

GOVERNMENT OF INDIA  
CENTRAL WATER AND POWER COMMISSION

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REPORT  
OF  
THE ADVISORY COMMITTEE  
ON  
HIRAKUD DAM PROJECT

\*

MARCH 1952

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HIRAKUD.  
6th March, 1952.

To

The Secretary to the Government of India,  
Ministry of Natural Resources and Scientific Research,  
NEW DELHI.

DEAR SIR,

We the Members of the Advisory Committee on Hirakud Dam Project, appointed by the Govt. of India vide Resolution No. DWII-12(24) dated the 10th January 1952, have reviewed the Revised Estimates of the Hirakud Dam Project prepared by the Central Water and Power Commission, and submitted our Report for the consideration of the Government.

The Committee met at Hirakud on the 11th February and concluded its sitting on the 6th March 1952. During this period, it inspected the works under construction and the areas to be irrigated both in the Sambalpur District and the Delta lower down and interviewed several important officers of the Orissa State and the Hirakud Administration.

We wish to acknowledge the unfailing courtesy and cooperation received from Shri B. Sivaraman I.C.S., Commissioner, Northern Circle and Member, Board of Revenues, Orissa and his officers; Shri Kanwar Sain, I.S.E., Member (Designs) and Chief Engineer, Hirakud Dam Project, his Superintending Engineers and Executive Engineers; Shri S. Sundararajan, Financial Adviser and Chief Accounts Officer Hirakud Dam Project; Dr. J. B. Mohanty, Secretary, River Valley Development Department, Orissa; Mr. J. Shaw, I.S.E., Chief Engineer (Irrigation) Orissa; Shri R. L. Narayanan, Chief Engineer (Electricity), Orissa; Col. B. N. Hajra, Director, Public Health, Orissa; Dr. Ramanujam, Director, Central Rice Research Institute and Shri Pujari, Director of Agriculture, Orissa and his staff. Particularly we wish to place on record our high appreciation of the services rendered by our Secretary Shri M. G. Hiranandani. But for his hard work and thorough grasp of facts concerning this Project, it is doubtful if we would complete the work within such a short time.

In our considered judgement the Revised Estimates of the Hirakud Dam Project, as modified by us are fair on the basis of the present price level—neither inflated nor inadequate and are acceptable.

Yours faithfully,  
(Sd.) S. C. MAJUMDAR,  
6-3-52  
(Sd.) M. L. CHAMPHEKAR,  
6-3-52  
(Sd.) T. J. MIRCHANDANI,  
6-3-52

D. A. As above.

# REPORT OF THE ADVISORY COMMITTEE ON HIRAKUD DAM PROJECT (MARCH 1952)

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## SECTION I

### INTRODUCTORY

#### 1.1 Appointment of Committee

THE Hirakud Dam Project, which was originally estimated to cost Rs. 47.8 crores was sanctioned by the Government of Orissa in April 1948. On account of general rise in prices both in India and abroad, devaluation of the rupee, increase in labour wages, and extension of the scope of the project, the original project estimate had to be revised, cost of which amounted to Rs. 89.09 crores.

The Government of India considered that the revised estimate should be reviewed by a Committee of Experts, who should examine the project estimates and make their recommendations to the Government in the Ministry of Natural Resources and Scientific Research.

The following Committee, sanctioned *vide* Ministry of Natural Resources and Scientific Research, Resolution No. DWII-12(24) dated 10th and 31st January 1952, was appointed:—

1. Shri S. C. Majumdar, Consulting Engineer to the Government of West Bengal—**CHAIRMAN.**
2. Shri M. L. Champhekar, I.S.E., Chief Engineer, P.W.D., Government of Bombay—**MEMBER.**
3. Shri T. J. Mirchandani, Chief Engineer, Bombay Electrical Grid—**MEMBER.**
4. Shri M. G. Hiranandani, Executive Engineer, Central Designs Organisation—**SECRETARY.**

#### 1.2 Terms of Reference

The Committee was requested by the Government of India to report on the following points:—

- (i) Technical feasibility of the project;

(ii) Financial anticipations and economics of:—

- (a) Irrigation;
- (b) Power Generation and Utilisation, and
- (c) Project as a whole.

(iii) The amount of compensation for land and houses acquired in the project area.

The Committee was appointed to function for three weeks from the date of meeting at Hirakud.

#### 1.3 Programme of Visits

During their stay at Hirakud, the Committee visited a number of places round about Hirakud, Sambalpur, Cuttack and Puri. The detailed programme of their visits appears in Accompaniment No. I.

#### 1.4 Officers Interviewed

The Committee was interviewed by His Excellency the Governor of Orissa and Hon'ble the Chief Minister of Orissa, and had discussions with important officers of both the Hirakud Administration and the Orissa Government. A full list of officers, who were interviewed in this connection is attached *vide* Accompaniment No. II.

The Committee has accepted the figures of quantities and costs supplies as correct and has not exercised any arithmetical checks to test their accuracy.

## SECTION II

### TECHNICAL FEASIBILITY OF THE PROJECT

#### 2.1 Technical feasibility

2.1 This Committee is not in a position to express an opinion on the broad question whether the Project as now conceived is technically the best method of achieving the benefits expected to accrue. It has not had the time, nor the opportunity, for such a comprehensive review.

The Construction work is in full swing and the cost already incurred amounts to Rs. 18 crores, which is exclusive of the amount of Rs. 6.0 crores for the cost of electrical plant and equipment on order. The Committee has, in the circumstances, accepted the main outline of the Project already sanctioned and under active execution as a *fait accompli* which cannot be disturbed. It has confined its examination to such features as may be technically unsound or susceptible of readjustment and improvement to secure a more sound job or better financial results.

#### UNIT NO. I—MAIN DAM AND APPURTENANT WORKS

#### 2.2 Dam Site

The dam site already selected appears to be suitable from the technical point of view, though having regard to the long lengths of the earthen dykes, it cannot be considered to be an ideal one.

#### 2.3 Maximum flood Discharge

The Committee examined the flood discharge for which the Hirakud Dam has been designed. This discharge, according to the Hirakud Dam Advisory Committee Report (June 1948) had been worked out to 11,10,000 cusecs. The gross surplussing capacity of the dam as now designed, amounts to 15 lac cusecs, out of which 6 lacs will be discharged through the under-slucices and 9 lacs over the spillway. The latter is capable of discharging 25 per cent more for an increase of 3 feet depth over the crest. This will bring surplussing capacity of the dam to 17.25 lac cusecs,

which will be a little over 50 per cent more than the maximum recommended in the Advisory Committee Report (June 1948).

The Committee is satisfied that the discharging capacity provided, is sufficient.

#### 2.4 Reservoir Capacity

The Hirakud Reservoir has been designed for a gross storage capacity of 6.75 m.a.ft. of which 2.4 m.a.ft. form the dead storage which provides a silt reserve for over 100 years. The Committee went into the note on the Probable Rate of silting of Hirakud Reservoir, which has been attached as an appendix to Volume I and is of the opinion that the dead storage provided is adequate.

#### 2.5 Filling up of Reservoir in Lean years

The Committee considered whether it would be possible to fill up the reservoir to R.L. 630 in a lean year like 1902, when the mean annual run-off of the river was of the order of about 20.61 m.a.ft.

The run-off of Mahanadi at Sambalpur, which had been worked out for the period 1926—46 from the discharge at Naraj on the basis of proportionate areas has been examined. It is observed that from the run-off data available for the period, the reservoir can be filled to R.L. 630 in all the years, if the filling of the reservoir at Hirakud is done from 1st of September each year, except in the case of a year like 1941. In such an abnormal year of deficient rainfall, the reservoir can be filled by commencing filling operations 4 days earlier than September 1st, when indicated by flood warnings.

It has been further observed from the data of run-offs that the minimum river flow during the months of July and August is sufficient to keep the reservoir filled upto R.L. 595, which should be the level maintained during July and August.

### 2.6 Working Table of Hirakud Reservoir

The working table of Hirakud Reservoir *vide* page 195 of Volume I, which has been based on an average in flow of 2.3 m.a.ft. during the 8 non-monsoon months from November to June was examined. It is observed that in 2 years out of 25 years, the inflow during the 8 non-monsoon months has been less than 2.3 m.a.ft. *viz.* in the years 1941 and 1947-48.

It is found from the availability and requirements of supplies during the 8 non-monsoon months reproduced below that there will be a deficiency of 0.58 m.a.ft. in a bad year, which will roughly work out to a reduction of about 10 per cent.

### 2.7 Water Planning Data

HIRAKUD MAIN DAM		Million Acre Feet
Capacity of the reservoir with W.L. at +630 (F.R.L)	.. ..	6.75
Capacity of the reservoir with W. L. at +590 (Normal minimum water level)	.. ..	2.24
Capacity of the reservoir with W. L. at +585 (Bad Year minimum water level)	.. ..	1.87

#### AVAILABILITY OF WATER DURING NON-MONSOON MONTHS

	In Million Acre Feet	
	Normal year	Bad year
Live storage capacity	4.51	4.51
Inflow during non-monsoon months	2.32	1.70
Evaporation losses	-0.4	-0.4
<b>Net TOTAL</b>	<b>6.43</b>	<b>5.81</b>

#### REQUIREMENTS FOR NON-MONSOON MONTHS

Power	.. ..	4.70
Irrigation	.. ..	1.69
<b>TOTAL</b>	<b>.. ..</b>	<b>6.39</b>

Deficiency in a bad year .. .. 0.58 m.a. ft.

This in the opinion of the Committee can be taken up either by 10 per cent cut in Power and Irrigation for 8 months or by re-arrangement of intensities of rabi crops converting rabi paddy into other dry crops.

Working tables for Hirakud main dam for a normal year like 1948-49 and for a bad year like 1947-48, which will impose a 10 per cent cut, are attached as Accompaniments III and IV.

### 2.8 Flood Control

The problem of flood control as discussed in Volume VI of the Revised Hirakud Dam Project Report has been examined. The Committee agrees with the method of flood regulation suggested therein.

It is, however, of the opinion that in addition to the installation of meteorological stations, which will give forecasts of rainfall and flood warnings, gauges should be fixed at suitable points upstream of the reservoir along the river and its important tributaries, to enable gauge discharge curves being plotted and flood warning of the probable discharge, which would be expected to flow into the reservoir, being received sufficiently in advance.

This together with the adequate discharging capacity provided for in the designs of the dam should make it possible to regulate the reservoir so as to reconcile the needs of flood control with those of Power and Irrigation.

### 2.9 Navigation

As navigation in the Mahanadi river will not be possible until Tikarpara dam is constructed, as visualised by the framers of the Project, the revised project provides for minimum structures for the construction of a lock consisting of 40' x 52' R.C.C. slab which would be fixed to the dam, proportionate cost of Power Channel bridge and any other charges already incurred.

The provision of Rs. 1.0 crore under this head in the Revised Estimates allowed corresponding credit to Unit No. I.

The actual cost of minimum structures and navigation surveys etc., since calculated comes to Rs. 20.0 lacs only.

Necessary adjustments under this Unit have been made in the abstracts prepared by the Committee. This, however, does not alter the total cost of the Project.

### 2.10 Designs

The designs and specifications of the dam have been examined in general. The Committee is satisfied with the designs except in case of flank walls where it considered that short masonry projections might be provided on the earthen side of the flank wall, with advantage.

On further examination, it was satisfied that the concrete projections had been provided in the rear of the flank walls, where the impervious section of the earthen dam abutted against it. Projections were not considered necessary in the case of pervious portion, as the rear of the flank wall where it came in contact with the pervious portion would be sand blasted and puddle soil placed against it to prevent flow along the junction between the flank and the pervious portion of the earth dam.

#### UNIT NO. II—MAIN CANALS, BRANCHES, DISTRIBUTARIES AND WATER COURSES

##### 2.11 Rainfall

Orissa, which is mainly an agricultural province is favourably situated in regard to rainfall. The maximum rainfall so far recorded has been 71.21" in 1919 and minimum of 37.02" in 1902. The mean annual rainfall is of the order of 54.38". The amount of rainfall in most years is, however, sufficient but is often unevenly distributed and deficiency in critical months is likely to be fatal to crops. To protect against the vagaries of monsoon rainfall, irrigation has been proposed both in the Sambalpur district and in the Delta areas of the Orissa State.

##### 2.12 Irrigation in the Sambalpur District

Culturable commanded area of 5,42,000 acres is proposed to be irrigated in the Sambalpur district both on the right and left side of the Mahanadi river. The annual irrigated area with Kharif intensity of 100 per cent, a rabi flow intensity of 48 per cent and a rabi lift intensity of 35 per cent, will be of the order of 7,91,000 acres.

The Committee has examined the plans showing the alignment of Bargarh Canal, Right Side Lift Canal and Left Side Truncated Canal and their off-taking channels. All the 3 main canals had been aligned as contour canals, and the alignments were generally found to be satisfactory.

The Committee has also examined typical plans of cross regulator, arch and slab bridges, aqueduct and syphon prepared by the Central Designs Organization for the main Bargarh Canal and is satisfied generally with the designs prepared. Whereas progress on designs of major

masonry structures appeared to be satisfactory, the Committee was apprehensive whether the designs of small masonry structures for distributaries and minors numbering over 400 would be prepared in time to enable distributaries and minors to function by the due date. The committee has, however, been assured that the progress in the design of such structures will be much quicker, as the design of constituent parts of these structures *viz.*, slabs, abutments, wing walls, arches and pitching sections, had already been standardized, and a branch of Central Designs Organization of Central Water and Power Commission has been established at Hirakud.

##### 2.13 Culturable Area

As culturable commanded area had been assumed at 84 per cent of the gross area, which percentage appeared to be high, the Committee examined copies of some settlement records produced by the local Sub-Divisional Officer at Bargarh as a test check. The percentage of culturable Commanded area assumed in the Project Estimate has been found to be correct.

##### 2.14 Duty

The Committee considers that the duty of 100 for paddy in July and 120 for sugarcane in November and December is rather high. In the case of paddy, if the duty is lowered from 100 to say 90—duty which has been adopted in the design of canal for D. V. C. the extra discharge required could be pushed into the canal in the month of July by raising the full supply level by 6" as surplus water would always be available in the reservoir in that month.

Subsequent enquiries from the Director, Central Rice Research Institute, showed that it was not necessary in an area where there is plentiful rainfall to use too much water nor to keep the paddy crop under water. If the ground under a paddy crop is nearly kept wet, the duty for paddy would be quite high, and the yields better.

The Committee was further informed by the Chief Engineer Orissa, that the latter had obtained a duty of 60 at the head of the outlets and that if efficient system of irrigation was introduced, this could be improved upon and even increased to 100. The Committee, therefore, considers that duty of 100 for paddy in the month of July is a reasonable assumption and can be



worked up to, except during abnormal breaks in the monsoon during July and August.

In case of sugarcane, the duty of 120 for November and December should be lowered to 60 and necessary readjustment made in the intensity of other crops during the rabi season, as the extra discharge would be drawn from the reservoir.

