes: (1) The Corporation shall be liable to pay any taxes on income levied by the Central Government in the same manner and to the same extent as a company.

(2) The Provincial Governments shall not be entitled to any refund of any such taxes paid by the Corporation.

44. Budget: (1) The Corporation, in consultation with the financial adviser, shall in October each year prepare in such form as may be prescribed a budget for the next financial year showing the estimated receipts and expenditure and the amounts which would be required from each of the three Participating Governments during that financial year.

(2) Printed copies of the budget shall be made available to each of the three Participating Governments by the 15th day of November each year.

(3) The budget shall be laid before the Central and the Provincial Legislatures concerned as soon as may be after it is prepared.

45. Annual Report: (1) The Corporation shall prepare, in such form as may be prescribed, an annual report within six months after the end of each financial year giving a true and faithful account of its activities during the previous financial year, with particular reference to—

- (i) irrigation;
- (ii) water supply;
- (iii) electrical energy;
- (iv) flood control;
- (v) navigation;
- (vi) afforestation;
- (vii) soil erosion;
- (viii) use of lands;
- (ix) resettlement of displaced population;
- (x) sanitation and public health measures; and
- (xi) economic and social welfare of the people.

(2) The annual report shall also give a true and faithful account of the income and expenditure during the previous financial year, the net amounts attributable to each of the three main objects and the distribution of the capital cost between the three Participating Governments and show the progressive totals from the inception of the Corporation and the up to date financial results.

(3) The payments provisionally made by each of the three Participating Governments on the basis of the budget estimates shall be adjusted as soon as possible in accordance with the allocation made in the annual report.

(4) Printed copies of the annual report shall be made available to each of the three Participating Governments by the 15th day of October each year.

(5) The annual report shall be laid before the Central and the Provincial Legislatures concerned as soon as may be after it is prepared.

46. Other annual financial statements: (1) The Corporation shall also prepare such other annual financial statements in such form and by such dates as may be prescribed.

47. Accounts and Audit: The accounts of the Corporation shall be maintained and audited in such manner as may, in consultation with the Auditor General of India, be prescribed.

(2) Printed copies of each such annual financial statement shall be made available to each of the three Participating Governments by such date as may be prescribed.

PART V

MISCELLANEOUS

48. Directions by the Central Government: (1) In discharge of its functions the Corporation shall be guided by such instructions on questions of policy as may be given to it by the Central Government.

(2) If any dispute arises between the Central Government and the Corporation as to whether a question is or is not a question of policy, the decision of the Central Government shall be final.

49. Disputes between the Corporation and Governments: (1) Save as otherwise expressly provided in this Act, any dispute between the Corporation and any Participating Government regarding any matter covered by this Act or touching or arising out of it shall be referred to an arbitrator who shall be appointed by the Chief Justice of India.

(2) The decision of arbitrator shall be final and binding on the parties.

50. Compulsory acquisition of land for the Corporation: Any land required by the Corporation for carrying out its functions under this Act shall be deemed to be needed for a public purpose and such land shall be acquired for the Corporation as if the provisions of Part VII of the Land Acquisition Act, 1894 (1 of 1894) were applicable to it and the Corporation were a company within the meaning of clause (c) of section 3 of the said Act.

51. Control of Central Government: (1) The Central Government may remove from the Corporation any member who in its opinion—

(a) refuses to act,

(b) has become incapable of acting,

(c) has so abused his position as a member as to render his continuance on the Corporation detrimental to the interest of the public, or

(d) is otherwise unsuitable to continue as member.

(2) The Central Government may suspend any member pending an enquiry against him.

(3) No order of removal under this section shall be made unless the member concerned has been given an opportunity to submit his explanation to the Central Government, and when such order is passed the seat of the member removed shall be declared vacant and

another member may be appointed under section 4 to fill up the vacancy.

(4) A member who has been removed shall not be eligible for reappointment as member or in any other capacity to the Corporation.

(5) The Central Government may declare void any transaction in connection with which a member has been removed under sub-section (1).

(6) If the Corporation fails to carry out its functions, or follow the directions issued by the Central Government under this Act, the Central Government shall have the power to remove the Chairman and the members of the Corporation and appoint a Chairman and members in their places.

52. Application of certain provisions of the Indian Forest Act, 1927, to the forests of the Corporation: All acts prohibited in respect of a reserved forest under section 26 of the Indian Forest Act, 1927 (XVI of 1927) shall be deemed to be prohibited in respect of any forest owned by or under the supervision or control of the Corporation and all offences in respect of such forest shall be punishable under the said Act as if they were committed in respect of a reserved forest.

53. Penalty: Whoever contravenes the provisions of Sections 17 and 18 of this Act or any rule made thereunder shall be punished with imprisonment for a term which may extend to six months or with fine or with both.

54. Procedure for prosecution: No Court shall take cognisance of an offence under this Act except on the complaint of an officer of the Corporation authorised by it in this behalf.

55. Power of entry: Any officer or servant of the Corporation generally or specially authorised by the Corporation at all reasonable times enter upon any land or premises and there do such things as may be reasonably necessary for the purpose of lawfully carrying out any of its works or of making any survey, examination or investigation preliminary or incidental to the exercise of powers or the performance of functions by the Corporation under this Act.

56. Members, officers and servants of the Corporation to be public servants: All members, officers and servants of the Corporation, whether appointed by the Central Government or the Corporation, shall be deemed, when acting or purporting to act in pursuance of any of the provisions of this Act to be public servants within the meaning of section 21 of the Indian Penal Code (XLV of 1860).

57. Protection of action taken under the Act: (1) No suit, prosecution, or legal proceeding shall lie against any person in the employment of the Corporation for anything which is in good faith done or purported to be done under this Act.

(2) Save as otherwise provided in the Act no suit or other legal proceeding shall lie against the Corporation for any damage caused or likely to be caused by anything in good faith done or purported to be done under this Act.

58. Effect of other laws: The provisions of this Act or any rule made thereunder shall have effect notwithstanding anything contained in any enactment other than this Act or any instrument having effect by virtue of any enactment other than this Act.

59. Power to make rules: The Central Government may, by notification in the official Gazette, make rules to provide for all or any of the following matters, namely:—

(1) the salaries and allowances and conditions of service of members, the secretary and the financial adviser;

(2) the functions and duties of the financial adviser;

(3) the dams or other works or the installations which may be constructed without the approval of the Corporation;

(4) the forms of the budget, the annual report and the annual financial statements and the dates by which copies of the annual financial statements shall be made available to the Participating Governments;

(5) the manner in which the accounts of the Corporation shall be maintained and audited;

- (6) the appointment of an Advisory Committee; and
- (7) the punishment for breach of any rule made under this Act.

60. **Power to make regulations:** (1) The Corporation may, with the previous sanction of the Central Government, by notification in the *Gazette of India*, make regulations for carrying out its functions under this Act.

(2) In particular and without prejudice to the generality of the foregoing power, in such regulation the Corporation may take provision for—

- (a) making of appointments and promotions of its officers and servants;
- (b) specifying other conditions of service of its officers and servants;
- (c) specifying the manner in which water rates and charges for electrical energy shall be recovered;
- (d) preventing the pollution of water under its control;
- (e) regulating the taking out of fish from the water under its control;
- (f) regulating its proceedings and business;
- (g) prescribing punishment for breach of any regulation.

(3) All regulations made under sub-sections (1) and (2) shall, as soon as possible, be published also in the official Gazettes of the Provincial Governments.