### 2.15 Intensities

Intensities for kharif and rabi for canals in Sambalpur district have been accepted as proposed in the Revised Project Estimates, except that 15 per cent intensity of dry rabi has been divided into cash rabi 8 per cent and light rabi 7 per cent, as the water rates for these two will be different. In the case of lift canal which has a dry rabi intensity of 35 per cent, 25 per cent will be cash rabi and 10 per cent light rabi.

### 2.16 Water Table

It is apprehended by the Committee that on account of introduction of rabi paddy in Sambalpur district to the extent of 33 per cent of the culturable area, and sugarcane to the extent of 10 per cent, water from higher lands is likely to flow into low lying areas thereby, raising the water table.

This question has been examined in detail and the Committee is definitely of the opinion that investigations should be made by opening up natural drainages at a few places and observations regarding the movement of sub soil flow recorded, in horizontal direction. If the rate of sub soil flow is found to be satisfactory, it may be assumed that danger of water-logging apprehended due to the introduction of second wet crop in this area can be kept in check by opening surface drains.

The Committee recommends that a provision for opening up drainages to the extent of 25 lacs of rupees should be made in the Project for this purpose, as no such provision had been made in the Revised Estimates.

The Committee also wishes to make a suggestion that if possible, wet crops like rabi paddy and sugarcane should be confined to only low lands in the Sambalpur area. In this connection, the procedure followed in Bombay in sanctioning Cane areas may be studied.

The Committee is further of the opinion that in order to educate the people who are not used to

perennial irrigation, demonstration farms should be opened and different rotations of crops with improved varieties of seeds experimented upon. The sites of farms should be selected in places, which represent the full cross-section of the valley so that the effect of growing second wet crop on higher lands on low-lying areas like 'Bahl' lands can be investigated.

### 2.17 Crop Rotation

In order to obtain increased yields from double cropping of wet crops there is a definite need for planning proper crop rotation on scientific basis, for this area as well in the Delta areas lower down.

The Director, Central Rice Research Institute states that under canal irrigated conditions, it is quite feasible to grow either two crops of rice or one crop of jute and one crop of rice on the same land year after year without impairing the soil fertility, by including a green manure crop in the sequence or by judicious manuring.

The Director, Central Rice Research Institute, Cuttack, who has carried out experiments on double cropping of paddy and jute followed by paddy, in his Institute, has suggested the following three patterns of crop rotations:

- |                        |                          |  |
|------------------------|--------------------------|--|
| (i) (a) Jute           | .. .                     | .. Sowing in May and harvesting in August. |
|                        | (b) Green manure         | .. From September to December.             |
|                        | (c) Rabi paddy           | .. January to April.                       |
| (ii) (a) Aus paddy     | ..                       | May to September.                          |
|                        | (b) Green manure         | .. September to December.                  |
|                        | (c) Second crop of paddy | January to April.                          |
| (iii) (a) Green manure | ..                       | May to July.                               |
|                        | (b) Aman paddy           | .. July to December.                       |
|                        | (c) Second crop of paddy | January to April.                          |

The Committee recommends the rotations of crops mentioned above may be tried out in the demonstration and extension farms to educate the cultivators in the proposed canal area. This is necessary to ensure quick development of irrigation.

### 2.18 Irrigation in Delta Area

Revised proposals in connection with Delta Irrigation submitted by the Chief Engineer Hirakud Dam Project, along with revised Abstract of Cost, have been considered by the Committee.

The Committee inspected the Naraj, Birupa and Mahanadi weirs. The site of syphon where the proposed canal for the new delta areas would

cross Katjuri, the sites of proposed canal crossings on the Khushabadhra and Bharjovi rivers were also inspected.

The Committee is of the opinion that the effect of closure of Kuakhai and the reduction of width of Naraj weir on the distribution of discharges and Biransai spill should be investigated by means of model experiments, at the Hydrodynamic Research Station, Poona and the following suggestions in regard to the reduction of width of Naraj weir experimented upon while performing model experiments:

- (a) Reduction of width of weir from left side.
- (b) Reduction of width in section throughout the length of the weir.

Poona Research Station might also carry out experiments on the off-takes of all the 3 main canals and propose measures for silt exclusion if the canals were drawing more than their due share of silt. This seems necessary as the canal heads are at present closed when river level rises above R. L. 69 at Jobra gauge.

The Committee has examined various alternatives for the position of off-take of the new canal for the delta areas, and agrees that off-take of the new canal should be located upstream of Mahanadi weir, as already proposed in the Revised Project Estimates.

The Committee, however, does not agree to the proposal of closing the Kuakhai as made in the Project Report, with a view to give complete immunity from flooding to the areas in the Puri district, which are now being brought under irrigation.

Kuakhai is the parent stream of a net work of the river channels in this part of the delta, the prominent ones being the Khushabadhra, Bhargovi and Daya, which it may be noted feeds the Chilka lake with sweet water, value of which in the interest of the growing fish industry was stressed to the Committee by His Excellency the Governor of Orissa. These will also die along with the closure of the Kuakhai leaving behind a large number of stagnant pools and undrainable swamps and aggravating the malaria problem further. And due to lack of flushing with silt laden flood occasionally, the productivity of the land will deteriorate. There are several instances in the deltaic tracts in the contiguous state of Bengal, where similar situation created by the natural diversion of the parent rivers has caused serious deterioration in public health and productivity of the soil—for instance in Central Bengal due to diversion of the Ganga, in Mymensingh and Dacca Districts due to diversion of the Brahmaputra, and

in North Bengal due to diversion of the Teesta. In fact one of the main objects of the Ganga Barrage Project now under investigation by the Central Water and Power Commission, is to resuscitate the dead and dying rivers of Central Bengal, and restore the productivity of the soil by flood flushing. In the present case the Kuakhai system is already functioning fairly efficiently, and though certain amount of flood control is undoubtedly needed to prevent frequent flood damages, the control should not be stressed to the extent of their total extinction, as that would be like deliberately killing the patient while curing the disease.

The public health aspect of the problem was discussed with Col. B. N. Hajra, Director of Health, Orissa, and the Committee is grateful for the valuable suggestions made in his note, a copy of which is attached as Appendix I to this Report. It will be seen that he is opposed to the closure of the Kuakhai system as "these dead rivers in course of time will become filled with thick vegetation with enormous output of *A. annularis* which is a reputed vector in the deltaic areas of Orissa. This possibility and its subsequent threat to Bhubaneshwar and also to all the villages on the bank of these rivers require careful investigation".

Even from purely flood control point of view, the proposed closure of the Kuakhai system will at best transfer the complaint elsewhere. According to the Flood Distribution Chart of 140, this system disposed of 2.53 lac cusecs out of the total estimated flood discharge of 14.54 lac cusecs for the entire Mahanadi system. Effect of the closure will be to transfer this burden over the rest of the Mahanadi system, which will in consequence cause even greater damages. It is no doubt true that with the help of the Hirakud reservoir, it will be possible to moderate the highest flood by about 3 lac cusecs and to keep the Naraj gauge within 89 upto which a stage, it is claimed in the Project Report, no damage is caused.

Mr. J. Shaw, the Chief Engineer, Orissa, with whom the point was discussed, however, informed the Committee that even at this latter stage, flood damages do occur though they are not very serious. Under the circumstances the prudent course would be to distribute the benefit of flood moderation proposed to be effected by the Hirakud Reservoir, equitably over the entire Mahanadi system, instead of attempting to make the Kuakhai area absolutely immune from flooding, thereby increasing the flood congestion and consequently the risk of flood damages in the rest of the Mahanadi area. As stressed before, flooding by itself is not necessarily an evil, but in the deltaic area it is necessary in the interest of public health and productivity of the

soil. The factor which makes flooding objectionable in the present case is excessive depth of flooding and its long duration owing to inefficient drainage system. By equitably distributing the residual flood after moderation by the Hirakud reservoir, over the whole of the delta area by means of regulating barrages proposed below, the depth of flooding can be reduced to a fairly low level and this very process of flood flushing, apart from furnishing much needed silt to the land thereby increasing its productivity, will also help in maintaining the drainage system by the scouring action of clear water drained back from the land thereby reducing the duration of flooding.

A note giving the suggestions as to how the 12.0 lac cusecs flood, should be disposed of in the various channels of the delta system and especially those of the Kuakhai system, is given in Appendix IV. That note also gives suggestions for an alternate system of irrigation, which the Committee recommends, should be considered before the final decisions are given.

With the time at their disposal, the Committee could not possibly go into very many details and the figures suggested by them are to be considered only as provisional, to be confirmed after detailed examination by the Organization staff.

In view of the above considerations, the Committee recommends that instead of syphoning the canal under Katjuri, which would cost about Rs. 1.6 crores and bunding up Khushabadhra and Bhargovi, construction of requisite number of barrages on the Katjuri, Khushabadhra and Bhargovi etc. may be considered with a view to provide level crossings for the main canal at these points. This arrangement, the Committee considers would enable flood discharge through the branches of Kuakhai being regulated to safe limit without causing any serious damage.

The discharge to be admitted into Kuakhai, and its distribution into different branches should be carefully computed, and the effect of flood moderation at Hirakud reservoir taken into account, while doing this. This suggestion would enable some relief being afforded both to Mahanadi and Katjuri rivers in the shape of reduction in flood levels, since Kuakhai would be carrying some discharge, which it did not, according to the Revised Project Proposals.

The Committee, therefore, desires that this proposal, though undoubtedly, more expensive than the one made in the Revised Estimates,

should be thoroughly investigated before the final proposals for irrigation and flood control in the Puri district are formulated, as it would have the advantage of keeping the river channels open to flushing without bringing in the problems arising from their complete closure. The approximate cost of these proposals may be included in the Project Estimates.

The Committee roughly estimates that the cost of these regulators across the various channels would be of the order of Rs. 4.5 crores. Against this there will be a saving of Rs. 1.6 crores on the syphon across Katjuri provided in the revised estimates. The net additional cost will thus be Rs. 2.9 crores.

The Committee agrees with the rest of the proposals made in connection with the perennial irrigation both for the existing and new delta area, which are eminently suited for irrigation.

The Committee considers that as the cost per acre of C.C.A. in delta areas is much less than the cost of providing lift irrigation in Sambalpur district, the lift area proposed in the latter may be replaced by flow irrigation in the delta area, provided sufficient irrigable areas are available in the delta. This suggestion may be considered.

### 2.19 Culturable Area

The Committee considers that the culturable commanded area, which has been worked out from 1"=1 mile sheets, is available. The figures of culturable area should, however, be verified from the settlement records before the canals in that area are finally designed.

### 2.20 Duty

The duties for this area should be the same as recommended for Sambalpur area.

### 2.21 Intensities

Intensities of irrigation in the case of canals in the delta areas have been slightly modified as under—

#### *Kharif*

Paddy instead of 70	..	..	60%
Sugarcane, same as proposed in the Project, viz.	..	..	20%
Jute not provided in the revised estimates	..	..	20%

**Rabi**

Paddy as proposed in the Project estimates .. .. .	33%
Cash rabi crops like wheat, groundnuts, potatoes etc. .. .. .	8%
Light rabi like Moong, Kulti etc. .. .. .	7%

**2.22 Water Table**

The Water table in the delta area is 3.0 ft. below ground level in the monsoon and 12 to 20 ft. in the fair season.

The Committee, therefore, anticipates no trouble due to water logging in the delta areas and is of the opinion that double cropping of rice could be profitably done, provided suitable crop rotation is resorted to and water carefully utilised. The crop rotation to be adopted will be the one already suggested by the Committee in the case of Sambalpur areas.

**2.23 Yields**

According to the experiments carried out at the Central Rice Research Institute, the average yield of paddy in lbs. per acre can be of the order of 24,000 lbs.

The enquiries from the Assistant Director of Agriculture, Orissa, have shown that the yields can be increased by nearly cent per cent averaging about 20 maunds per acre, if green manuring is done in between the two crops of paddy. Assuming an increase of 9 maunds of paddy per acre, the gross increase in income will be Rs. 72 per acre.

The yield in case of sugarcane varies between 500 to 600 maunds, which gave about 50 to 60 maunds of jaggery. Assuming the price of jaggery at Rs. 15/- per maund, an acre of sugarcane will yield between Rs. 750/- to Rs. 900/- per acre.

**2.24 Navigation on Delta Canals**

The Committee considers that the present facilities for navigation on the existing canals should be retained. His Excellency the Governor of Orissa in his interview with the Committee, stressed the necessity of leaving these facilities unimpaired.

**2.25 Growth of Weeds**

In the Hirakud Dam Project, the question of weeds does not seem to have been considered.

The canals in the Sambalpur area take off directly from the reservoir and will receive comparatively silt free water even in the monsoon. In the fair season, both in the Sambalpur area and in the delta area, the canal water will be silt free and the temperatures are comparatively high. Both these features are favourable for weed growth which may be expected to prove a serious nuisance unless steps are taken to keep it in check.

Weeds do not grow in muddy water and it may safely be expected that in the delta area canals the weed trouble will not be experienced in the monsoon season. In the fair season also, the water let down from the Hirakud reservoir will probably pick up enough silt to keep the weed growth in check. So this trouble may not be so serious in the delta area.

The only practicable remedy found in the Bombay Deccan, where this weed trouble is experienced to a serious extent, is to run the canals in rotation. With the crop pattern proposed on the canals in the Hirakud Dam Project, the canals have practically to run full supply, except in the month of December and May. This leaves no margin for running the canals in rotation, and if the weeds do establish, as there is every possibility that they will do, this is likely to create a serious problem. The canal capacities may in that case be found much too low.

The Committee strongly recommends that this question should be examined and the canal capacities increased, as considered necessary. The other way would be to adopt a crop pattern, for which the fair weather discharge will be only 50 per cent or 60 per cent of the Kharif discharges. In that case it would be possible to run the canals rotation at least in the fair weather when the trouble of weeds is likely to be intense.

**UNIT No. III—POWER****2.26 Salient Features**

The salient features of the power development as described in the Revised Hirakud Dam Project Report of 1952 are—

- (i) the installation of generating plant in the power house at the foot of the main dam designated Power house No. I, operating at a variable head between 76' and 115' ;

- (ii) diversion of the tail water of this plant by means of a weir on the river two miles downstream and conveying it through a high level canal 11 miles long to a reservoir created by a subsidiary dam 120 ft. high specially built for this purpose ; and
- (iii) installation of generating plant working under a practically constant head of 77' at a Power house, designated Power house No. II, at the subsidiary dam discharging water in the Mahanadi, thereby utilising the steep river fall in 14 miles between the Main and the Subsidiary Dams.

The two power houses are intended to be connected electrically as they are connected hydraulically.

The electric power so generated is proposed to be transmitted by long distance extra high tension lines to distant places like Cuttack (160 miles) Jamshedpur (224 miles) and Kharagpur (271 miles) for onward transmission to Calcutta.

After careful study of the water conditions, the power potential is fixed as 1,99,500 kW at 60 per cent load factor (1,20,000 kW continuous). Prior to change in plans necessitated by Government decision referred to latter, this was proposed to be obtained from 4 Nos. 24,000 kW sets in Power house No. II and 6 Nos. 37,500 kW sets in Power house No. I. To the latter were to be added two extra sets as may be required for generating secondary power in monsoon times.