THE SCHEDULE

(See section 24)

PART I

Acts	Provisions of the Acts specified in column (1)
(1)	(2)
1. The Canals Act, 1864 (Ben. Act V of 1864)	Section 6 (Power of Provincial Government to fix and alter rates of tolls). Section 8 (Power of Provincial Government to appoint persons to collect tolls who may farm collection).
2. The Indian Forest Act, 1927 (XVI of 1927)	Section 35 (Protection of forests for special purposes). Section 36 (Power to assume management of forests).

PART II

Acts	Provisions of the Acts specified in column (1)
(1)	(2)
1. The Bengal Irrigation Act, 1876 (Ben. Act III of 1876).	Part III (Power of the maintenance of canals). Section 41 of Part IV (Power of Canal Officer to issue notice to person causing obstruction). Section 42 of Part IV (Power of Canal Officer to cause obstructions to be removed).
2. The Bengal Embankment Act, 1882 (Ben. Act. II of 1882).	Part II (Powers of Collector and procedure thereon). Part III (Powers of Collector in cases of imminent danger to life or property).
3. Indian Forest Act, 1927 (XVI of 1927).	Section 36 (Power to assume management of forests).

APPENDIX I

RULES

Corrected up to 25th June, 1953

(Vide Ministry of Works, Mines & Power Notification dated 23rd April, 1948).

No. DW-III-A-4(7) Dam: In exercise of the powers conferred by Section 59 of the Damodar Valley Corporation Act, 1948, the Central Government is pleased to make the following rules:—

SALARIES AND CONDITIONS OF SERVICE

1. These rules may be called the Damodar Valley Corporation Rules, 1948. (Inserted by the Government of India, Ministry of Irrigation & Power by Notification No. 43(3) DWIV/57 dated 8.4.58).

2. The Chairman, Members, Secretary and Financial Adviser of the Corporation shall be appointed for such term not exceeding five years as the Central Government may think fit and shall be eligible for reappointment.*

Omitted.†

3. The Chairman or a Member may resign his office by giving three months notice in writing to the Central Government.

4. The Chairman, Members, Secretary and the Financial Adviser shall draw such salary as may be determined by the Central Government in each case.‡

5. Omitted.‡

6. The Chairman, Members, Secretary and the Financial Adviser shall be entitled to leave and leave salary under the model leave terms which may from time to time be applicable to Central Government servants engaged on contract on similar salaries.

7. The Chairman, Members, Secretary and the Financial Adviser shall be entitled to Travelling Allowances for journeys performed in the service of the Corporation on the scale provided for in the rules supplementary to the Fundamental Rules applicable to the class of officers to which the Central Government may declare them to correspond in status.

7A. The other conditions of service of the Chairman, Members, Secretary and the Financial Adviser, if they are not Government servants, shall be such as may be determined by the Central Government in each case. (Inserted by the Government of India, Ministry of Irrigation & Power by Notification No. 49(2)-DVC/53 dated 17th May, 1955).

8. Notwithstanding anything in rules 1 to 7 of these rules the pay, allowances and other conditions of service of the Chairman, Members, Secretary and the Financial Adviser, if he is a person already in the service of the Government, shall be such as may be determined by the Central Government in each individual case.

9(1). The Chairman, the Members, the Secretary and the Financial Adviser who are not Government servants will be entitled to the benefit of the Contributory

* As amended by Govt. of India, Ministry of W.M.P. Notification No. DW-III-A-4(6)-Dam/6, dated the 5th August 1948 and Ministry of Irrigation & Power Notification No. 44(15)/53-ADM, dated the 25th June, 1953.

† Vide Govt. of India, Ministry of W.M.P. Notification No. DW-III-A-4(6)-Dam/6, dated the 5th August, 1948.

‡ Vide Govt. of India, Ministry of W.M.P. Notification DW-III-A-4(6) Dam/1, dated the 6th July, 1948.

Provident Fund of the Corporation to which the Corporation shall contribute an amount equal to the contribution paid by the subscriber, subject to a maximum of 6¼ per cent upto the 31st August, 1957 and of 8-1/3% thereafter. The Contributory Provident Fund Rules (Damodar Valley Corporation) made under Section 60 of the Damodar Valley Corporation Act, 1948 shall, so far as may be, apply in relation to the Chairman, the Members, the Secretary and the Financial Adviser who are subscribers to the Fund as they apply in relation to the officers and servants of the Corporation, subject to the condition that the powers exercisable by the Corporation to grant advances from the fund under Rule 12 and to direct deductions from the account standing to the credit of a subscriber in the fund under rule 19 of the said rules shall, be exercised by the Central Government.

- (2). The benefits of the Contributory Provident Fund of the Corporation shall not be admissible to re-employed personnel who are in receipt of any retirement benefits from the Government in the form of pension or Contributory Provident Fund. They may, however, be permitted to join the Fund and contribute to it but shall not be eligible to the Corporation's contribution. (Inserted by the Government of India, Ministry of Irrigation & Power by Notification No. 43(3)DWIV/57 dated 8.4.58).

10. The Central Government may terminate the services of the Secretary or the Financial Adviser at any time without giving any reason therefore by giving three months' notice.

11. The Secretary or the Financial Adviser may resign his office at any time by giving three months' notice in writing to the Central Government.

FUNCTIONS AND DUTIES OF THE FINANCIAL ADVISER

12. The Financial Adviser shall advise the Corporation on all matters relating to revenue and expenditure.

13. The Financial Adviser shall have the right to attend every meeting of the Corporation but shall not have the right to vote. He shall also have the right to refer to the Corporation any matter which in his opinion ought to be brought to its notice.

14. The Financial Adviser shall be responsible for the manner in which annual and other financial statements are completed and the accounts of the Corporation are maintained and made available to audit.

15. The Financial Adviser may, with the approval of the Corporation and by order in writing, direct that any power or duty which under these rules is conferred or imposed upon him shall, under such conditions, if any, as may be specified by him, be performed or discharged by an officer subordinate to him.

BUDGET

16. *Budget Estimates.*—The budget estimates of the Corporation for each financial year shall be prepared and presented to the Corporation in the form prescribed in Annexure I to these rules with such additional information as may be required by the Corporation from time to time.

17. The budget shall be authenticated by affixing the common seal of the Corporation.

18. If, in respect of any financial year, expenditure over and above the amount provided for in the budget becomes necessary, a supplementary statement shall be prepared and laid before the Corporation showing the estimated amount of expenditure and shall be authenticated in the same manner as the annual budget.

ACCOUNTS

19. All moneys received by the Corporation on account of its revenue receipts, loans or advances due to it, shall be remitted in full into the bank. On no account shall any money so collected be utilised for making any payment relating to the Corporation.

20. The Corporation shall at all times maintain complete and accurate books of accounts.

21. In the maintenance of accounts and the classification of charges, the object served by the expenditure rather than the agency incurring the expenditure should be the guiding principle. Subject to this general requirement, the accounts shall be maintained under the heads prescribed in Annexure I for the budget of the Corporation.

22. A consolidated account of the Corporation shall be prepared after obtaining accounts from the disbursing officers.

23. The accounts of each month shall be made upto the end of the month by the various drawing officers of the Corporation and a consolidated account of the Corporation as a whole shall be prepared and placed before the Corporation at the end of the following month with such detailed memoranda as may be required by the Corporation from time to time.