Owing to urgent demand for power, Power house II was planned to be commissioned first, in 1953. To keep to this programme, orders for two 24,000 kW sets were placed and work on power canal subsidiary dam and other civil engineering works connected therewith commenced. Owing to the inordinately long deliveries of plant and heavy equipment from abroad, orders were also placed for a quantity of sub station switchgear and transmission lines while final details were being worked out as well as for two sets of 37,500 kW capacity for Power house I.

But in December 1951, Government of India decided that irrigation part of the Project which arose only from the main dam should receive more emphasis and all equipment and finance available should be diverted thereto. The works in progress on the subsidiary dam Power house II and power canal were, therefore, suspended and effort concentrated on expediting the main dam and canals.

In consequence of these changes, the power house at the toe of the main dam viz. Power house I will be built first and will have installed therein

machines on order for both Power house I and Power house II the latter with such modifications as may be necessary giving an effective plant capacity of 85,500 kW. For additional plant, the Revised Report contemplates installation of two 26,000 kW sets in Power house I raising its effective capacity to 1,37,500 kW and three 31,000 kW sets in Power house II (including one spare) raising the total effective capacity of the system to 1,99,500 kW.

The transmission system is laid out in the first stage to supply Cuttack, Talcher and Keonjogarh on the 132 kV system—total length of line 220 miles, and Jharsuguda, Raigarh, Champa, Bilaspur, Rajgangpur, Bolangir, Titlagarh, Rairangpur, Badipada, Naumandi (off Keonjogarh) on the 66 kV system, a total length of 471 miles plus 25 miles for lift irrigation. The sub stations for these lines in the first stage are to be installed at Cuttack, Talcher, Keonjogarh, Rajgangpur, Badipada, Jharsuguda, Titlagarh, etc. The effective installed transformer capacity in these stations is 30,000 kVA on the 132 kV system and 14,000 kVA on the 66 kV system, the balance of load out of 85.5 kW being intended for bulk supply to industries near the power Station. In the second stage a 220 kV double circuit line is proposed to be constructed via Keonjogarh to Kharagpur to tie up with the D.V.C. transmission system for supplying 60,000 kW to Calcutta. A double circuit 132 kV line is also to branch off from Keonjogarh for supply to Jamshedpur, the intention presumably being to supply as much power as possible at Jamshedpur and at Calcutta, to market the bulk of power available at Hirakud. When completed, the E. H. T. system is to comprise 256 miles of 220 kV lines, 424 miles of 132 kV lines and 496 miles of 66 kV lines.

The onward distribution of power from the 132 kV and 66 kV sub stations is to be done by officers of the Orissa Government by means of 33 kV and 11 kV lines.

These proposals, further amplified and explained by concerned officers have been scrutinized and the following remarks are offered—

The electrical works are designed in conformity with the standards followed on other similar works in this country and abroad. They are technically sound and no radical change of design is called for. Such changes as are deemed desirable are indicated in the notes which follow.

It may be mentioned that the Hirakud Dam site has no special physical or geographical advantage which make it specially suitable for electric power production. The head created by the Dam is comparatively low and variable. The run off is large but the maximum economic storage is only

sufficient to generate 120,000 kW continuously (200,000 kW at 60% L. F.) in two power stations. Major and expensive civil engineering works are necessary at both Power house I and Power house II to enable power generations. But what is most important is that the established markets of power are hundreds of miles away.

### 2.27 Water Planning

The storage planned is only one sixth of the monsoon run-off in an average year. Therefore, there should be no difficulty in obtaining a full reservoir at the end of monsoon. Since, however, incidence of monsoon is by no means regular, the following two extreme conditions will have to be guarded against during operation.

The reservoir has to be kept as near empty as possible i.e., at R. L. 590 throughout July and August, so that when the floods arrive, the whole of the reservoir capacity is available for flood absorption. On the other hand if refilling is left to be done too late, a full reservoir in beginning of fair season may not materialise.

Even during July and August when the total run-off is large, dry spells occur and there should be sufficient water retained in the reservoir to supply power demand, that is to say, the level should be kept appropriately above + 590, say at + 595.

It has been established by study of hydrological data that in the driest year on record, it should be possible to obtain 90 per cent of the average power. This is within permissible limits of variation and provision of steam standby plant is not called for.

### 2.28 Power House

Owing to the historical circumstances mentioned earlier, the first lot of machines in Power house I is to consist of 2—24,000 kW sets and 2—37,500 kW sets already on order, yielding firm power of 85,500 kW.

The next extension proposed is by means of two 26,000 kW units raising the effective plant capacity to 137,500 kW. This seems more than necessary.

Working tables I and II in Volume V of the Report show that the maximum power potential of the water passing through Power house I. is 80,700 kW at 100% L.F. Making allowance for the pumping load at 100% L.F. the effective plant capacity for supplying power even at 60% L.F.

is  $\frac{80.7-14.8}{.6} + 14.8 = 124.8$  kW. Therefore,

one more set of 37.5 M.W. making up an effective capacity of 123 M.W. should be sufficient. The overall demand on the power station estimated at 199,800 kW is based on 60 per cent load factor. It has been reported, as would be amplified later, that the major part of the load intended to be supplied from Hirakud has a very high load factor so that the average over-all load factor will be higher than 60 per cent, in fact not less than 70 per cent. This circumstance reduces the maximum capacity that would be required to be installed for primary power. It also does not seem desirable to have three separate sizes in a comparatively small power house containing five or six units. Therefore, it is suggested that the next expansion should be by adding one 37,500 kW set. The eventual set up of this power station then will be two 24,000 kW sets and two 37,500 kW sets already on order and a fifth set of 37,500 kW capacity making a total of 123,000 kW effective plant with one 37,500 kW as a standby. Provision should, however, be made in the power station building for two more sets of 37,500 kW for utilising secondary power, if and as conditions warrant their installation.

For the secondary dam power house, the proposal in the report is to instal three Nos. 31,000 kW sets to give 62,000 kW effective plant with one standby. It is explained in the Report that the Power house II will be run as a base station as near 100 per cent load factor as possible and Power house I will carry the variations of load and the peak.

It is seen from the working table that the power potential of water in Power house II reaches 60.8 M.W. and averages 55.8 M.W. The proposed plant will, therefore, have to run sometimes at 98.5 L.F. and mostly above 90% L.F. It would appear that less rigorous service will contribute to longer life and reliable service.

All the water from Power house I has to pass through Power house II either through the turbines or suitable surplussing arrangement, to Mahanadi River. Water takes 8 hours to pass from Power house I to Power house II and therefore, there is no quick response or adjustability between their respective requirements. The forebay capacity of Power house II is also not too large and consequently there is danger of waste of water. Taking these facts in consideration, it is not desirable to legislate too rigidly about the utilisation of plant in Power house II, which should be capable of more flexible operation. The plant may consist of 4 Nos. 25,000 kW sets giving

an effective capacity of 75,000 kW and the operation so arranged that the plant in Power House II takes on as much load as it can without drawing down the water level of the forebay below the prescribed minimum level.

But in as much as 24,000 kW units have been contemplated previously for this power station, it is recommended that that size may be retained and the availability of power from this station fixed at 72,000 kW. The plant will then run between 85 per cent and 75 per cent load factor for most of the time.

The selection of this size—*viz.* 24,000 kW units may also conceivably assist in resolving the difficulty being experienced in modifying the sets ordered for Power House II to suit Power House I. Turbine rotors and connected parts may be stored for future use in Power House II.

### 2.29 Transmission Lines

As noted earlier, the transmission system included in the Revised Report is extensive and far flung. The two striking features are that :

- (1) Long distances have to be traversed for carrying comparatively small blocks of power *e.g.* 50,000 kW to Kharagpur 256 miles away and 30,000 kW to Jamshedpur, a distance of 224 miles and 9,000 kW over the eastern arm of 66 kV system 146 miles in total length.
- (2) Single circuit lines at 132 kV and 66 kV have been adopted on a large scale.

Regarding (1), it is generally accepted that power transmission near the surge impedance loading is a technically correct and economical design. This figure for 220 kV line is 120,000 kW and for 132 kV 55,000 kW. The power proposed to be transmitted is much less.

As to (2), operation experience goes to show that a properly designed and constructed tower line is not liable to many interruptions due to faults. But maintenance has to be undertaken and for this purpose lines have to be taken out of service at periodical intervals. The necessity for this is felt after a few years of service. In case of single circuit lines, this means interruption of supply whereas in double circuit lines, the supply is maintained from the second circuit while the first is being attended to. The hardship in case of single circuit line is no doubt mitigated by synchronising the shut-downs with the light load periods and holidays, but this notwithstanding, when single circuit lines are used, the continuity of

service has to be classed as second class. For important load centres, when double circuit cannot be adopted, alternative source of supply has to be provided.

The transmission system has to be laid out with reference to load potential of the area. Power which cannot be sold in the immediate neighbourhood of the power station for new industries, has to be transmitted to existing load centres, situated hundreds of miles away. As most of the important loads are still being negotiated, many of the lines and sub stations proposed in the Revised Report are tentative in character. As a matter of fact, orders have been placed for equipments which according to present anticipations will not be immediately used.

The Committee received from Dr. H. B. Mohanty, Secretary of the River Valley Department of Orissa Government, a load survey report dated 14-2-52 prepared by Dr. K. P. P. Menon of the Central Water and Power Commission and took the opportunity to discuss it with Shri R. L. Narayanan, Chief Engineer (Electricity), Orissa at Puri. The latter officer endorses this load survey fully. Since it changes several assumptions made in the Revised Report, the Committee felt that the usefulness of the load survey would have been enhanced if it had been undertaken earlier. This load survey is taken as the basis for recommendations of the Committee, but note is taken of the fact that there may actually be major redistribution before the project is completed.

A copy of the Load Survey received from Dr. K. P. P. Menon is attached as Accompaniment No. VI.

Two important facts emerge from this load survey. First that a load of 100,000 kW may be reasonably expected on the system by 1960, that is, 5 years after commencement of supply and second that 60,000 kW out of this will be high load factor demand of Aluminium and Ferro-alloys (Alum 50,000 kW, 90% L.F.) in or near Sambalpur and 20,000 kW industrial load at other centres also of relatively high load factor, with the result that the overall load factor of the system has to be taken as 70%. Since the water quantum is fixed and is equal to 120,000 kW, continuous, the load demand which can be satisfied from the system is 170,000 kW instead of 199,800 kW calculated in the Revised Report.

Negotiations for a steel factory load of 30,000 kW are reported to be in progress and there is also a possibility of supplying 30,000 kW to the steel works at Jamshedpur and linking up with the D. V. C. system there. Orissa State



should reserve a few thousand kws of power for the normal growth of its industries. The balance, if any, is not sufficient to justify an expensive 220 kV line to Kharagpur to supply Calcutta. The Committee recommends that the line between Keonjogarh and Kharagpur as well as the Kharagpur substation should be dropped. The 132 kV line between Talcher and Keonjogarh should also be dropped because the eastern arm of the 66 kV system intended to be supplied off Keonjogarh is not included in the load survey and not proposed for supply in the first stage. In the second stage, Hirakud and Keonjogarh are proposed to be connected by the 132 kV double circuit line and eastern arm is proposed to be supplied therefrom.

The transmission system modified as above will provide in the first stage, for supply to Cuttack for local industrial and other requirements and onward distribution in the Eastern part of the State up to Puri, distribution of about 60,000 kW in Sambalpur area for big industries like aluminium and ferro-alloys and local distribution in Jharsuguda, Raigarh, Bolangir, Titlagarh, by a 66 kV system. The second stage will provide for bulk supply of approximately 30,000 kW to Jamshedpur and link up with the D. V. C., alternative supply to Cuttack from Keonjogarh and a 66 kV system off Keonjogarh to supply Rairangpur, Baripada and Naumandi. Provision will also be made for a block of 20,000 kW to a steel factory in or around Bonaigarh. But the progress and character of the developing load will have to be watched from year to year and works planned accordingly. For instance, if the load near the power house does not develop and the line to Jamshedpur which is planned at 132 kV double circuit has to carry more than 40,000 kW its voltage will have to be raised to 220 kV. This and other major changes may be necessitated by circumstances. It is considered that a lump sum provision of 1.33 crores of rupees should be included to provide for this and other contingencies.

The Committee has had under consideration how far important centres like Cuttack which have to maintain electric supply for essential services to waterworks and hospitals as well to the A. I. R. Radio transmitters, should be made dependent on long distance single circuit lines. Some of the relevant considerations have been mentioned already. A single circuit service for such centres can be contemplated only if an alternative source of supply can be established at momentary notice. It is understood that the original design of the line from Hirakud to Cuttack was by 132 kV double circuit but later on in August last year the

Development Board accepted the proposal of Central Water and Power Commission that the initial supply may be by single circuit lines. In discussions, the Chief Electrical Engineer, Orissa has expressed grave anxiety over this feature of the design which he stated, would entail, among others, his having to maintain a costly thermal plant valued at Rs. 43 lakhs of rupees as a standby. It is understood that orders for this line have been placed six months ago and the material is in course of manufacture. It is, therefore too late to recommend drastic changes. Only certain ameliorative measures are suggested. Towers proposed to be used are of painted steel which require periodical repainting in order to maintain the safety of structures. This will have to be a regular operation and it is essential that the disadvantages of a single circuit line should not be accentuated by avoidable features like the painted towers. Since galvanizing is now being done in India, the Committee recommends that the order be modified and the steel structure members in the upper portion of the towers including the cross arms galvanized, to enable the painting of the rest of the structures to be done without switching off supply from the line. The cost of this modification is estimated to be about 20 per cent of the cost of the towers.

For the same reasons, a similar modification is recommended for all single circuit towers on order.

It is recommended that as an essential operation feature, disconnecting switches should be installed in T. L. sections of more than 50 miles. This has special reference to the 132 kV line between Talcher and Hirakud.

### 2.30 Sub-stations.

The load in most of the substations is of small magnitude and both on account of the high voltage and low demand cost per kW. installed is relatively high. It is also observed that circuit breakers have been used for transformer units as low as 2,000 and 1,000 kW. It has, however, been explained in discussion that the original specifications provided for high tension fuses for these units but the tenderer for the equipment volunteered to supply circuit breakers of the low oil content, expansion type in place of the high tension fuses without any extra cost. It also came out in discussion that although the list of material submitted in the Revised Report mentions circuit breakers in all stations, the 66 kV stations on the eastern arm of the system would have high tension fuses for transformers of small size and not circuit breakers.



The 66 kV circuit breakers cost as much as small size transformers. High Tension fuses of reputed manufacture have been found reliable in service and the economy of their use is endorsed. Necessary changes will have to be made in the list of material.

The revised estimates do not provide for additional transformer capacity in substation with growth of load. Necessary additions have to be made.

The method of voltage control is nowhere mentioned in the Report. But it was found out in discussion that transformers at distant stations like Cuttack and Talcher will be provided with onload tap changing equipment. Use of synchronous condensers is superior as they reduce and hold the system voltage where as the onload taps merely alter the voltage at the receiving end. It is felt that need for synchronous condensers will arise on these long lines to Cuttack and provi-

sion should be made for them in the estimates, in the second stage.

Although not mentioned specifically, it is found that 11 kV control gear for outgoing circuits has also been provided.

A fresh detailed estimate allowing for all the above modifications proposed under Power Plant, Transmission Lines and Sub stations has been prepared and is on file. Abstracts of costs pertaining to Production and Transmission are enclosed in this Report as Appendix III.

Accompaniment VIII shows the progress of power plant installation and load development and other details. It will be noticed that time has been allowed for building up load in different stages and figures given in the Load Survey have been spread out.

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SECTION III—*Omitted.*

## SECTION IV\*

### FINANCIAL ANTICIPATIONS AND ECONOMICS OF THE PROJECT

#### Rates of Construction

##### 4.1 Unit No. I—Main Dam and Appurtenant Works

The average rates for earthwork and concrete on the construction of earth and concrete dams were discussed.

The average cost of earthwork including stripping, compaction etc. for %0 cft. for an average lead of 1.8 miles works out to Rs. 50.5 against the provision of Rs. 65/13/- in the revised estimates. This rate includes the cost of depreciation of machinery at rates provided in the revised estimates. The actual average rate for concrete in the concreting for flank walls and main dam on the left has worked out as under :

November 1951—Rs. 193/1/-	per	%	cft.
December 1951—Rs. 132/8/-	..	..	..
January 1952—Rs. 138/11/-	..	..	..

The corresponding rate of mass concrete provided in the revised estimates has been Rs. 141/14/- per 100 cft. of concrete. This rate includes provision for staging and shuttering. Omitting this provision the rate for concrete provided in the estimate is Rs. 125/9/-. This rate contemplates cost of cement at Rs. 4/- per bag. Moreover 20 per cent of cement is to be substituted by Puzzalona. The present rate of cement is Rs. 4/12/- per bag, which gives an excess of Rs. 11/14/- per 100 cft. and explains the present high rate given above. According to the arrangements made with the new Cement Factory at Rajgangpur, the project will obtain cement at a concession of Rs. 7/- per ton, and the cement will be transported in bulk. Due to these factors it is expected to get cement at Rs. 3/- per bag, against Rs. 4/- per bag, the provision made in the Revised Estimate. This gives a margin of Rs. 12.75 per 100 cft. of 1 : 3 : 6 concrete. Moreover the work is not yet fully organised. The batching plants are not yet working. When the work is fully organised, lower operation costs are to be expected. The Committee considers therefore that the rates for earthwork and concrete on earth and concrete dams are adequate.

The Committee also went into the question of ownership costs of machinery, which have been based on the data for similar machines used in

Bhakra and Nangal and have been approved by the Bhakra Nangal Control Board. Capital cost, depreciation, and other details for different types of machinery *viz.*, showels, crushing plants, earth moving machinery and trucks etc. were also gone into detail. The Committee is of the opinion that depreciation of machinery as worked out, appears to be reasonable and the residual value shown in the Revised Estimates will be realized if the machinery is transferred to some other projects after it became available from the Hirakud Project, but not if sold in the open market.

##### 4.2 Unit No. II—Main Canals, Branches, Distributaries and Water Courses

The Committee went into the rates of earthwork ruling on the Bargarh Canal, which were as under :

Basic rate for 50' lead and 5' lift—Rs. 20/-	per %0 cft.
Hardness allowance	—Rs. 7/- per %0 cft.
Lead for extra 150'	—Rs. 1/8/- for each'.

The rate of earthwork for distributaries was Rs. 21/- per %0 cft. including hardness allowances

The Committee compared these rates with the rates ruling on other projects and found them lower in comparison. The lower rates may be attributed to the low price of rice in the Orissa State, which is sold at Rs. 10/- per maund. Rates of masonry work were also compared and found reasonable.

A lumpsum rate of Rs. 30/- per acre of C. C. A. for distributaries and minors which had been arrived at by working out detailed estimates for a few systems, was also considered reasonable.

##### 4.3 Unit No. III—Power

Fresh estimates have been prepared, incorporating the changes recommended by the Committee. The cost figures adopted in the estimates for the first stage are those at which orders for plant and

equipment have already been placed. As stated earlier in this report most of the material being of long delivery and foreign manufacture, has been ordered already to keep pace with the progress of other works.

The "per kW" method of estimating, adopted in the previous revised estimates has been replaced by actual cost. Similarly the equipment included under miscellaneous items the Revised Estimate has been itemized and priced.

The programme of plant extensions reaches out to 1969. It is not possible to foresee the changes in costs for this equipment over this long period. The uncertainty may be gauged from the fact that some of the electrical equipments have registered a rise of 25—40% in the past two years. The cost figures adopted for the future equipment are those prevailing at present. The estimated amount in this category which is liable to change due to world conditions, is about Rs. 10 crores.

Abstracts of cost of works and the comparative statements have been scrutinized. The Committee considers that if the present conditions in regard to labour rates and price level continue to prevail, it would be possible to work up to the revised estimates.

### Programme of Construction

#### 4.4 Dam

The programme of construction has been phased and spread over 20 years into two stages as indicated on page 115 of Volume I of the Revised Hirakud Dam Project Estimates. The revised programme of expenditure after giving due effect to the recommendations of the Committee and the changes suggested by the Chief Engineer, Hirakud, subsequent to the submission of the Project estimates, which have been accepted, will be as under—

#### STAGE 1.—Development of Irrigation & Power

Main Dam & Power house for 4 units and  
Transmission lines and sub-stations for  
1st stage.  
Reservoir Level .. .. . 625

#### (a) Expenditure upto end of 1955-56—

2 Units in Power house No. I		Crores
Unit I .. .. .	35.18	
Unit II .. .. .	13.00	
Unit III, Civil Works, Sub Dam & Power Channel .. .. .	1.50	
Work done already		
Power house No. I .. .. .	1.40	
Electrical—		
Production .. .. .	4.95	
Transmission .. .. .	5.21	
<b>TOTAL</b> .. .. .	<b>61.24</b>	

#### (b) 1956-57 to 1960-61—

Reservoir Level .. .. .	630	
Additional 2 units in Power house No. I		Crores
Unit I (Land Compensation) .. .. .	1.00	
Unit II (Additional canal system) .. .. .	6.64	
Unit III, Civil, Power house No. I .. .. .	0.32	
Electrical, Production .. .. .	1.40	
Transmission .. .. .	1.40	
<b>TOTAL</b> .. .. .	<b>10.76</b>	

#### STAGE 2.—Development of further Power

#### (a) 1961-62 to 1965-66—

F. R. L. .. .. .	630	
Additional one unit in Power house No. I		
Construction of Sub Dam, Power Channel etc. and one unit No. Power house No. II, Transmission Lines and Sub stations for Stage 2.		
Unit I .. .. .	—	
Unit II .. .. .	—	
Unit III, Civil Sub Dam and Power Channel Power house No. I .. .. .	5.12	Crores
Power house No. II .. .. .	0.32	
Electrical Production .. .. .	0.34	
Transmission .. .. .	2.94	
<b>TOTAL</b> .. .. .	<b>8.17</b>	
<b>TOTAL</b> .. .. .	<b>16.89</b>	

#### (b) 1966-67 to 1970-71

Additional 3 units in Power house No. II		
Unit I .. .. .	..	
Unit II .. .. .	..	
Unit III Civil—Power house No. II .. .. .	0.32	Crores
Electrical Production .. .. .	2.11	
Transmission .. .. .	0.76	
<b>TOTAL</b> .. .. .	<b>3.19</b>	
<b>GRAND TOTAL</b> .. .. .	<b>92.08</b>	

The Committee went into the question whether the main dam will be completed by 1955-56. The total quantity of cement concrete in the dam will be of the order of 3,92,00,000 cft. out of which about 3,72,00,000 cft. still remains to be done.

With the completion of installation of 'Winget Batching Plant' which will go into commission by April next on the right side of the Dam, 60,000 cft. of concrete will be done in two shifts. Four 'Blow-Knox Batching Plants' which will be installed on the Left Side will be capable of 40,000 cft. per day in two shifts, the gross output will total 100,000 cft. of concrete per day. Assuming efficiency at 70 per cent and 200 working days in a year, it will be possible to complete the job in three working seasons i.e., by June 1955.

#### 4.5 Canals

The Committee went into the programme of construction of canals in the Sambalpur area.

Out of 33 crores cft. of earthwork on the main line, 21 crores cft. had already been done and the

balance was expected to be completed by June 1953.

The Committee was satisfied with the progress and the organisation of construction work on the canal system in the Sambalpur district and considers that there is a reasonable prospect of completion of canal work, as there is ample local labour available.

The Chief Engineer, Hirakud, informed the Committee that whereas the main canal and branches would function by June, 1955, all the distributaries and minors may not be completed by the above date. Some of these would flow by the rabi of 1955-56 and the rest by kharif of 1956.

As regards the canals in the Delta area, the proposals were not yet worked out in sufficient detail to be able to draw up a construction programme. The investigations in these areas may take another year or so before the proposals are finalised. The construction of these canals may still take a few years more. The existing canals and canals in one of the Doabs, will probably begin to function by June 1955-56, and the canals, in the remaining two Doabs by June 1958-59.

#### 4.6 Hydro-Electric

All the electrical plant and equipment for first stage of supply is on order. If the promised deliveries of foreign equipment are kept, there is reasonable prospect of having the first two machines running in 1956, and the remaining two at yearly intervals. The small quantum of transmission line and sub station equipment associated with the first stage is expected to be installed by 1956. It has to be recorded that out of the first stage plant 25,000 kW is expected to be consumed by Aluminium plant and 5,000 kW by Ferro-Manganese plant installed at or near Hirakud Dam.

Orders for the remainder plant will have to be placed as load develops and evidently no useful programme can be discussed for these future works, although certain progress of load has been assumed in financial forecasts. It should be possible to instal sufficient plant progressively to supply the load.

Two points which are likely to hold up progress of works for the first stage are specially brought to notice.

1. The two 24,000 kW sets ordered for Power House II and proposed to be installed in Power House I are not entirely suitable for the

varying head at the latter place and necessary modifications have to be decided on. The power house construction is held up for want of decision regarding the draft tube excavations. Unless a decision is reached within the next three months, the commencement of supply may be delayed.

2. It is understood that the crane for Power house I has not yet been ordered. Tenders have been invited. Large cranes of this size (150 Tons) have often deliveries as long as the plant. While adjudicating tenders, short delivery of 15 months or less should be ensured even at some extra cost.

Unless this is done, the benefit of the forethought in ordering plant in advance will be lost.

The Committee recommends that special attention should be given to these points to ensure satisfactory progress.

#### 4.7 Cost of the Project

The revised cost of the project had been worked out to Rs. 89.09 crores *vide* page 114 of Volume I. The Chief Engineer, Hirakud Dam Project, has since submitted a statement requesting for extra provision to be included under certain sub-heads of different units, copy of which is attached as Appendix II to the Committee's Report. The extra provisions requested for by the Chief Engineer, Hirakud, have been discussed and accepted by the Committee. The modified cost of the Project after incorporating the cost of suggestions made by the Committee and the extra provisions suggested by the Chief Engineer, Hirakud, amount to Rs. 92.08 crores. The break up of the cost of the project as per Revised Estimates and now modified by the Committee, under different units will be as under—

	Cost as per Revised Estimates	Cost as per Committee's proposals
	(In crores of rupees)	
Unit I—Dam & Appurtenant Works	34.39	35.98
Unit II—Main Canals, branches, distributaries and water courses	16.52	19.64
Unit III—Power—		
(a) Generation—		
(i) Civil Works .. .. .	8.83	9.32
(ii) Power Plant .. .. .	11.37	11.40
(b) Transmission .. .. .	16.98	15.54
Unit IV—Navigation .. .. .	1.00	0.20
<b>TOTAL</b> .. .. .	<b>89.09</b>	<b>92.08</b>

Statement showing the cost of changes recommended by the Committee is attached *vide* Accompaniment VII.

#### 4.8 Allocation of Cost of the Dam between Power and Irrigation

It is proposed in the report on the Revised Estimates of the Hirakud Dam (Vol. I, pp. 118-119) that the allocation of the cost of the main dam *viz.*, Rs. 35.4 crores, between power and irrigation should be in the proportion of 29 : 71, which is the proportion of water utilised from the storage for power and irrigation in the 1st Stage *i.e.*, 1.3 m.a.ft. for power and 3.045 m.a.ft. for irrigation, during the 8 months from November to June. The Committee feels that this is not a fair basis.

The Committee also does not agree to another step, followed in these calculations. The recovery from the betterment tax of Rs. 13 crores is first deducted from the cost of the dam, and the remainder of Rs. 22.4 crores is allocated between power and irrigation. As betterment of land values is due to irrigation only, the deduction of Rs. 13.0 crores should be from the irrigation share only. So the correct procedure would be to allocate Rs. 35.4 crores between power and irrigation first and then to deduct Rs. 13 crores from the irrigation share.

The allocation of the cost of a dam or other common features of a multi-purpose scheme, between the various purposes, is a controversial subject and no fixed principles have yet been evolved, or cannot probably be evolved as the proportion of benefits derived in respect of the various purposes of a multi-purpose scheme are bound to vary in each case.

One method, which it is learnt, has been used in the Damodar Valley Scheme, is the "alternative justifiable cost basis". First it is found what would be the cost of the project, if it is constructed to serve only one of the purposes. This is done for each purpose and the cost of the combined project is allocated between the various purposes, in proportion of the cost thus worked out separately for each purpose.

If this method is followed in the present case, the allocation between power and irrigation would be somewhat as follows—

- (1) If the dam was constructed for irrigation alone, the total storage both live and dead would be as under—

	m.a.ft.
(a) Live storage for irrigation alone (last col. of table on page 119) .. ..	3.308
(b) Dead storage .. ..	2.240
TOTAL .. ..	5.548

The corresponding elevation of the Dam from table on page 182 .. .. R.L. 622

- (2) If the dam was constructed for Power only, the total storage both live and dead would be as under —

	m.a.ft.
(a) Live storage for Power alone (last col. of table on page 118) .. ..	3.045
(b) Dead storage .. ..	2.240
TOTAL .. ..	5.285

The corresponding elevation of the dam from the table on page 102.

- (3) If the dam had been constructed for Flood Control alone, it would have been of the same capacity as that for Power, as the storage capacity required for flood control is also 3.0 million acre feet.

The cost of the dam would, therefore, be allocated equally between Irrigation, Power and Flood Control *i.e.*, Rs. 12.0 crores to each of these heads.

Another way of allocation of the cost of the dam would be to base it on the capacities utilised from storage for irrigation in Sambalpur district, for power and for maximum flood reserve required in the reservoir. This will vary in the ratio of 1 : 3 : 3. The cost of the dam would be allocated as under :

	Crores
Irrigation in Sambalpur district .. ..	5.15
Flood control .. ..	15.45
Power .. ..	15.45
TOTAL .. ..	36.05

The share of the cost of the dam debitable to Power will be further sub-divided into 50 : 50, between Power and Irrigation, as most of the waters utilised for Power will be utilised for the Delta Irrigation lower down.