24. Subsidiary accounts indicating the unit costs shall be maintained and presented to the Corporation simultaneously with the accounts for each month.

25. Within six months of the end of each financial year, the annual accounts, prepared in the forms prescribed in Annexure II to these rules, showing the financial results of irrigation, electricity and flood control schemes with such subsidiary accounts as may be necessary, shall be placed before the Corporation, and, after the accounts have been duly passed, communicated to the participating Governments and the Audit Officer.

26. Initial Accounts for stores including materials on the site of works, and tools and plant (including special tools and plant) shall be maintained in accordance with such instruction as may, from time to time, be issued by the Corporation.

27. A physical verification of stores and tools and plant shall be made by an officer who is not the custodian thereof. The results of the verification together with the orders of the Corporation for shortages and excesses shall be communicated to the Audit Officer.

AUDIT

28. The accounts of the Corporation shall be audited by an officer appointed by the (Comptroller and Auditor General of India, and under his direction and control).^{*} A statement of the results of audit for each month shall be presented to the Corporation.

29. The Audit Officer shall be supplied with copies of all contracts and other orders involving revenue or expenditure of the Corporation duly authenticated by the Secretary.

30. The Audit Officer shall have access to all papers, books, records, files and accounts at all reasonable times.

31. The Audit Officer shall certify to the correctness of the Annual Accounts prepared by the Corporation and append to the certificate an audit report. The annual accounts so certified and the audit report shall, after countersignature by the Comptroller and Auditor General, be submitted with three additional copies to the President. One copy shall be retained by the Central Government and one copy each shall be sent to the other two participating Governments. The Audit Report shall be printed along with the Annual Report and Annual Accounts.^{**}

32. After the accounts are audited no correction shall be made therein without reference to the Audit Officer.

33. The Audit Officer shall be consulted before any modification is made in any form in which accounts are maintained.

^{*} Inserted by Govt. of India, Ministry of Irrigation & Power Notification No. 40(1) 52-Adm, dated the 18th December, 1952.

^{**} Substituted by Govt. of India, Ministry of Irrigation & Power Notification No. 40(1) 52-Adm, dated the 18th December, 1952.

THE DAMODAR VALLEY CORPORATION

BUDGET FOR 194 -4 .		4. Overhead and General charges—	
PART I.—EXPENDITURE ON CAPITAL ACCOUNT		(a) General Administration expenses—	
1. Power Generation, Transmission and Distribution—	Rs.	(1) Corporation expenses .	Rs.
(a) Hydro-Electric Schemes:		(2) Secretary's office .	
(1) Generation . . .		(3) Financial Adviser's Office . .	
(2) Transmission . . .		(4) Contributions to Employees' Provident Fund . . .	
(3) Distribution . . .			
(b) Thermal Schemes:		(b) Stores and Workshops—	
(1) Generation .		(c) General Development expenses—	
(2) Transmission .		(1) Afforestation	
(3) Distribution .		(2) Soil conservation . . .	
Add—Overhead and general charges . . .	—	(3) Use of lands . . .	
		(4) Resettlement of displaced population .	
Deduct—Receipts from sale of power	—	(5) Agricultural development .	
(a) High tension . . .		(6) Industrial development .	
(b) Low tension . . .	—	(7) Experiment and Research Stations . . .	
		(8) Public Health and Sanitation . . .	
Power	—	(9) Economic and Social Welfare . . .	—
		(d) Other General charges—	
Irrigation, Water-supply and drainage—		(1) Interest . . .	
(1) Irrigation . . .		(2) Depreciation . . .	
(2) Water supply . . .		(3) Taxes . . .	
(3) Darinage . . .		(4) Audit charges . . .	—
Add—Overhead and general charges .			
Deduct—Receipts and Recoveries:—		Total Overhead and General charges . . .	
(a) Batterment levy (section 41) . . .		Deduct—Proportionate charges transferred to:	
(b) Water taxes . . .		1. Irrigation . . .	
(c) Miscellaneous . . .	—	2. Power . . .	
		3. Flood control . . .	—
Irrigation	—		
		Net Expenditure on Capital Account:	
Flood Control—		1. Irrigation . . .	
(1) Scheme in Damodar River . .		2. Power . . .	
(2) Scheme in Hooghly River . . .		3. Flood control . . .	—
(3) Navigation:—			
(a) Schemes in Damodar .		Carried over to Part II . . .	
(b) Improvements in Calcutta Port . . .			
Add—Overhead and general charges . . .	—		
Deduct—Receipts . . .	—		
Flood Control . . .	—		

PART II. — ALLOCATION OF CAPITAL EXPENDITURE BE- TWEEN GOVERNMENTS (A) FOR THE YEAR Estimated Expenditure brought forward from Due from— Part I— Rs. Rs. Irrigation ... (a) Central Power ... Govt.— Flood (i) For Control ... Power ... — (ii) For ... Flood control ... (b) <i>West Bengal—</i>	(i) For Power ... (ii) For Flood control ... (iii) For Irriga- tion (c) <i>Bihar Govt.—</i> (i) For Power ... (ii) For Irriga- tion ...
--	---

B/F from Part II

During from				Received from			
	To end of previous year 'Actuals'	During year 'Budget'	Total to end of year		To end of previous year 'Actuals'	During year 'Actuals'	Total to end of year
	Rs.	Rs.	Rs.		Rs.	Rs.	Rs.
(a) Central Government—				(a) Central Government—			
(i) For power				(i) For power			
(ii) For flood control				(ii) For flood control			
(b) West Bengal—				(b) West Bengal			
(i) For power				(i) For power			
(ii) For flood control				(ii) For flood control			
(iii) For irrigation				(iii) For irrigation			
(c) Bihar—				(c) Bihar—			
(i) For power				(i) For power			
(ii) For irrigation				(ii) For irrigation			

PART II (C)

(a) Central Government—

Rs.

(i) For power . .

(ii) For flood control

(b) West Bengal—

(i) For power . .

(ii) For irrigation . .

(iii) For flood control

(c) Bihar—

(i) For power . .

(ii) For irrigation . .

PART III—REVENUE ACCOUNT

Expenditure	Income
	Rs.
1. Power.	
Rs.	Rs.
Generation—	(1) Sale of power
Hydro-Electric . . .	(a) Industrial . . .
Thermal . . .	(b) Agricultural . . .
Transmission Lines and	(c) Municipal . . .
Receiving Stations—	(d) Commercial . . .
Hydro-Electric . . .	(e) Domestic . . .
Thermal . . .	(f) Miscellaneous
Distribution Lines Stations—	
Hydro-Electric . . .	(2) Other Revenues . . .
Thermal . . .	
L. T. Distribution System	
Add General expenses	
Depreciation expenses .	
Interest on Capital .	
Net Revenue from Power	
C/o to Part IV	

2. Irrigation

Rs.	Rs.
Miscellaneous Expenses—	Betterment levy . . .
Dams . . .	Miscellaneous Revenue . . .
Canals . . .	
Distributaries . . .	
Administrative expenses . . .	
Depreciation . . .	
Interest on Capital . . .	
Net Revenue from Irrigation C/o to	
Part IV . . .	
...	...

3. Flood Control

Maintenance Expenses—	Miscellaneous Receipts
Schemes in Damodar .	Net Expense carried
Schemes in Hooghly .	over to Part IV . . .
Schemes in Calcutta	
Port . . .	
General Expenses . . .	
...	...