Share of the cost debitable to Power would, therefore, be 7.725 crores, to Irrigation 12.875 and to Flood Control 15.45 crores.

As it is not proposed to debit any cost of the dam to Flood Control, and as all the benefit due to Flood Control will accrue to Irrigation particularly in the Delta area, where no development will be possible until the areas are protected from floods, it is proposed that the allocation of cost to Flood Control should be debited to Irrigation, thereby raising the cost of allocation of dam to the latter to Rs. 28.275 crores.

In the case of the Hirakud Dam Scheme, the prospects of development of irrigation are more bright than the development of power, as far as can be seen at present. Moreover, due to betterment levy, the share of the capital cost debitable to irrigation is likely to be lightened to great

extent. It is fair, therefore, to adopt that method of allocation of the dam cost, which gives the minimum figure as debitable to Power. In this case the method discussed last gives the minimum figure of Rs. 7.725 crores. The Committee, therefore, considers that this should be considered as the share of the cost of the dam debitable to Power.

## Irrigation

### 4.9 Water Rates

The main item of revenue of an irrigation project is from the water rates, and the financial success of such a project mainly depends on this source.

The water rates at present charged for irrigation in the delta area are of the following order—

	Per acre Rs. A.
(a) Under leases fully benefitted areas ..	3 0
Partially benefitted areas ..	1 12
(b) Outside lease area—	
Rice .. .. .	4 4
Jute .. .. .	2 0
Wheat .. .. .	2 0
Sugarcane .. .. .	5 8

It seems that these rates were revised in 1949 and are the current rates. The canals are able to supply water from June to March.

The Committee thinks that these rates are too low.

Water rates should have a relation to the quantities of water used, and also to the value of the produce and the profits of cultivation.

After the completion of the Hirakud Dam Project assured water supply will be available throughout the twelve months and, as the area to be irrigated under this project has a temperate climate, all kinds of crops can be grown. Of course at present the principal crop is rice, but other crops like jute, sugarcane, cotton, groundnut and potatoes can be grown. As a matter of fact, jute and potatoes are now being grown with outstanding success. A double crop of rice as in the Madras and Bengal deltas will also become possible.

Due to steady water supply, conditions even in the tract under irrigation in the delta area will improve. Of course in the areas where irrigation facilities are not available at present, the conditions will improve tremendously.

The rates proposed in the revised project are as follows—

	Per acre Rs. a.
Paddy .. .. .	8 8
Sugarcane .. .. .	13 8
Other kharif crops .. .. .	6 0
Other rabi crops .. .. .	5 0

The Committee questioned many officers of the Orissa Government regarding the yields of the various crops, both under the un-irrigated and the irrigated conditions. Most of them thought that the increase in yield due to irrigation alone was of the order of 50 per cent. However, the fact that the perennial supply makes it possible to grow green manure crops was not realised by most of these persons. One or two of them agreed that the increase in yield due to irrigation combined with green manuring will be of the order of 100 per cent.

The yields of paddy were roughly given as below under the un-irrigated conditions. The yields under irrigated conditions can be safely taken as double.

Area	Un-irrigated maunds per acre	Irrigated maunds per acre
(i) Sambalpur ..	8	16
(ii) Delta ..	12	24

The rate of paddy is of the order of Rs. 8/- per maund. Thus due to irrigation the gross income per acre will increase by about Rs. 64 per acre in the Sambalpur area and by Rs. 96 in the delta area.

Looking to these results of irrigation and also the water rates for rice and other crops in other States, the Committee thinks the water rates given below will be perfectly justified.

	Rate per acre Rs. a.
Kharif paddy .. .. .	10 0
Rabi paddy .. .. .	15 0
Jute .. .. .	15 0
Sugarcane .. .. .	40 0
Other kharif .. .. .	6 0
Cash rabi crops like wheat, potato, cotton, groundnut .. .. .	8 0
Light rabi crops like mung, kulti etc.	6 0

Jute gives a yield of 10 to 12 maunds and the present rates are Rs. 50 to Rs. 60 per maund.

Sugarcane gives a yield of 50 to 60 maunds of jaggery, of which the rate at present is Rs. 15/- per maund. Taking these facts into consideration it will be seen that the water rates suggested by the Committee are not unfair.

The green manure crops taken between the principal crops should not be charged for, in order to encourage wide-spread cultivation of such crops, which will help in preserving the tilth and fertility of the soil.

#### 4.10 Betterment Levy

It has been an observed fact that the lands for which irrigation facilities are provided, immediately appreciate considerably in price. The rise in land values may be in some case of the order of 5 times or even 10 times. This increase in land value is an unearned increment to the land owners, and it is now generally recognised that the government who provide the irrigation facilities are entitled to take a substantial part of it. Some State Governments have recently legislated that half the increase in land prices may be recovered as betterment levy. Thus it is obvious that the rates of betterment levy should have relation to expected increase in land prices due to provision of irrigation facilities.

There is another factor also to be considered. Though the land prices will appreciate, it is not that every cultivator will sell a part of his holding to pay the betterment levy. That is not also desirable as it will lead to further fragmentation. The cultivators will mostly try to pay the betterment levy by instalments spread over say 10, 15 or 20 years, out of the increased profits due to irrigation. So if the betterment levy rates are fixed at a level which enables payment of it, out of the profits of cultivation, there is a better chance of the levy being fully collected. If the betterment levy instalment plus irrigation rates are not more than 50 per cent of the increased profits due to irrigation, the collection of betterment levy will be more or less assured.

In the revised Hirakud Project, it is proposed that the betterment tax should be levied at the rate of Rs. 100/- per acre. The Committee feels that looking to the appreciation in land prices and the profits of cultivation, the rate proposed for betterment levy is low.

The main crop at present in Orissa is rice and even in the canal tract it will be predominant crop. The land prices at present, and as expected after introduction of irrigation, as ascertained from enquiries, are roughly as follows—

Area	Before irrigation Rs. per acre	After perennial irrigation Rs. per acre
	Average	Average
(i) Sambalpur ..	400	1,000
(ii) Delta irrigated ..	2,000	3,000
(iii) Delta unirrigated ..	1,200	2,500

Looking to these figures, the Committee feels that the fair rates of betterment levy will be as follows—

	Rate of betterment levy Rs. per acre
(i) Sambalpur area—flow irrigation ..	150
(ii) Sambalpur area—lift irrigation ..	100
(iii) Delta area—under irrigation at present .. .. .	125
(iv) Delta area—not irrigated at present	250

In the delta area there will practically be complete flood protection. Thus that area gets double advantage of flood protection and irrigation.

The Committee feels that normally prudent cultivators will be able to pay these rates, by instalments spread over say 15 years; out of the profits of cultivation. Take the case of a farmer owning two acres in the delta area, which has no irrigation facilities at present.

Suppose he puts two acres under rice in kharif and one acre under rice in rabi. In between he grows a green manure crop for which he will not be charged.

The increase in his profits from irrigation will be as follows—

	Rs.
(i) Increase in kharif paddy in 2 acres i.e., $10 \times 2 = 20$ maunds @ Rs. 8/- per maund .. .. .	160
(ii) Half produce of rabi paddy over 1 acre, 10 maunds at Rs. 8 per md. ..	80
The other half goes for cultivators expenses, though they are not of that order	
<b>TOTAL ..</b>	<b>240</b>

Against these he will have to pay as government dues as follows—

	Rs.
(i) Irrigation dues in kharif on 2 acres	20
(ii) Irrigation dues in rabi on 1 acre ..	15
(iii) Betterment fee Rs. 250 spread over 15 years i.e., Rs. 17 per acre ..	34
<b>TOTAL ..</b>	<b>69</b>

If he grows other crops like jute, sugarcane, potatoes, cotton, groundnut, his profits will be more. These figures are enough to show that a prudent cultivator will be able to pay betterment fees very easily, out of profits due to irrigation.

The Committee recommends that instalments of betterment fee should begin to be charged 3 years after the water is made available.

It also recommends that the necessary legislation may be enacted by the Government of Orissa.

#### 4.10 (a) Rate of Development of Irrigation

The full development of irrigation has been assumed to take place in 5 years in case of existing irrigated areas in the delta and 10 years in case of other areas. The Committee considers that it is possible that full development may take place even earlier if the people are convinced ahead, by means of demonstration agricultural farms, of the benefits from perennial irrigation, as almost the entire culturable area is fully developed and is under cultivation on rainfall.

#### 4.10 (b) Credit for increase in Land Revenue

The Committee is of the opinion that in view of the betterment fees proposed to be recovered, there is no justification for taking credit for any increase in land revenue.

#### 4.11 Power Generation and Utilisation

Cost of power plant, civil works chargeable to Power and main step-up station works out to Rs. 1,600/- per kW of effective output in the first stage and Rs. 1,675/- per kW in the final stage when all the projected power plant has been installed. The cost of transmission works out to Rs. 1,378/- per kW in the first stage and Rs. 1,411/- per kW in the final stage. For arriving at the transmission cost only power expected to be transported is taken in account. The large block of power expected to be sold near the power house is excluded from the above transmission cost calculations. As may be seen from the above, the capital costs are high and there is no progressive reduction with increase in capacity.

4.111 It has already been mentioned in Section II that there is no special advantage in favour of power produced at Hirakud. It is not cheap, nor too plentiful. The existing markets which can absorb it are hundreds of miles away and can be reached only by long distance costly transmission lines. Moreover the cost of electrical plant and equipment which has to be imported from abroad has reached very high levels. The cost of coal which is the alternative competing source of large power in the load centres is much less than in other parts of the country and sets the upper limit on the charge which can be made. Conditions thus are not too favourable. It is essential for financial success of the power development that market for block power should be obtained in neighbourhood of Hirakud.

4.112 The Government of Orissa have been making strenuous efforts to persuade large industries based on use of Orissa minerals to instal themselves near Hirakud or where power can be conveniently supplied. The Committee were informed by Dr. Mohanty, Secretary of the River Valley Department, Orissa Government that an alluminium factory capable of giving an annual output of 10,000 tons and absorbing 25,000 kW of electric power is very likely to be installed at Hirakud, in time for the commencement of power supply in 1956, and one or more ferro-manganese factories are on point of maturing. Negotiations are also underway for starting a steel factory at Bonaigarh.

4.113 The load survey prepared by Dr. Menon to which reference is made earlier in this report has been accepted by the Committee as the basis of load and revenue forecast. However the load forecast indicated therein has been spread over a building up period.

4.114 It is axiomatic that power like any other consumable commodity has very little value unless a profitable market can be found for it. The margin of profit is a matter for discussion and decision. For a commodity like electric power which is a tool of production and influences the installation and operation of industries producing essential material, and employing large number of people, the indirect benefits to the community are vast and multifarious. The State as the owner of this commodity may justifiably take cognizance of such indirect benefits and not insist on the profit margin considered necessary to attract private investment.

4.115 Rates proposed to be charged to different classes of load are as follows—

	Per kW	year
Alluminium .. .. .	130	
Ferro-Manganese .. .. .	100	
Large industrial load including cement and textile mills .. .. .	200	
Steel .. .. .	190	
Other loads including small industries	240	

Assuming suitable load factors, the cost per unit at grid sub-stations will be somewhat as follows—

	Anna	per unit
Industrial load .. .. .	0.6	
steel .. .. .	0.5	
Other loads .. .. .	1.1	

This is the charge for supply in bulk at the grid sub-station. The charges to the consumer will have to include for distribution cost and energy loss in distribution. In case of the small consumers, this extra may amount to as much or even more than the bulk charge.



4.116 It is believed that in the present conditions, power can find market at these rates. But it seems improbable that any higher revenue will be realised.

4.117 Special attention is drawn to the fact that out of a total of 170,000 kW, 50,000 kW is included for aluminium, 20,000 kW for ferromanganese, 30,000 kW for steel.

4.118 Revenue and expenditure statements have been prepared and are placed on the records of the Committee. Revenue has been assessed on basis of rates mentioned above. Depreciation allowance is in accordance with requirements of Electricity, Supply Act. Operation and Maintenance charges correspond to what may be anticipated on different works. After meeting the operation and maintenance and depreciation charges, the power scheme yields a return of 0.75 per cent in the second year of operation and 1.87 per cent in the 10th year of operation. The position improves somewhat in the 11th year. The return covers the standard rate of interest *viz.*, 3.75 per cent in the 17th year. In the 19th year when all the power is sold, the return is 4.26 per cent *vide* Appendix V. To the extent that more power is sold near the Powerhouse, the financial position will be improved.

4.119 The development as it has now emerged has the merit of flexibility and can be adjusted according to actual load growth. The plant being installed in Power house No. I will meet an effective demand of 85,500 kW. With the addition of one more 37,500 kW set, the load capacity will be 123,000 kW. If the load anticipation does not materialize beyond the estimates 100,000 kW in the load survey for 1960, the balance of 23,000 kW will suffice for normal growth for some years. No work need be undertaken on subsidiary dam, power canal and Power House II till major load is in sight.

### **Financial results of the Project— Financial Statements**

#### **4.12 Estimates of Cost**

The revised cost of the Project *vide* Abstract of Costs attached as Appendix III and para 4.7 page 44 of this report works out to Rs. 92.08 crores as against Rs. 89.09 crores previously estimated.

#### **4.13 Estimates of Revenue**

**Irrigation**—Statements of revenue for irrigation based on water rates recommended in para 4.9 page 18 of this Report have been framed and kept

on the files of the Committee. The working expenses, sinking fund charges, depreciation, maintenance and operation charges on pumping plant etc. have been assumed on the same basis as in the Revised Project Estimates prepared by the Central Water and Power Commission.

The net revenue from irrigation after deducting working expenses etc. comes to Rs. 2,17,64,000 against Rs. 1,44,15,000, previously estimated.

**Power**—Revenue statements in case of power have also been prepared on the same lines as for the revised estimates submitted by Central Water and Power Commission and are placed on record of the Committee. The revenue from power has been based on rates mentioned in para 4.115 on page 55 of this Report. The net revenue from power after deducting working expenses etc. amounts to Rs. 2,14,48,000 as against Rs. 2,06,29,500 previously estimated.

#### **4.14 Allocation of Cost**

The allocation of cost of the dam between Power and Irrigation has been made as discussed in para. 4.8 page 47 of this Report, according to which the cost of Rs. 7.725 crores will be debited to Power and Rs. 28.275 to Irrigation.

#### **4.15 Financial Results**

4.151 **Irrigation**—The financial results have been worked out separately for Irrigation and Power and also with Irrigation and Power aspects combined.

While working out financial forecast for Irrigation, receipts from betterment levy have been assumed at the rates recommended in para 4.10, page 52 of this Report. The total recovery from betterment levy will amount to Rs. 23,32,63,000 which will be fully recovered by the year 1981-82. The betterment fee is proposed to be recovered in 15 equal instalments, payments for which will commence 3 years after water is made available.

Statement showing the percentage return on sum-at-charge is attached *vide* Appendix V.

Expenditure on Irrigation will be incurred upto 1958-59 due to the phasing of the programme of construction. The percentage return after 10

years, *i.e.*, in the year 1968-69 would be 5.42 per cent. The percentage return in 1984-85, *i.e.*, 3 years after the betterment fee is fully recovered in 1981-82 will be 20.67 per cent.

4.152 **Power**—Statement showing percentage return on sum-at-charge is attached *vide* Appendix V.

Expenditure on Production and Transmission (Unit No. III) will be incurred right upto 1970-71 on account of the phasing of the programme of construction. It will be observed from the statement that the return on sum-at-charge in case of Power in the year 1970-71, will be of the order of 3.57 per cent and on full development *i.e.*, in 1973-74, 4.26 per cent.

4.153 **Combined Financial Aspect**—A statement showing the combined financial returns from Irrigation and Power has also been worked out and is attached *vide* Appendix V.

The financial returns which will be obtained at the end of four, 5-year periods commencing from 1955-56 would be as under—

at the end of 1960-61	..	..	2.60%
at the end of 1965-66	..	..	3.43%
at the end of 1970-71	..	..	4.63%
at the end of 1975-76	..	..	5.92%

The percentage return in 1984-85, *i.e.*, 3 years after the betterment levy is fully recovered, would be of the order of 7.8 per cent.

While working out the financial results, the interest on the capital outlay has been taken at the rate of 3.75 per cent.

## SECTION V

### MISCELLANEOUS

#### 5.1 Financial Control—Financial Adviser

During the discussions with the Chief Engineer Hirakud and the Superintending Engineers of the Hirakud Dam Project, it has been pointed out to the Committee that the financial and accounting system, which had been introduced in the case of Hirakud Dam Project has been causing difficulties both in the execution and the progress of work at Hirakud.

Although this matter does not fall within the terms of the reference of this Committee, it considers that any impediments which retard the progress and thereby the completion of works by due date is likely to affect seriously the economics of the Project and since the Committee has been charged to give its recommendations in regard to the financial anticipations from this Project, it proposes to make the following observations for the consideration of the Government.

The Committee has been informed that under the existing orders, the Chief Engineer cannot exercise any financial powers without the concurrence of the Financial Adviser and Chief Accounts Officer.

No contracts on the basis of lowest tenders can be entered into nor local purchase made without the concurrence of the Financial Adviser.

Although the Chief Engineer can make appointments on Work-charged Establishment, the Financial Adviser has the powers to stop payment to the work-charged staff appointed by the Chief Engineer, if he considers the staff unnecessary. This has actually happened in a number of cases. The Chief Engineer has found it difficult to obtain the concurrence of the Financial Adviser in a number of other cases, as he does not generally agree to his proposals.

The Chief Engineer also complained of delays of payments of contractor's bills, which arise due to the present arrangements. He stated that some contractors while tendering for certain works, had given in writing, that if prompt payments were made of their bills, they would accept 5 per cent lower than the tendered rates. The Committee is of the opinion that as the delays in payment affect both the progress and the cost of the Project, this state of things should be remedied.

The Committee submits that the powers delegated to the Financial Adviser at Hirakud Dam are extremely wide and seriously interfere with the

efficient performance by the Chief Engineer of his duties.

The Committee has interviewed the Financial Adviser and Chief Accounts Officer in this respect, and understood from him that the system of accounting and financial control introduced at Hirakud did not exist on any big construction work elsewhere in India.

The Committee, therefore, recommends that the system of accounting and financial control at Hirakud may be brought in line with the accounting systems prevalent on other big projects in India like the Bhakra-Nangal. This will enable the Chief Engineer to perform his functions efficiently and to undertake full responsibility for the execution and completion of the project, thereby ensuring the financial anticipations from the project to be realized.

#### 5.2 Purchase of Stores and Plant through the Director General of Supply and Disposals

It has been pointed out to the Committee that considerable delay is caused in placing orders and obtaining supplies through the D.G.S. & D. with the result that for want of supply of some very minor items, considerable delay is caused in the execution of work. As any postponement of work in the project of the magnitude of Hirakud Dam is likely to reflect in its cost, the Committee recommends that a representative of D.G.S. & D. may be posted at Hirakud, through whom the orders for supplies available in India could be obtained more expeditiously than otherwise. The Committee understands that some such system has been introduced by the Stores Purchasing Officer on one of the dams in the Bombay State, which may also be introduced at Hirakud with advantage.

#### 5.3 Remarks of the Financial Adviser and Chief Accounts Officer on the Revised Hirakud Dam Project Estimates

In response to Committee's request, the Financial Adviser has supplied his comments on the Revised Estimates of the Hirakud Dam Project. These

were discussed with him personally, and the Committee is grateful for the valuable suggestions made by him.

The following important points which have a bearing on the cost of the project as a whole have been considered—

5.31 The Financial Adviser has pointed out that the requirements of land acquisition shown in the Revised Estimates have been under-stated, as the area provided under Unit No. I was 1,57,600 acres against an area of 1,82,598 acres shown by the Member, Board of Revenues Orissa. The latter officer in a note on "Land Acquisition" in connection with the Hirakud Dam Projects, supplied to the Committee has shown that an area of 1,82,598 acres will be acquired, out of which 59,296 acres will be waste land. The total cost of land acquisition intimated by the Member, Board of Revenues, in case of Unit No. I, which accounts for the excess under this head from Rs. 5 crores to Rs. 11.71 crores, agrees with the amount shown in the revised estimate. The Member, Board of Revenues, during his discussions has further assured the Committee that there was no likelihood of any excess on this sub-head, as has already been mentioned elsewhere in this Report.

5.32 The Financial Adviser is of the opinion that the cost of delta irrigation should not be included in the Revised Project Estimates, until the investigations are complete. The Committee has been informed by the Chief Engineer, Hirakud, that work in connection with irrigation in the delta was originally proposed to be undertaken by the Orissa Government. It was only a few months back that the Orissa Government expressed its inability to the Central Water and Power Commission to undertake this work for want of funds and staff and requested the Hirakud Administration to do it instead. The investigations have accordingly been started about six months back and will take sometime to complete.

In the meantime the area has been inspected by the Chief Engineer, Hirakud and subsequently by the Committee, which is of the opinion that the area to be irrigated in the delta is eminently suitable for irrigation and the provision made in the Revised Estimates, which has been suitably modified by the Committee, would be adequate to meet the cost of works required for irrigation.

The Committee considers that neither the position regarding the total cost of the project nor the financial aspect thereof, will be complete without including the cost of delta irrigation.

5.33 The Financial Adviser's comments in connection with affording credit to the Orissa Government for the revenue realized from existing irrigation canals has been considered. No such credit was given in the Revised Estimates, as the existing canal system was a source of loss to the Orissa Government, the working expenses being greater than the gross revenue.

The Committee considers that Rs. 6 lacs which is the average gross revenue from the existing Orissa canals should be credited to Orissa Government and only the balance of water rates revenue credited to the Project estimate. The financial forecast has been prepared accordingly.

5.34 The Financial Adviser's remarks in connection with the capitalization of abatement of land revenue, which had been assumed at 5 per cent of the cost of land have been accepted. This has been reduced to one per cent of the cost of land.

5.35 The Financial Adviser's remarks on the provision of Rs. 1.0 crore in the Revised Estimate under Unit No. IV—Navigation have already been dealt with by the Committee.

#### 5.4 Compulsory Water Rates

The Committee is of the opinion that to secure rapid development of irrigation, a system of charging water rates on all the commanded areas, for which irrigation facilities are provided, irrespective of the fact whether canal water is taken or not, should be introduced. The Committee feels that having regard to its experience elsewhere the financial success of the Project, cannot otherwise be ensured. It, therefore, recommends that the necessary enabling legislation should be passed. Several responsible officials of the Orissa Government with whom this point was discussed by the Committee, generally agreed with this view.

#### 5.5 Settlement of some displaced persons on the Fringe of the reservoir

The higher lands in the reservoir basin, i.e., lands near the fringe of the reservoir will come out of water early in the fair season, and will become available for cultivation. One crop is possible on all lands which come out of water before middle of March. Such lands are about 35,000 acres in extent. It is the experience on all reservoirs that such lands get richer due to deposition of silt and give bumper crops and are therefore in keen demand. As it is proposed to maintain the reservoir level, below R.L. 600, upto end of August, even an early kharif crop may be grown on these lands.

The Committee thinks that some of the displaced persons may be settled on the fringe of the reservoir beyond the dykes, who may be given these lands for cultivation. This may help to reduce the resettlement problem to a certain extent, and also expedite resettlement.

#### 5.6 Arrangements for distributing Hirakud Power

The estimates of the main Project provide only for the delivery of power at the main grid substation at 132 kV or 66 kV. Transmission and distribution therefrom, are to be under taken by officers of the Orissa Government.

The Committee made enquiries from the Chief Electrical Engineer of the Orissa State as to the arrangements he had initiated for distributing the electric power expected to be made available from Hirakud in 1956. He represented that his estimate of cost of distribution in the first stage was one crore of rupees and for the final stage 1.5 crores, and that no sanction had been accorded to him to commence preparation. It is of great importance that there should be no delay in utilising electric power as soon as it becomes available. The Orissa Government should be urged to sanction the necessary estimates. Electric plant

and equipment is scarce at present and manufacturers are quoting very long deliveries.

#### 5.7 Supply to Naumandi, Rairangpur, etc. in the Northern part of Orissa State

It has been mentioned earlier in this Report that substation equipment has already been ordered for the Eastern arm of the 66 kV system proposed to be fed from Keonjogarh. In the revision suggested by this Committee based on the load survey, supply to this section has been postponed to the second stage of development. The cost of material on order, for which there will be no immediate use, is estimated as Rs. 34 lakhs.

It has been brought to the notice of the Committee that supply to Naumandi, Rairangpur and Baripada situated in this Eastern arm was decided on by the Development Board at its meeting in August 1951. The provision for this section in the second stage estimates is about Rs. 125 lacs. If Orissa Government decide that for development reasons, this area should be supplied in advance of the construction of the Hirakud-Keonjogarh line programmed for the second stage, the above provision will have to be brought forward to the first stage and the Talcher-Keonjogarh 132 kV line also restored.

## SECTION VI

### CONCLUSIONS AND RECOMMENDATIONS

#### 6.1 Conclusions

The Hirakud Dam Advisory Committee as a result of scrutiny of the Revised Estimates, discussion with responsible officers of both Hirakud Administration and the Orissa State and inspection of dam and canal works in progress and of the areas to be irrigated in the Sambalpur district and in the delta lower down, has arrived at the following conclusions.

6.11 The total cost of the Project revised at Rs. 89.09 crores in the Project Report, has been further increased to Rs. 92.08 crores, due partly to the amendments proposed by the Chief Engineer Hirakud on account of inadvertent omissions and extra provision required for establishment due to the phasing of the progress for 20 years and partly due to the changes recommended by the Committee in its Report.

*N.B.*—The above cost does not take into account the effect due to the levy of sales tax proposed by the Orissa Government nor any royalty to be recovered on stone and ballest to be used in connection with this project.

6.12 The total cost therefore, represents an excess of 93 per cent over the original project proposals costing Rs. 47.8 crores. The increase in the cost has been due to—

- (a) increase in the irrigation potential of the project, which has nearly doubled ;
- (b) increase in wages of labour, which have gone up by 100 per cent ; increase in the rates of mechanical and electrical equipment due to devaluation of the rupee and the rise in the wholesale price index both in the United States and the United Kingdom ;
- (c) increase in the cost of land acquisition and compensation for houses, schools, temples, tanks, trees, etc. in the reservoir area due to the reasons already mentioned in the Committee's report.

After going into the rates of the more important items of work, the Committee considers that the increase of 93 per cent is due to reasons which could not be foreseen at the time of framing the original project estimates, is justifiable.

The Committee considers that if the present conditions in regard to labour rates and price level continue to prevail, it should be possible to complete the Project within the revised cost of Rs. 92.08 crores.

6.13 The excess in the amount of compensation, which has increased from Rs. 5 crores to Rs. 11.71 crores, is due to the increase found necessary after detailed surveys in the area to be acquired in the reservoir and the consequent increase in number of houses, tanks, temples and trees. Part of this increase is due to raising the reservoir level from R.L. 625 to R.L. 630.

The Committee is satisfied that the cost of land acquisition, which is of the order of Rs. 400 per acre on an average and the valuation of buildings, trees and tanks etc. have been estimated on a fair basis and the excess, thereon, is reasonable.

6.14 Having regard to the arrangements and the organisation put up at Hirakud both for the construction of the main dam and the excavation of canal system, the Committee feels that it should be feasible to complete the main dam and the major portion of the canal system in the Sambalpur district by the year 1955-56 and deliver power by the same year.

#### 6.2 Recommendations

6.21 If the Hirakud Dam Project is to be completed by the scheduled date and the financial results expected therefrom, are to be realized, the Accounting System and the Financial Control prevalent at present should be suitably modified and the Chief Engineer, Hirakud Dam, invested with powers similar to those enjoyed by the Chief Engineer, Bhakra-Nangal Project.

6.22 In order that financial results expected from irrigation be realized and the Project made to pay for itself, the Orissa Government may be requested to pass the necessary legislation in the State Assembly approving the levy of betterment fee and compulsory payment of water rates.

6.23 Early sanction of the Government to the estimate as now revised may be accorded so that the programme of construction during the 1st five-year period may be pursued with vigour.

6.24 The Committee has made certain suggestions regarding flood disposals and irrigation in the delta area. These may be considered before finalising these proposals.

6.25 The financial success of the power part of the Project is mainly dependent on the establishment of major industries consuming large block of electric power within reasonable distance of the Power house.

The Government of Orissa should pursue a vigorous policy to faster the development of important industries utilising the rich mineral resources of the State and encourage them to establish as near the Power Station as possible.

(Sd.) S. C. MAJUMDAR,  
6-3-52

(Sd.) M. L. CHAMPHEKAR,  
6-3-52

(Sd.) T. J. MIRCHANDANI,  
6-3-52

## SECTION VII

### LIST OF ACCOMPANIMENTS

- Accompaniment I—Tour Programme of the Advisory Committee.
- Accompaniment II—List of officers interviewed.
- Accompaniment III—Working Table of Hirakud Reservoir for a normal year (1948-49).
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- Accompaniment V—Schedule of Rates for compensation of Houses in the Submerged area.
- Accompaniment VI—Details of Load Survey by Dr. K. P. P. Menon.
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- Appendix II—Statement of extra provisions to be made in the Abstracts of Expenditure submitted by the Chief Engineer, Hirakud, to the Advisory Committee.
- Appendix III—Abstracts of Cost.
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- Appendix V—Financial Statements.