PART IV—DISPOSAL OF PROFITS AND DEFICITS

Expense	Revenue
Rs.	Rs.
From Part III . . .	From Part III . . .
Net expense on flood control	Net Revenue from power . . .
Corporation tax . . .	Net Revenue from irrigation . . .
...	...
Net Profit payable to	Net deficit recoverable
(a) Central Government—	On account of flood control—
For power . . .	From (a) Central
(b) West Bengal—	Government . . .
For power . . .	From (b) West Bengal
For irrigation . . .	
...	...

PART V—BUDGET SUMMARY

	Balance payable to year ending 31-3-19			
	B/F from Rs.	Part II (C)	Part IV	Net
(a) Central Government:		By	By To	By To
(i) for power . . .				
(ii) for flood control . . .				
(b) West Bengal Government:				
(i) for power . . .				
(ii) for irrigation . . .				
(iii) for flood control . . .				
(c) Bihar Government:				
(i) for power . . .				
(ii) for irrigation . . .				
Total . . .				
Financial Adviser.		Common Seal		Chairman.
Accounts Officer.		of		Member.
		D.V.C.		Secretary.

ANNEXURE II

THE DAMODAR VALLEY CORPORATION

Note—(The Corporation may open such suitable detailed heads as may be considered necessary).

I.—BALANCE SHEET AS ON 31ST MARCH 194 .

Liabilities	Assets
Rs. Rs.	Rs.
Central Government—	Irrigation . . .
Power . . .	Power . . .
Flood Control . . .	Flood Control . . .
West Bengal Government—	Flood Control Expenses
Irrigation . . .	(Revenue A/C) . . .
Power . . .	Tools & Plant . . .
Flood Control . . .	Materials in Stock . . .
Bihar Government—	Sundry debtors for—
Power . . .	Current supplied . . .
Irrigation . . .	Other debtors . . .
Central Government	Other items (to be
Received . . .	specified) . . .
Revenue Account—	Cash at Bank . . .
Power . . .	Cash in hand . . .
Irrigation . . .	
Sundry Creditors—	
Security Deposits	
from contrac-	
tors . . .	
Deposits from	
Consumers . . .	
Other creditors . . .	
Depreciation Fund—	
Renewals and	
replacements	
reserve fund .	
Other Reserve funds	
(to be specified) .	
Employees' Provident	
Fund . . .	
Other Items—(to be	
specified) . . .	

2. Schemes in Hooghly River . . .	Central Government . . .
3. Navigation—	West Bengal Government . . .

Add — Proportionate overhead and general charges
Deduct—Receipts

 Total—Net expenditure C/O to Balance Sheet . .

* Expenditure on each major work will be shown separately.

Expenditure		Income	
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20
21	22	23	24
25	26	27	28
29	30	31	32
33	34	35	36
37	38	39	40
41	42	43	44
45	46	47	48
49	50	51	52
53	54	55	56
57	58	59	60
61	62	63	64
65	66	67	68
69	70	71	72
73	74	75	76
77	78	79	80
81	82	83	84
85	86	87	88
89	90	91	92
93	94	95	96
97	98	99	100

1.—POWER		
	Rs.	Rs.
<i>Generation—</i>		<i>Sale of Power—</i>
Hydro-Electric		Industrial
Thermal		Agricultural
<i>Transmission Lines and Receiving Stations—</i>		Municipal
Hydro-Electric		Commercial
Thermal		Domestic
<i>Distribution Lines and Stations—</i>		Miscellaneous
Hydro-Electric		<i>Other Revenues</i>
Thermal		
<i>L. T. Distribution Systems—</i>		
<i>Commercial Expenses</i>		
<i>General Expenses</i>		
<i>Depreciation and other Reserve Funds—</i>		
<i>Interest on Capital</i>		
<i>Net Revenue from Power C/O to Balance Sheet</i>		
	...	
 2.—IRRIGATION		
<i>Maintenance Expenses—</i>		
Dams		Betterment levy
Canals		Miscellaneous Revenues
Distributaries		
<i>General Expenses</i>		
<i>Depreciation and other Reserve Funds</i>		
<i>Interest on Capital</i>		
<i>Net Revenue from Irrigation C/O to Balance Sheet</i>		
	...	

3.—FLOOD CONTROL

Maintenance Expenses—	Miscellaneous Receipts—
Schemes in Damodar . . .	Net Expense carried
Schemes in Hooghly . . .	over to Balance Sheet . . .
Schemes in Calcutta	
Port	
General Expenses	
—	—
—	—

IV.—STATEMENT SHOWING OVERHEAD AND GENERAL EXPENSES FOR THE YEAR ENDING 31st MARCH 194 AND THEIR ALLOCATION

Expenses		Allocation	
	Rs.		Rs.
(a) General Administration Expenses—		Capital A/C	
(1) Corporation Expenses . . .		Irrigation	...
(2) Secretary's Office		Power	...
(3) Financial Adviser's Office .		Flood Control	...
(4) Contribution to Employees' Provident Fund . .		Revenue A/C—	
		Power	...
		Irrigation	...
		Flood Control	...
(b) Stores and Workshops Expenses—			
(1) Stores			
(2) Workshops			
(c) General Development Expenses—			
(1) Afforestation			
(2) Soil conservation			
(3) Use of lands			
(4) Resettlement of displaced population			
(5) Agricultural development			
(6) Industrial development			
(7) Experimental and Research Stations			
(8) Public Health & Sanitation			
(9) Economic and Social Welfare			
(d) Other General Charges—			
(1) Interest			
(2) Depreciation			
(3) Taxes			
(4) Audit charges			
—	—	—	—
—	—	—	—

APPENDIX II REGULATIONS

(Vide Damodar Valley Corporation Notification dated 4th October, 1951 published in the Gazette of India, Part III—Sec. 4, dated the 27th October, 1951)

No. 1.—In exercise of the powers conferred by section 60 of the Damodar Valley Corporation Act, 1948 the Corporation, with the previous sanction of the Central Government, hereby makes the following regulations:—

1. *Short Title.*—These Regulations may be called the Damodar Valley Corporation (Conduct of Business) Regulations, 1951.

2. *Definitions.*—In these Regulations, unless the context otherwise requires:—

- "Assistant Secretary", "Under Secretary" and "Deputy Secretary" mean the officers appointed as such by the Corporation.
- "Chairman" means the Chairman of the Corporation.
- "Financial Adviser" means the Financial Adviser of the Corporation.
- "Secretary" means the Secretary of the Corporation.

3. *"Business ordinarily to be conducted at meetings of the Corporation."*—The business of the Corporation shall be transacted either at meetings of the Corporation or by circulation of files amongst the Members and the Financial Adviser. Ordinarily meetings shall be held once a week.†

No final decision on any matter involving revenue and expenditure shall be taken without the advice of the Financial Adviser.

4. *Quorum.*—Any two Members shall form a quorum at a meeting of the Corporation.

5. *Notice of meeting.*—Notice of a meeting signed by such officer as the Chairman may authorise shall ordinarily be given to every Member and the Financial Adviser at least 3 days before the meeting.

6. *Circulation of Agenda.*—The Agenda and record of proceedings of meetings of the Corporation should be prepared and maintained either by the Secretary or a Deputy Secretary.

The Agenda note shall contain the views of the Financial Adviser on all matters involving revenue and expenditure. No matter relating to revenue and expenditure shall be included in the agenda or be circulated for decision unless previous advice has been taken thereon from the Financial Adviser.