## ACCOMPANIMENT I

*Tour Programme of the Members of the Hirakud Dam Advisory Committee appointed by the Government of India in connection with the Hirakud Dam Project Estimates.*

<i>February and March 1952</i>			
13th February	Leave Hirakud Rest House and return. Inspection of subsidiary dam. (Superintending Engineer, Mahanadi Canal Circle to accompany).	9-00 hrs. 1-00 p.m.	22nd and 23rd February. Halt at Cuttack. Inspection of Taldanda, Kendrapara and other canals including flood embankments of Katjuri etc. Discussion with Director and Agronomist of Central Rice Research Institute, Cuttack.
14th February	Leave Hirakud Rest House and return. Inspection of typical villages, which will be flooded in the reservoir area, as a result of construction of the Hirakud Dam. (Superintending Engineer, Development Circle to accompany).	9-00 hrs. 1-00 p.m.	Discussion with Dr. H. B. Mohanty, Secretary, River Valley Development Department, Cuttack.
15th February	Leave Hirakud Rest House and return. Inspection of reclamation work, which is being done by the Land Reclamation Officer of the Orissa Government. (Superintending Engineer, Development Circle to accompany).	9-00 hrs. 1-00 p.m.	24th February Leave Cuttack .. .. 8-30 hrs. Arrive Konarak after inspecting delta areas in the Puri district and thence to Puri .. .. 7-00 p.m.
16th February	Discussion at Hirakud. Superintending Engineer, Hirakud Dam Circle, to discuss analysis of rates of important items.		25th and 26th February. Halt at Puri. Inspection of flooded areas and areas proposed to be irrigated and discussion with the Chief Engineer, Electricity, Orissa (Shri R. L. Narayanan) at Puri. Discussion with Mr. J. Shaw, I.S.E., Chief Engineer (Irrigation), Orissa.
17th February	Leave Hirakud for Bargarh and return.	9-00 hrs. 5-30 p.m.	27th February Leave Puri .. .. 8-00 hrs. by road. Arrive Hirakud .. .. 17-00 hrs.
18th February	Discussion at Hirakud.		28th February Halt at Hirakud. Discussion with Director of Agriculture, Orissa. Discussion with Shri K. L. Vij, Superintending Engineer (Electrical Circle).
19th February	Discussion at Hirakud with Dr. R. C. Hoon, Deputy Director, Hirakud Research Station.		29th Feb. to 6th March. Halt at Hirakud. Discussion with Shri S. A. Gadkary, Member (Hydro-Electric), C.W. P.C. Finalisation of Committee's Report.
20th February	Discussion at Hirakud with Dr. K. L. Rao, Director, Central Designs Organisation.		
21st February	Leave Hirakud .. .. Arrive Cuttack .. ..	9-00 hrs. 17-00 hrs	

HIRAKUD ;  
12th February, 1952.

(Sd.) M.G. HIRANANDANI,  
Secretary,  
Hirakud Dam Advisory Committee.

## ACCOMPANIMENT II

### *List of Officers interviewed by the Hirakud Dam Advisory Committee*

Sl. No.	Name	Designation	Sl. No.	Name	Designation
1	Shri B. Sivaraman, I.C.S.	Commissioner, Northern Circle and Member, Board of Revenue, Sambalpur.	11	Dr. B.N. Sahu ..	Provincial Organiser, Orissa, Cuttack.
2	Dr. H. B. Mohanty ..	Secretary, River Valley Development Department, Government of Orissa, Cuttack.	12	Shri Dixit ..	Assistant Director of Agriculture, Orissa.
3	Shri Kanwar Sain, I.S.E.	Member (Designs) and Chief Engineer, Hirakud Dam Project, Hirakud.	13	Dr. Vachani ..	Agronomist, Central Rice Research Institute, Cuttack.
4	Shri S. A. Gadkary ..	Member (Hydro-Electric) Central Water & Power Commission.	14	Shri M.L. Batra, I.S.E.	Superintending Engineer, Hirakud Dam Circle, Hirakud.
5	Shri J. Shaw, I.S.E.	Chief Engineer (Irrigation), Government of Orissa, Bhubneshwar.	15	Shri Indra Sen ..	Superintending Engineer, Subsidiary Dam and Canal Circle.
6	Shri R. L. Narayanan	Chief Engineer (Electricity), Government of Orissa, Puri.	16	Shri K. L. Vij ..	Superintending Engineer, Electrical Circle.
7	Shri S. Sundararajan	Financial Adviser and Chief Accounts Officer, Hirakud Dam Project.	17	Shri S. K. Palit ..	Superintending Engineer, Development Circle.
8	Col. B. N. Hajra ..	Director General of Health and Inspector General of Prisons, Orissa.	18	Dr. K. L. Rao ..	Director, Central Designs Organisation, New Delhi.
9	Shri Pujari ..	Director of Agriculture, Orissa, Cuttack.	19	Dr. R. C. Hoon ..	Deputy Director, Hirakud Research Station, Hirakud.
10	Dr. K. Ramanujan	Director, Central Rice Research Institute, Cuttack.	20	Shri Dass ..	Land Reclamation Officer, Sambalpur.
			21	Shri L. T. Wadhvani	Executive Engineer, Canal Division No. I, Hirakud Dam Project, Bargarh.
			22	Shri K. S. Misra ..	Executive Engineer, Delta Irrigation Division, Bhubneshwar.

ACCOMPANIMENT III

Table No. I—Working Table for Hirakud Main Dam for a normal year 1948-49

Year & Month	Reser- voir level at the begin- ning of the month	Capa- city of the Reser- voir	Inflow during the month	Total quantity avail- able	Draw off for power	Evaporation losses		Draw off for irriga- tion*	Total Draw off	Quantity at the end of the month	Re- ser- voir level at the end of the month	Dis- charge avail- able for Power	Average Reser- voir level	Head available for power.	Power avail- able QXH	Power with 60% L.F.
						In- ches	m.a. ft.								14	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1948																
November ..	630	6.75	.856	7.606	.52	3.3"	.046	0.298	.864	6.742	630	8,750	630	120	75,000	1,25,000
December ..	630	6.742	.459	7.201	.541	2.5"	.035	0.070	.646	6.155	628	8,830	629	119	75,000	1,25,000
1949																
January ..	628	6.555	.197	6.752	.565	3.6"	.048	0.289	.902	5.85	624	9,200	626	116	75,000	1,25,000
February ..	624	5.85	.143	5.993	.524	2.9"	.036	0.261	.821	5.172	619	9,450	621.5	111.5	75,000	1,25,000
March .	619	5.172	.077	5.249	.620	5.5"	.06	0.289	.969	4.28	612	10,000	615.5	105.5	75,000	1,25,000
April ..	612	4.28	.042	4.322	.635	6.0"	.053	0.280	.968	3.354	604	10,700	608	98	75,000	1,25,000
May ..	604	3.354	.037	3.391	.642	9.2"	.069	0.080	.791	2.6	595	10,900	599.5	89.5	70,000	1,16,000
June ..	595	2.6	.510 2.321	3.110	.705 4.725	8.0"	.055 .402	0.121 1.688	.881 6.842	2.23	590	11,850	592.5	82.5	70,000	1,16,000
July ..	590	2.23	5.335	7.565	.697	8.6"	.029	0.357	1.083	4.51	610	11,350	602.5	92.5	75,000	1,25,000
August ..	610	4.51	15.240	19.750	.6	8.4"	.053	0.265	.918	5.25	620	9,770	617.5	107.5	75,000	1,25,000
September ..	620	5.25	7.584	12.834	.555	9.0"	.088	0.345	.988	5.92	625	9,320	622.5	112.5	75,000	1,25,000
October ..	625	5.92	4.047	9.007	.548	5.0"	.065	0.357	.970	6.75	630	8,930	627.5	117.5	75,000	1,25,000

NOTES

F.R.L. ..	630.00
<i>Tail Water Elevations—</i>	
Nov. to June	510.00
July ..	515.00
Aug. & Sept.	520.00
October ..	515.00

\* IRRIGATION—

- (i) 6.68 Lakh acres for upland Irrigation.
  - (ii) 11.37 Lakh acres of Delta Irrigation.
  - (iii) 1.23 Lakh acres of lift Irrigation on the Right side.
- 19.28 Lakh acres of Total Irrigation or  
19 Lakh acres of Irrigation.

ACCOMPANIMENT IV

Table No. I—Working Table for Hirakud Main Dam for a Bad year (1947-1948) (with 10 per cent. Power cut)

Year	Month	Reservoir level at the beginning of the month	Capacity at the beginning of the m.a. ft.	Inflow during the month m.a. ft.	Total quantity available m.a. ft.	Draw off for power m.a. ft.	Evaporation Losses		Draw off for irrigation m.a. ft.	Total draw off during the month m.a. ft.	Net capacity at the end of month m.a. ft.	Reservoir level at the end of month	Discharge available for power generation (Q) cusecs	Average reservoir level	Head available (H) in feet	Power generated kW in thousands $\frac{QH}{14}$
							Inches	m.a. ft.								
1947	Nov.	630.00	6.750	.446	7.196	.490	3.3	.046	.298	.834	6.362	627.66	8,230	628.83	118.83	70,000
	Dec.	627.66	6.362	.254	6.616	.516	2.5	.035	.070	.621	5.995	625.10	8,450	626.28	116.28	70,200
1948	Jan.	625.10	5.995	3.243	6.238	.531	3.6	.048	.289	.868	5.372	620.60	8,680	622.85	112.85	70,000
	Feb.	620.60	5.372	.127	5.499	.503	2.9	.036	.261	.800	4.699	615.60	9,070	618.10	108.10	70,000
	March	615.60	4.699	.069	4.668	.533	5.5	.060	.289	.882	3.886	608.10	8,720	611.85	101.85	63,200
	April	608.10	3.886	.042	.928	.558	6.0	.053	.280	.891	3.037	599.60	9,400	604.85	94.85	63,500
	May	599.60	3.037	.026	3.063	.641	9.2	.069	.080	.790	2.273	590.63	10,500	595.1	85.13	64,000
	June	590.63	2.273	.507	2.780	.675	8.0	.675	.121	.851	1.929	585.6	11,300	588.1	78.20	63,200
	..	..	..	1.714	..	4.447	..	0.402	1.688	6.537	..	..	..	..	..	..

Assumptions :—

1. F.R.L..... 630.00
2. Tail water elevation November to June .....510.00
3. Irrigation .....19.28 Lakh acres total irrigation
4. 10 per cent. cut on power for 4 months from March to June.

ACCOMPANIMENT V (i)

Proposed Schedule of Rates for Compensation of Houses in submerged area of Hirakud Dam Project

Serial No.	Description of Walls, Roof and Floor of Rooms of House.	Proposed Rates for 50 ft. of Plinth Area				Remarks
		By L.A.O.	At 15% above Orissa Schedule	At 200% above Orissa Schedule	By S.E. Dev. Circle	
1	2	3	4	5	6	7
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	
1	Walls of sundried bricks in mud, mud plastered both sides, thatched roof and mud floor including leaping, for heights 5 to 7 ft. of walls.	1 8 0	1 11 0 for 6'	2 0 6 for 6'	1 8 0	
2	Walls of sundried bricks in mud, mud plastered both sides, C. T. Roofing and mud floor including leaping, for heights 5 to 7 ft. of walls.	2 8 0	..	..	3 0 0	
3	Add for every additional foot of height of walls for items 1 & 2.	..	..	..	0 1 6	
	Notes — (a) For no plaster to walls, deduct -/2/- from the above rates.					
	(b) For plaster on one side of walls, deduct -/1/- from the above rate.					
	(c) For perches, half of the above rates to be allowed.					
	(d) Walls of Flagstones in mud to be treated as walls of sundried bricks.					
4	Walls of burnt bricks in mud, mud plastered both sides, C. T. Roof and mud floor including leaping, for heights 5 to 7 ft. of walls.	3 12 0	{ 2 5 0 for 6' 2 8 0 for 7'	3 12 6 for 6' 3 0 0 for 7'	3 0 0	
5	Walls of burnt bricks in mud, mud plastered both sides, C. T. Roof and mud floor including leaping for heights 8 to 10 ft. of walls.	3 12 0	..	..	3 6 0	
6	Walls of B. B. in mud, mud plastered both sides, thatched roof and mud flooring including leaping, for 5 to 7 ft. high walls.	2 4 0	{ 2 4 0 for 5' 2 10 0 for 7'	2 11 0 for 5' 3 1 0 for 7'	2 8 0	
7	For every additional foot of height for items 4, 5 and 6 add a rate of—	..	..	..	0 3 0	
	Note— (a) For no plaster to walls, deduct -/2/- from rates of items 4 to 7.					
	(b) For plaster on one side only, deduct -/1/- from rates of items 4 to 7.					
	(c) Perches to be rated at half rates for items 4 to 7.					
8	Walls of B. B. in mud, lime plastered both sides, C. T. Roofing and mud flooring including leaping for height of walls 5 to 7 ft.	..	{ 2 4 0 for 5' 2 11 0 for 7' (Thatched roof)	2 11 0 for 5' 3 2 0 for 7'	3 4 0	

1	2	3	4	5	6	7
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	
9	For every additional foot in height of walls of item 8 add.	..	..	..	0 3 6	
10	Walls of B. B. in lime, lime plastered both sides, C. T. Roofing and mud floor including leaping for height of walls 5 to 7'.	..	{ 2 9 0 for 5' 3 1 6 for 7'	{ 3 2 0 for 5' 3 10 0 for 7'	3 8 0	
11	For every additional foot in height of walls of items 10 above, add  <i>Note</i> —For no lime plaster to walls, deduct -/3/- from rates of item 10. For perches, half the rates to be allowed.	..	..	..	0 4 0	
12	Walls of jungle brush wood (Wittle) and plastered both sides, thatched roof and mud floor including leaping for walls upto 5 ft. high.  <i>Note</i> —(a) For no plaster to wittle walls deduction of -/2/- in rate of item 12 to be made.	0 14 0	..	..	1 0 0	
13	Open Sheds or lean to sheds of Salballi or jungle wood poles or K. B. Pillars thatched roof and mud floor.	..	..	..	0 8 0	
14	Walls of B. B. in lime, lime plastered both sides, corrugated G. I. Sheet roof and mud floor including leaping for height of 13' walls (for schools).	5 0 0	4 5 0	5 3 0	5 0 0	
15	For Dhabha of Salwood Ballies of Sawn Timber and flagstone plastered mud on top add Rs. 50 per cent sq. ft. of plinth area of the room.	..	..	..	0 8 0	
16	For Dhabha of jungle wood or bamboos, mud on top and mud plaster add Rs. 25 per cent sq. ft. of plinth area of the room.  <i>Note</i> —For packs flooring of flagstones in lime of cement mortar over 3" lime concrete or B. Bricks flooring 6" thick or cement concrete flooring, 3" thick, add a rate of	..	..	..	0 4 0	
		..	..	..	..	