The agenda shall be circulated to Members and Financial Adviser at least 24 hours before the meeting is held with explanatory notes on each item.

7. *Minutes.*—(1) The minutes of every meeting shall be recorded by such officer as the Chairman may authorise in this behalf.

(2) The minutes of the previous meeting shall be placed before the next meeting of the Corporation for confirmation.

8. *President of the meeting.*—The Chairman, when present, and in his absence one of the Members shall preside over every meeting of the Corporation.

9. *Decision by majority.*—Every decision of the Corporation shall be taken by a majority of the votes of the members present at the meeting.

10. *Proceedings of Corporation confidential.*—The proceedings of meetings of the Corporation shall not be disclosed to any person without the consent of the Members and Chairman.

11. *Powers of Executive Officers.*—The Corporation may in connection with its business and functions authorise or require its officers and servants to do anything necessary for the proper discharge of the functions and business of the Corporation.

12. *Authentication of orders.*—(1) Orders and other instruments made and executed in the name of the Corporation shall be authenticated by the signature of the Secretary, Deputy Secretary, Under Secretary or Assistant Secretary.

(2) All contracts and assurance of property made on behalf of the Corporation shall be executed on behalf of the Corporation by the Secretary, Deputy Secretary or by such other officer as the Corporation may, in any particular case, authorise in this behalf. Provided that contracts and assurance of property in respect of which tenders or offers are accepted by an officer authorised by the Corporation in that behalf may be executed on behalf of the Corporation by such officer. (By order of Secretary).

† As amended by D.V.C. Notification No. 2 dated the 20th October 1954, published in the Gazette of India, Part III—See 1, dated the 6th November, 1954.

FLOODS IN THE DAMODAR AND BARAKAR RIVERS AND THEIR CONTROL BY DVC DAMS DURING THE WEEK OF 15 SEPTEMBER 1958

"According to newspaper reports, the normal life in Midnapore and Bankura districts has been severely affected. Due to lack of any effective flood control measures, the two rivers—Kaleghai and Chanda—have breached their embankments and submerged several hundred villages in the adjoining area. The railway and other communication systems in this region and between Howrah and Kharagpur have been badly affected. The damage caused to the standing paddy crop is estimated to be very heavy. Due to this heavy rainfall, the Damodar and Barakar

"It may be seen from this figure that a maximum peak inflow of 20,000 cusecs had occurred at Tilaiya at about 12 noon on 15.9.58. There was practically no outflow from the reservoir during this period. As a result of this, the pond level which was at El.1213.3 at the beginning of the flood on 13 Sept. 58 rose to El. 1219 on 17 Sept. 58 storing the entire flood volume of 67,000 acre-ft. (shaded portion of the inflow hydrograph). Similarly, a maximum peak inflow of 38,000 cusecs had occurred at about 2 p.m. on 15 Sept. 58. About

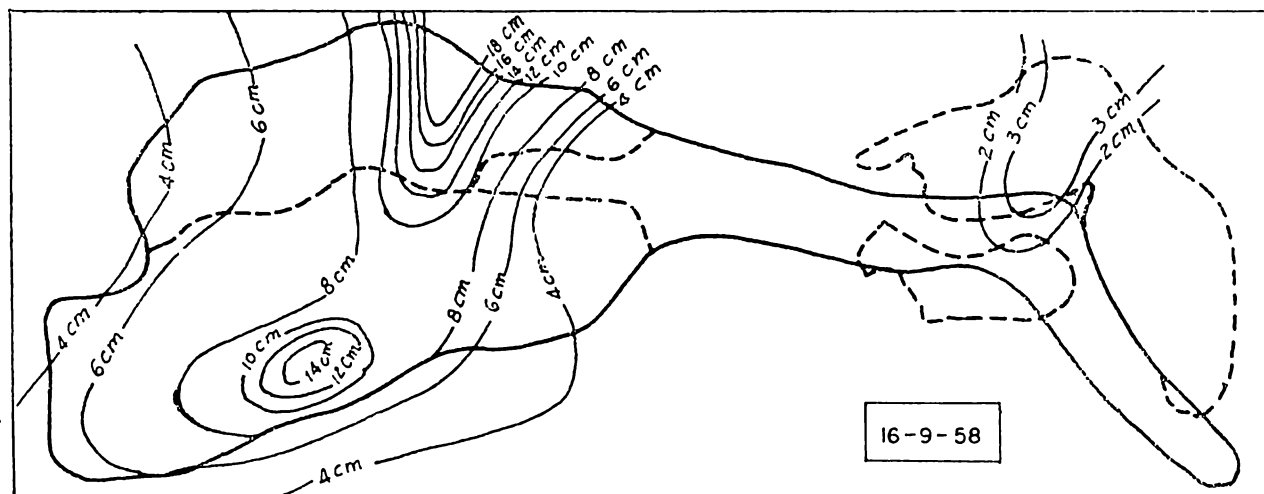
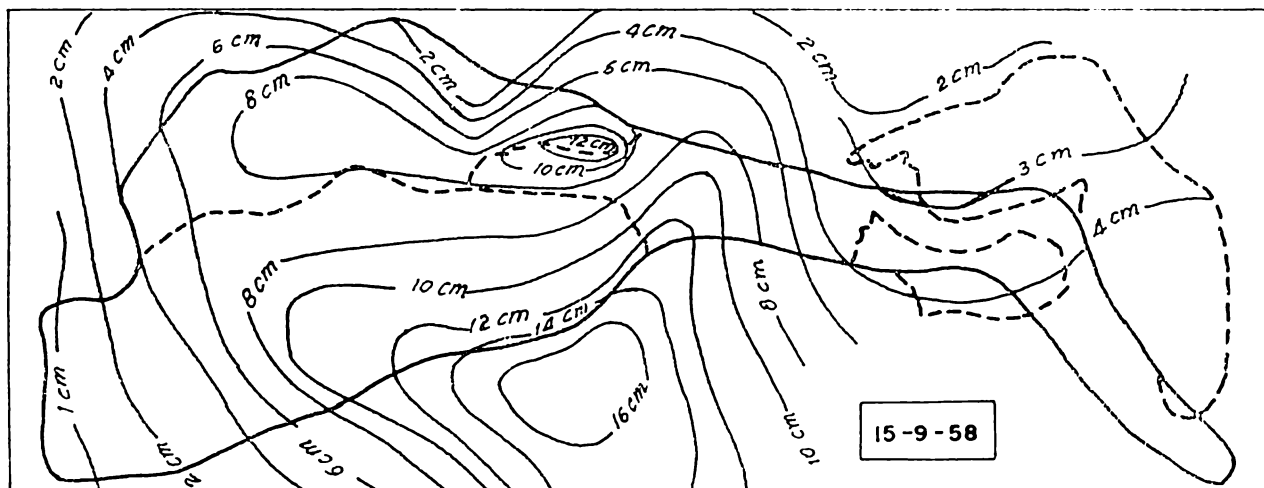
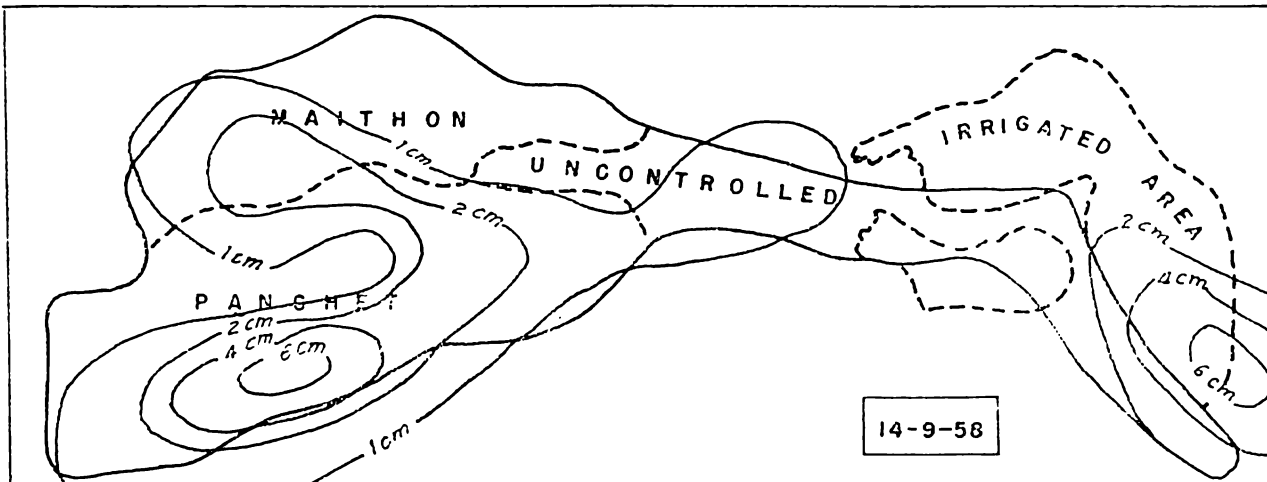
"At Panchet the maximum observed peak inflow was 430,000 cusecs which occurred at about mid-night of 15 Sept. 58. The pre-flood level at the beginning of the flood was Elevation 382 at noon on 14 Sept. 58, which was about 23 ft. below the crest. The rate of inflow was so high that the reservoir was filled up to crest level by about 8 p.m. on 15 Sept. 58 and further rose to a maximum elevation of 421.2 by 10 a.m. on the next day. Even without the crest gates, the peak inflow of 430,000 cusecs was moderated to 180,000 cusecs due to he storage capacity of 450,000 acre-ft. available behind the dam between El. 382 and El. 421.2.

The maximum observed peak inflow at Maithon was 170,000

in the reservoir. As a result of this, the pre-flood reservoir level which was at El. 476.6 at 12 noon on 15 Sept. 58 rose to a maximum elevation of 492 at 6 a.m. on 17 Sept. 58.

"Similarly, without Tilaiya dam the peak flow of 20,000 cusecs at Tilaiya which occurred at about 12 noon on 15 Sept. 58 would have reached Maithon by about mid-night of the same day increasing the peak flow from 170,000 cusecs to about 190,000 cusecs. The total flood volume from Barakar branch at Maithon would have been 426,500 acre-ft. The maximum contribution from the uncontrolled catchment during this flood was about 60,000 cusecs with a volume of 100,000 acre-ft. at Durgapur.

"However, it may be remembered that under no circumstances could a design flood of one million cusecs peak which may occur at any time be regulated by the present dams to an outflow such that would not flood the lower Damodar Valley. The pre-flood conditions at the reservoirs, the ratio of contribution of peak flow from the two branches and the flow condition of the river in the lower reach were extremely favourable in this flood and therefore, the procedure of reservoir operation that was adopted in this case has resulted in lowering the peak flow of 665,000 cusecs to 205,000 cusecs at Durgapur."



NOTE:-

The isohyets as shown above,
correspond to the rainfall during
past 24 hrs. ending 8-30 A.M.
of the date.

SCALE 0 10 20 40 80 MILES

DAMODAR VALLEY CORPORATION	
GENERAL	RESERVOIR OPERATION CONTROL
ISOHYETALS FOR THE STORM OF 14-9-58 TO 16-9-58	

DWG. NO.
GA - 1196

Appendix III

TYPICAL AGREEMENT FORM FOR SALE OF ELECTRIC POWER AND ENERGY

THIS AGREEMENT made this _____ day of
195 BETWEEN the DAMODAR VALLEY
CORPORATION, a Corporation constituted under the Damodar Valley
Corporation Act, 1948 (hereinafter called the "Corporation") of
the one part AND

(hereinafter called the Consumer, which expression shall include
his executors and administrators legal representatives successors and
permitted assigns) of the other part:

WHEREAS the Consumer has requested the Corporation to
furnish to him a supply of electrical energy in bulk at

(hereinafter referred to as the "Substation") for his own use/re-sale
purposes and the Corporation has agreed to afford such supply to
the Consumer on the terms and conditions hereinafter contained:
NOW IT IS HEREBY DECLARED AND AGREED AS
FOLLOWS:

1. Subject to the provisions hereinafter contained and during
the continuance of this Agreement, the Corporation shall supply the
Consumer and the Consumer shall take from the Corporation a
supply of electrical energy at a power not exceeding a demand
of _____ kilo-volt-amperes (hereinafter referred to as the
"Contract Demand") subject to the provisions of Clause 24 hereof.

2. The Consumer shall begin to take electrical energy from
the Corporation under the conditions of this Agreement within two
months from the date on which intimation is sent in writing to the
Consumer by the Corporation that a supply of electrical energy
to the full extent of the Contract Demand is available under this
Agreement.

3. The Corporation shall at its own expense and subject to
the conditions hereinafter contained provide and erect such switch-
gear and meters (hereinafter referred to as "the Corporation's
Apparatus") as may be necessary to afford control by the Corpora-
tion of the Supply and to measure the same.

4. The energy supplied to the Consumer by the Corporation
shall be on the 3-phase 50 cycles alternating current system at a
normal pressure of _____ volts. The frequency and pressure
of the electrical energy at the point of supply to the Consumer
shall be subject to the fluctuations that are ordinary, usual and
incidental to the generation and transmission of electrical energy,
but such fluctuations shall not except owing to extra-ordinary reasons
beyond the control of the Corporation be more than those permitted
by the Indian Electricity Rules 1937 or any statutory modification
thereof as may be in force from time to time.

5. Save as provided herein the supply shall be available con-
tinuously except in cases of lockout or strike of the employees of
the Corporation, breakdown of machinery or plant, force majeure
or any other cause over which the Corporation has no control in
any of which cases the Corporation shall not be responsible for
any discontinuance of the energy but it shall restore the supply as
soon as it reasonably can.

6. The point of supply shall be at the Substation at the out-
going terminals of the Corporation's apparatus from which energy
is conveyed to the Consumer.

7. All transformers, switchgear and other electrical equipment
belonging to the Consumer and directly connected to the feeders or

lines of the Corporation shall be of suitable design and be main-
tained to the reasonable satisfaction of the Corporation. The settings
of fuses and relays on the Consumer's control gear as well as the
rupturing capacity of any of its circuit breakers shall be subject to
the approval of the Corporation.

8. For the purpose of registering the electrical energy taken
by the Consumer under this Agreement there shall be provided at
the point of supply defined in Clause 6 one _____ volt
metering equipment on each feeder of the Consumer which shall be
the property of and be kept in repair and calibrated by the Cor-
poration. Each metering equipment shall consist of the necessary
instrument transformers one polyphase integrating kilowatt-hour meter
with one KVA demand meter.

9. The Consumer may at his own expense instal check meters
in his feeders at the Substation.

10. The meters referred to in Clauses 8 and 9 above shall
be properly sealed on behalf of both parties and shall not be
interfered with by either party except in the presence of the other
party or its representatives duly authorised in that behalf.

11. The readings of the meters referred to in Clause 8 shall
be taken by accredited representatives of the Consumer and the
Corporation on or as near as practicable to the last day of each
calendar month and the readings so taken shall be binding and
conclusive between the Consumer and the Corporation as to the
amount of electrical energy supplied to the Consumer, provided
that in the event of any Corporation's meter being found defective
the power consumed during the period when the meter was defective
shall be determined unless otherwise mutually agreed upon by taking
the average recorded for the previous 3 calendar months.

12. The Consumer shall from time to time and at all times
allow the employees of the Corporation to inspect the electrical
equipment of the Consumer installed for all or any of the purposes
connected with the supply of electrical energy of the Consumer
under this Agreement.

13. The Consumer shall be entitled on application to the
Corporation or its authorised representatives in this behalf to have
a test carried out on the meters at any time and the expense of
such test shall be borne by the Corporation or the Consumer ac-
cording as the meters are found defective or correct as a result of
such a test. Such meters shall be deemed to be correct if the
limits of error do not exceed those laid down in the Indian Electri-
city Rules, 1937, or any other statutory modification thereof for the
time being in force.

14. For the purpose of this Agreement the maximum demands
of the supply to the Consumer in each month shall be the largest
total amount of kilovolt-amperes (KVA) delivered to the point of
supply of the Consumer during any consecutive _____ minutes
in the month.

15. Maximum demand charges for any month and at the point
of supply will be based on the maximum KVA demand for the
month or 75% of the Contract Demand whichever is higher. For
the first twelve months' service the maximum demand charge for
any month will be based on the actual monthly maximum demand
for that month.

16. For each calendar month during the term if this Agreement the Consumer shall pay to the Corporation a maximum demand charge set out below:

The Consumer shall pay the maximum demand charge as a minimum without prejudice to the conditions set out in Clause 21.

17. In addition to the demand charge to be paid each month as provided in Clause 16, the Consumer shall pay an energy charge which shall be at the following rates per kilowatt-hour of all electrical energy consumed by the Consumer during the month:

The above rate is given on the express condition that the Consumer guarantees and pays an energy charge of Rs.

per annum as a minimum.

18. The rate per unit as specified in Clause 17 hereof shall be deemed to be based on an average cost of coal of Rs. 9/- per ton delivered at the bunkers of the Corporation's generating stations. For the purpose of this Agreement, the generating station at the Government of India Fertilizer Factory, Sindri, will be considered as a Corporation's generating station to the extent that the generating station at Sindri is used by the Corporation. In the event of there being at any time or times during the continuance of this Agreement a rise or fall in the cost of coal delivered as aforesaid, the said rate shall be increased or reduced as the case may be by 0.003 of an anna per unit for each four-anna variation in the cost per ton of coal.

An adjustment under this Clause shall be made in each monthly bill in respect of the energy charged in such bill and shall be based on the average cost of coal delivered as aforesaid during the latest period for which a certificate of cost by the Corporation's Chief Accounts Officer is available. A final adjustment under this clause shall be made at the end of six calendar months ending 30th September and 31st March and shall be based on the average cost of coal delivered as aforesaid during such period of six calendar months as certified by the Corporation's Chief Accounts Officer whose certificate therefor shall be binding and conclusive for purposes if this Agreement on both parties hereto.

19. The overall unit rate including the demand charge but excluding any surcharge payable under Clause 18 shall not exceed one anna per kilowatt-hour without prejudice to the minimum charge set out in Clause 16 and the guaranteed energy charge in Clause 17.

20. Any levy such as Sales Tax, Electricity Duty, Octroi or by whatever other name called made by the State Government or other competent authorities on energy purchased by the Consumer from the Corporation shall be paid by the Consumer.

21. If at any time the Consumer is prevented from receiving or using the electrical energy to be supplied under this Agreement either in whole or in part owing to any strike, riots, insurrections, command of a civil or military authority, fire, explosions, act of God or any other cause reasonably beyond control or if the Corporation is prevented from supplying or unable to supply such electrical energy owing to all or any of the causes mentioned above, then the demand charge set out in Clause 16 and the guaranteed energy charge set out in Clause 17 payable by the Consumer shall be reduced in proportion to the ability of the Consumer to take or the Corporation to supply such power.

22. The Corporation shall within fifteen days after the expiration of each calendar month deliver to the Consumer an account stating the number of units supplied to the Consumer by the Corporation in accordance with the readings of the said meters and the amount payable therefor as also the amount payable in respect of the maximum demand charge and other charges if any payable by the Consumer to the Corporation and the Consumer shall pay the same within thirty days from the delivery of such account.

23. If the Consumer fails to pay the amount of any bill due under this Agreement within thirty days from the date of receipt of the bill referred to, he shall pay a surcharge of one per cent per month from that date. If the amount of such bill remains unpaid for sixty days after the date of receipt of the bill referred to above, the Corporation shall give the Consumer seven days'

notice of its intention to discontinue the supply of electrical energy and at the expiry of such period if the payment has not been received may forthwith disconnect the supply until full payment for all obligations pending and the charge for the work of disconnection and reconnection have been made.

24. In the event of the Consumer desiring to increase or decrease the Contract Demand the Corporation may require the Consumer to give the Corporation twenty-four months' notice in writing stating the quantity of energy required.

25. This Agreement shall subject as hereinbefore provided be and remain in force for seven years from the date of commencement of supply and thereafter from year to year provided that either party shall be at liberty to determine this Agreement after the expiration of the seventh or any subsequent year on giving twelve months' notice in writing of such intention, and at the expiration of such notice this Agreement shall absolutely cease and determine but without prejudice to the rights and remedies if any of either party which may have accrued or arisen hereunder in the meantime, and provided further that the Corporation shall on giving the Consumer twelve months' notice in writing of such intention be at liberty at any time after the expiration of the third year to alter the demand charge set out in Clause 16, and the energy charge set out in Clause 17.

26. Should a tariff for electric power for a similar class of load for a corresponding supply of energy more favourable than that specified in Clauses 16 and 17 be allowed by the Corporation during the life of this Agreement, then the Consumer shall be entitled to such a tariff.

27. In the event of any dispute or difference arising at any time between the Corporation and the Consumer in regard to any matter arising out of or in connection with this Agreement such dispute or difference shall be referred to the Arbitration of two Arbitrators, one to be appointed by each party hereto, and an Umpire to be appointed by the Arbitrators before entering upon the reference and the decision or award of the said Arbitrators or Umpire shall be final and binding on the parties hereto and any reference made under this Clause shall be deemed to be a submission to arbitration under the Indian Arbitration Act, 1940, or any statutory modification thereof for the time being in force.

The Arbitrators or the Umpire giving their or his decision shall also decide by which party the costs of the arbitration and award shall be paid and if by both parties in what proportion.

IN WITNESS WHEREOF two parties hereto have executed or caused to be executed these presents the day and year first above written.

SIGNED FOR AND ON BEHALF OF

WITNESS

SIGNED FOR AND ON BEHALF OF THE
DAMODAR VALLEY CORPORATION

WITNESS

Appendix IV

DAMODAR VALLEY CORPORATION CONFIDENTIAL ANNUAL PERSONAL REPORT PL/F-1

ASSESSMENT SHOULD BE ONE OF THE FOUR—
VERY GOOD/GOOD/SATISFACTORY/POOR.

1. Period of report fromto.....
 2. Name in full—
 3. Designation—
 4. Department and Branch in which employed—
 5. Scale of pay—
 6. Present pay—
 7. Date of increment—
 8. Age—
 9. Total Service—
 10. Personality—
 11. Integrity—
 12. Capacity for sustained work—
 13. Tact and ability to work with others—
 14. Ability to control subordinates—
 15. Reliability in carrying out instructions—
 16. Ability to state a case—
 17. Initiative—
 18. Power of taking responsibility—
 19. Power to inspire confidence in the general public—
 20. Devotion to duty—
 21. Knowledge of his work—
 22. Do you consider him to be an officer—
- (a) of more than ordinary attainments and abilities deserving of special selection for promotion, should the occasion arise, and if so, to what post;
- (b) fit for promotion in the ordinary way; or
- (c) at present unfit for promotion?
- General remarks, (including a statement on character and physical fitness and a note of any special qualifications not covered by the above).
- Signature and Designation of the
Reporting Officer.
- Remarks by higher Officers.
- A. Has he been responsible for any outstanding work during the period under review meriting special commendation? If so, please give particulars.
- B. Any other remarks.
- Signature and Designation.

Appendix V

DAMODAR VALLEY CORPORATION CONFIDENTIAL ANNUAL PERSONAL REPORT PL/F-2

ASSESSMENT SHOULD BE ONE OF THE FOUR—
VERY GOOD/GOOD/SATISFACTORY/POOR.

1. Period of report fromto.....
 2. Name in full—
 3. Designation—
 4. Department and Branch in which employed—
 5. Scale of pay—
 6. Present pay—
 7. Date of increment—
 8. Age—
 9. Total Service—
 10. Observations on—
 - (a) Personality—
 - (b) Integrity—
 - (c) Capacity for sustained work—
 - (d) Ability to control subordinates—
 - (e) Reliability in carrying out instructions—
 - (f) Initiative—
 - (g) Power of taking responsibility—
 - (h) Devotion to duty—
 11. Description of work on which officer has been engaged. Has he managed his work well during the period under report?
 12. Are projects and reports, received from him, carefully and lucidly prepared, and do they show that he is professionally and otherwise well qualified and an officer of sound judgment?
 13. Are his relations with those working with him generally cordial and does he display good temper and tact in dealing with those with whom he is brought in contact?
 14. Is his office in good order? Does he habitually delay in dealing with matters which can and ought to be disposed of promptly? Does he indulge in unnecessary correspondence?
 15. Are his arrangements for carrying out work good, and are his methods economical or extravagant?
 16. Has he such a knowledge of accounts as to sufficiently control his expenditure?
 17. Has he any special professional acquirement?
 18. Has he a special aptitude for any particular class of work?
 19. Do you consider him to be an officer—
 - (a) of more than ordinary attainments and abilities deserving of special selection for promotion, should the occasion arise, and if so, to what post;
 - (b) fit for promotion in the ordinary way; or
 - (c) at present unfit for promotion?
- General remarks, (including a statement on character and physical fitness and a note of any special qualifications not covered by the above).
- Signature and Designation of the
Reporting Officer.
- Remarks by higher Officers.
- A. Has he been responsible for any outstanding work during the period under review meriting special commendation? If so, please give particulars.
 - B. Any other remarks.
- Signature and Designation.

Appendix VI

DAMODAR VALLEY CORPORATION CONFIDENTIAL ANNUAL PERSONAL REPORT PL/F-3

ASSESSMENT SHOULD BE ONE OF THE FOUR—
VERY GOOD/GOOD/SATISFACTORY/POOR.

1. Period of report fromto.....
2. Name in full—
3. Designation—
4. Department and Branch in which employed—
5. Scale of pay—
6. Present pay—
7. Date of increment—
8. Age—
9. Total Service—
10. (a) Nature of work on which employed—
(b) Manner in which he has discharged his duties—
(c) Whether his technical qualifications, theoretical as well as practical, are sufficient to enable him to perform his duties competently.
(d) Comment on his—
(i) Initiative.
(ii) Tact and judgment.
11. Observations on—
(i) Intelligence and general ability.
(ii) Integrity.
(iii) Amenability to discipline.
(iv) General behaviour.
(v) Punctuality in attendance.
12. Has he been responsible for any outstanding work during the period under review meriting special commendation? If so, what?
13. Has he been reprimanded for indifferent work, or for other causes during the period under review? Give brief particulars.
14. Discuss his fitness for more responsible work, indicating whether he is considered on the record of his work during the year fit for promotion to the next higher post, should occasion arise.
15. General remarks, including remarks as to defects in character, indebtedness etc., which militate against efficiency and suitability for particular classes of work.

Signature and Designation of the
Reporting Officer.

Remarks by higher Officers.

Signature and Designation.

Appendix VII

DAMODAR VALLEY CORPORATION CONFIDENTIAL ANNUAL PERSONAL REPORT PL/F-4

ASSESSMENT SHOULD BE ONE OF THE FOUR—
VERY GOOD/GOOD/SATISFACTORY/POOR.

1. Period of report fromto.....
2. Name in full—
3. Designation—
4. Department and Branch in which employed—
5. Scale of pay—
6. Present pay—
7. Date of increment—
8. Age—
9. Total Service—
10. Observations on—
 - (i) Intelligence and general ability.
 - (ii) Integrity.
 - (iii) Knowledge of procedure and regulations.
 - (iv) Energy in applying himself to work.
 - (v) Skill in drafting.
 - (vi) Amenability to discipline.
 - (vii) Behaviour and assistance rendered to other staff.
 - (viii) Capacity for inspiring respect.
 - (ix) Punctuality in attendance.
11. Whether the employee has been careful in observing routine, e.g.—
 - (i) Referencing and paging of notes & correspondence.
 - (ii) Keeping his files and papers in tidy condition.
 - (iii) Prompt and accurate in disposing of work without pressure.
12. Work as typist—
 - (i) Accuracy—
 - (ii) Speed—
13. Work as Steno-typist or Stenographer—
 - (i) Accuracy—
 - (ii) Speed—
 - (iii) Trustworthiness in confidential and secret matters—
14. Work as a Cashier, Accounts Clerk or Accountant—
 - (i) Proper maintenance of books of accounts.
 - (ii) Familiarity with rules and regulations relating to accounts.
 - (iii) Reliability.
15. Work as a Store-keeper—
 - (i) Is he familiar with all the stores under his charge?
 - (ii) Does he maintain proper record of the receipt and issue of stores?
 - (iii) Reliability.
16. Work as Superintendent—
 - (i) Superintendence of the work.
 - (ii) Maintaining order, discipline and checking late attendance.
 - (iii) Submission of cases in proper order.
 - (iv) Capacity to train, help and advise his less experienced staff.
 - (v) Ability to handle the most difficult cases.
17. Has he been responsible for any outstanding work during the period under review meriting special commendation? If so, what?
18. Has he been reprimanded for indifferent work, or for other causes during the period under review? Give brief particulars.
19. Is he considered on the record of his work during the year fit for promotion to the next higher post, should the occasion arise?
20. General remarks, including remarks as to defects in character, indebtedness, etc., which militate against efficiency and suitability for particular classes of work.

Signature and Designation of the
Reporting Officer.

Remarks by higher Officers.

Signature and Designation.

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