ACCOMPANIMENT V (ii)

Depreciation of houses	..	..	..	..	..
Average rate of depreciation allowed	..	..	..	..	..
Sun dried Brick Work and Mud Walling	..	..	..	..	36%
Random Rubble Masonry	..	..	..	..	25%
Burnt Brick Work	..	..	..	..	20%
For Temples	..	..	..	..	10%
Jungle stump walling with plaster	.	..	..	..	40%
Jungle stump walling without plaster	..	..	..	..	50%

HIRAKUD DAM PROJECT REPORT

ACCOMPANIMENT VI

Details of load survey by Mr. K. P. P. Menon

Prospects of Hirakud Power Utilisation, 14th February, 1952

Location & type of loads							1955-56		1960	
							kW	Total	kW	Total
<b>1. Talcher S/S—</b>										
Colliery loads	..	..	..	..	..	1,500		2,000		
Town Loads	..	..	..	..	..	250		..		
Irrigation & rural loads	..	..	..	..	..	250	2,000	1,000	3,000	
<b>2. Cuttack S/S—</b>										
Electric Supply Co.	..	..	..	..	..	1,500		2,250		
Rolling Mill	..	..	..	..	..	300		350		
Refrigerator factory	..	..	..	..	..	300		400		
Orissa Textile Mills	..	..	..	..	..	1,000		..		
Orissa Cotton Mill	..	..	..	..	..	500		2,000		
Tube Mill	..	..	..	..	..	500		1,000		
Jute Mill	..	..	..	..	..	500		500		
Other industries (not so far planned)	..	..	..	..	..	500		2,000		
Paper Mill	..	..	..	..	..	..		2,000		
						5,100		10,500		
Bhubaneswar Capital and old town	..	..	..	..	..	350		500		
Water Works for the Capital	..	..	..	..	..	125		150		
Industries that may crop up including A.I.R. — say	..	..	..	..	..	150		300		
						625		950		
Puri	..	..	..	..	..	400		500		
Jatni & Khurda area	..	..	..	..	..	500		700		
Barang area	..	..	..	..	..	250		350		
Rural loads in the delta area including small scale riverside pumping by private parties.						1,000		1,500		
						2,150	7,875	3,050	14,500	
Taking diversity into account	..	..	..	..	..		6,000		12,000	
<b>3. Jharsuguda S/S—</b>										
Orient Paper Mill	..	..	..	..	..	3,000		3,000		
Chlorine & Caustic Soda	..	..	..	..	..	1,000		1,000		
Town Loads	..	..	..	..	..	200		400		
Colliery loads	..	..	..	..	..	1,200		1,500		
Irrigation loads	..	..	..	..	..	100		500		
Supply to Madhya Pradesh	..	..	..	..	..	1,500		5,000		
						7,000		11,400		
Taking diversity	..	..	..	..	..	..	6,000		10,000	



Location & type of loads	1955-56		1960	
	kW	Total	kW	Total
<b>4. Rajgangpur S/S—</b>				
Cement factory .. .. .	2,500		5,000	
Ferro-Manganese .. .. .	5,000		10,000	
Other industries & quarries .. .. .	500		1,000	
Rural and Urban loads, including lift irrigation .. .. .	250		1,000	
	<u>8,250</u>		<u>17,000</u>	
Taking diversity .. .. .		8,000		15,000
<b>5. Sambalpur Area—</b>				
Total load including small scale industry .. .. .	1,000		2,000	
Aluminium factory .. .. .	25,000		50,000	
Ferro-alloys (location is not known) .. .. .	5,000		10,000	
	<u>31,000</u>		<u>62,000</u>	
Say		30,000		60,000
<b>6. Bargarn-Barpali area—</b>				
This load could be supplied directly from Hirakud Power Station	300	300	500	500
<b>7. Bolangir District etc.—</b>				
The towns in this area have no industrial potentialities. There are a small scale lift irrigation possibilities for Bolangir, Titalagarh, Khariar Road, Ketamanji and Bhavani Patna, including small scale lift irrigation possibilities the loads may total. .. .. .	1,000	1,000	2,000	2,000
(It is a matter for consideration if a 66 kV line would be justified for these loads).				
GRAND TOTAL .. .. .		<u>53,000</u>		<u>102,500</u>
Taking a diversity and also the losses into account the loads on the power station may be .. .. .		50,000		100,000

## ACCOMPANIMENT VII

*Statement showing the cost of charges recommended by the Committee*

Amount in Lakhs of Rupees

Unit	Amount
Unit No. I—Dam & Appurtenant Works	Rs.
Unit No. II—Main Canals & Branches	
(i) Drainage & Protective Works in the Sambalpur District .. .. .	25·0
(ii) Cost of Barrages in Delta areas.. .. .	450·00
Less the cost of syphon already provided .. .. .	<u>—160·00</u>
Net cost .. .. .	290·0
(iii) Reduction in the amount under Drainage & Protective Works from Rs. 50 to Rs. 25·0 lakhs	<u>—25·00</u> 290·00
Unit No. III	
(i) Reduction in the cost under T—Transmission .. .. .	—154·00

*Note*—The amount of Rs. 25·0 laes under Drainage and Protective works for Sambalpur District has also been included by the Chief Engineer, Hirakud Dam *vide* Appendix II.

ACCOMPANIMENT VIII  
Table IV—Development Programme

Year	System Load	Power House I Firm Spare	Power House II Firm Spare	Installed capacity	Firm capacity	Transmission Line terminii	Rate of sale per kW year	Remarks
1	2	3	4	5	6	7	8	9
	mW	mW	mW	mW	mW			
1955-56	10	$\frac{1 \times 24}{1 \times 24}$	..	48	24	Rajgangpur Cuttack		
1956-57	35	$\frac{2 \times 24}{1 \times 37.5}$	..	85.5	48	Titlagarh Raigarh.		
1957-58	40	$\frac{2 \times 24 + 1 \times 37.5}{1 \times 37.5}$	..	123.0	85.5			
1958-59	45	..	..	123	85.5			
1959-60	50	..	..	123	85.5			
1960-61	60	..	..	123	85.5			
1961-62	70	..	..	123	85.5			
1962-63	80	$\frac{2 \times 24 + 2 \times 37.5}{1 \times 37.5}$	..	160.5	123	Rajgangpur II	Rs. 167/kW year.	The line to the sub-station shown in column 7, along with the sub-station en-route, to be ready in the respective years  P. H. I—Stage II to be ready in 62-63.
1963-64	90	..	..	160.5	123	Keonjargarh		
1964-65	100	..	..	160.5	123	Baripada Noamandi		
1965-66	110	..	$\frac{1 \times 24}{1 \times 24}$	184.5	147	Jamshedpur		
1966-67	120	..	$\frac{1 \times 24}{1 \times 24}$	208.5	147	Cuttack II		
1967-68	130	..	$\frac{1 \times 24}{1 \times 24}$	208.5	147			
1968-69	140	..	$\frac{2 \times 24}{1 \times 24}$	232.5	171			
1969-70	150	..	$\frac{3 \times 24}{1 \times 24}$	256.5	195		Rs. 182/kW year	
1970-71	160	..	..	256.5	195			
1971-72	170	..	..	256.5	195			

APPENDIX I

D. O. No. X M. BHUBNESWAR, FEBRUARY, 52.

DEAR MR. MAZUMDAR,

As desired I send herewith my observations on (i) impounded water at Hirakud Area and its relations to Malaria (ii) Malaria in the coastal belt of Orissa and (iii) Malaria in the deltaic areas of Mahanadi. I have also pointed out the risks involved in stopping the flow in Kuakhai river. I trust you will find them useful,

Yours Sincerely,

(Sd.) B. N. HAJRA,

*Director of Health and Inspector General of Prisons,  
Orissa.*

### MALARIA IN THE DELTAIC AREAS OF ORISSA

**Incidence**—Malaria survey in some of the representative areas of the deltaic region reveal that malaria is patchy and in some of the areas it is endemic and hyperendemic. The spleen rate in Kendrapara town of Cuttack district varies from 40 to 80. In Mahanga it is nearly 70. Malaria is also hyperendemic at Indipur. In short it can be said that the whole of Kendrapara subdivision is practically unhealthy and malarious. The headquarters town of Jajpur and most of the village in that subdivision are also malarious.

In Puri district the reputed malarious localities are Puri town, Raghurajpur, Sakhigopal and the adjoining villages, Pipili, Gop, Baliana, Balipatna etc. The spleen rate in these villages vary from 30 to 80.

The preponderating species of malaria parasites are B. T. and M.T. though quarta parasites are not rare.

**Malaria season**—The malaria season for all-practical purposes extends from August to December.

**Vector**—The main vector species so far incriminated is *A. annularis*. Heavy gut infection in *A. Ramsy* have been detected at Puri, Sakhigopal and Kendrapara. Gland and gut infections in *A. aconitus* have been also detected by the Railway authorities in some other localities of this region.

The infection rate in *A. annularis* is extremely low and it is curious that this species alone can maintain such high incidence of malaria in spite of the low infection rate. Whether by virtue of its sheer weight (density) that the species maintains such a high incidence of malaria remains still to be answered.

**Breeding places**—The chief breeding places of the vector species are large insanitary tanks covered with vegetation, Joras (streams) Dovas, Dead rivers, borrow pits and rice fields.

At Kendrapara town the main breeding places are large Joras (streams) and insanitary tanks.

The dead Ratnachiri river at Sakhigopal with innumerable bunds and approach roads is a prolific source of breeding in that locality. Pipili is beset

with large insanitary tanks and borrowpits breeding the vector species to a large extent. At Mahanga, there is also a dead river namely Joria which is the chief source of breeding of the vector species. As has been mentioned above the breeding places elsewhere consists of tanks, ponds, dovas, borrowpits, old neglected navigation canals and rice fields. The Chief factor associated with the breeding of the vector species is vegetation and algae.

**Control measures**—The species is susceptible to silt and introduction of silt laden water into the breeding places will stop breeding. This forms the basis of "flood and flush" system of control and requires considerable engineering skill. Excellent results have been obtained in some parts of Bengal by introducing this system where the vector species is *A. philipinenses* a species having the same breeding habits as *A. annularis*. Reclamation of dead rivers and filling up of borrowpits are again engineering projects the cost of which in some cases at least are likely to be prohibitive.

The only other alternative is to adopt temporary or more appropriately recurrent measures. These will mainly consist of deweeding water courses, use of larvicides like oil or paris green and lastly use of insecticides both immediate and residual. All these methods should be supplemented by suppressive and prophylactic drugs like Paludrine, Chloroquine and Plasmoquine. A word of warning is necessary regarding these recurrent measures. In the past anti-malaria measures have been adopted in various places most irregularly and very often either to silence local agitation or to combat a progressing epidemic with varying degrees of success. To be effective anti-malaria schemes must be carried out regularly from year to year like any other public health measure and they need expert supervision and direction at all times.

The antimalaria schemes to be adopted will vary from place to place depending upon local conditions and circumstances. While anti-larval measures like deweeding, parisgreen and oiling with little cost may be quite effective and suitable in some of the localities due to smallness of breeding places, at others residual insecticides have been adopted because the breeding places are extensive and the

anti-larval measures are either likely to be costly or impossible. Whatever method be employed continuity of effort is the *sine qua none* of success in executing these anti-malaria schemes.

**Effect of sealing Kuakhai at its point of bifurcation and feeding the river Daya by a separate canal from Mahanadi at Naraj and their effect on the incidence of Malaria.**

It is proposed to seal off Kuakhai at its point of bifurcation and feed the river Daya by a separate canal from Mahanadi at Naraj.

Kuakhai is a branch of Kathjuri and Kuakhai divides further below into Daya and Bhargabi. The result of sealing the Kuakhai at its point of origin is likely to convert this river and also Bhargabi into dead rivers. These dead rivers in course of time will become filled with thick vegetation with enormous output of *A. annularis* which is a reputed vector in the Deltaic areas of Orissa. This possibility and its subsequent threat to Bhubneswar and also to all the villages on the bank of these rivers require careful investigation.

The proposed canal from Mahanadi to feed the River Daya may also influence the incidence of malaria in this region by increasing the subsoil water level and causing water logging.

The Malaria season in this part of the country lasts from August to December and if by any device silt-laden water can be introduced into these rivers during the above malaria season the incidence of malaria is likely to be less. All these possibilities have to be investigated before undertaking and executing these schemes. With a view to obtain detailed and complete information regarding the incidence of malaria in these localities, it is advisable to have a complete survey by instituting a competent team for the purpose.

The result of this survey should be scrutinised both by the Director of Health and the authorities of the Engineering Departments and their ultimate effects on the health of the people determined. This joint cooperation by the Health Department and the Engineering authorities together with the survey results will enable the authorities to take appropriate preventive measures and thus reduce the chance of any future threat of malaria either to Bhubneswar or other villages likely to be effected by this scheme.

#### **MALARIA IN THE COASTAL BELT OF ORISSA**

Malaria in the coastal belt of Orissa was investigated by a research Unit deputed by the Malaria

Institute of India with headquarters at Rambha during the years 1939 April to 1942 March. The results of these investigations were published in the then Journal of Malaria Institute of India, 4 December, 1942.

**Incidence of Malaria**—Detailed systematic observations were carried throughout the above period from Sana Nasi 24 miles north of Rambha to Chatrapur 16 miles to the south while special expeditions to elucidate particular problems were made along the whole of the lake margin and as far south as a point on the coast opposite Vizayana-gram.

The distribution of malaria in this area is patchy and irregular. Hyperendemic conditions prevail in certain villages and epidemics of a serious nature occur from time to time at irregular intervals. As regards spleen rates the villages in the Chilka Lake area fall into two groups. Group I—Villages in which the spleen rates do not show any great reduction in non-epidemic years *i.e.*, Proyagi Debrkandi, Koroka and Keropur. Group II—Includes those villages in which the spleen rate falls markedly during the inter epidemic period (Soren, Sana Nairi, Balugaon and Salilia).

**Species of Malaria parasites**—In the early part of the malaria season and at the height of an epidemic the infections were almost all *P. falciparum* whilst as the epidemic was subsiding a certain proportion of *D. V. vax* and *P. Malaria* were encountered. Infections with *P. Malaria* were particularly numerous at Dutrakudi and Haripur Bandra during the period May to September.

**Malaria Season**—There were two transmission seasons the first in March-April and the second in the Autumn months commencing towards the end of September up to end of December.

**Vector**—The Malaria vector throughout the region is *A. Sundaicus*. There is no evidence that any other species plays any part in the transmission of the disease except in Puri town where *A. annularis* was also found to be an additional vector.

**Breeding Habits and Bionomics of the Vector**—*A. Sundaicus* breeds in the Chilka Lake itself and also in tanks, pools, swamps and ricefields subject to flooding by saline water.

The Chief factor favouring the breeding of *A. Sundaicus* is the presence of putrefying algae and other weeds. The optimum range of salinity is from 66 to 800 parts per 100,000 but salinity probably operates in so far as it affects the growth

of weeds. In some villages the vector also breeds in water of low salinity which are never flooded with sea water.

**Control Measures**—(1) In villages like Kosoka, Sbilā and Rambha where outbreaks of Malaria are due to local breeding of *A. sudaicus* in certain pools and tanks, the removal of weeds by manual labour offers a good prospect of success. In other areas where lake itself is the main source of breeding the problem is much more difficult. If the salinity could be raised to above 1,000 parts per 100,000 parts by admitting sea water to the lake the breeding of *A. sudaicus* would cease. This is a huge engineering problem, the cost of operating and maintaining which, will be prohibitive. The difficulties likely to be encountered in any attempt to alter the physical conditions in the Chilka lake are stressed on the report of the Orissa Flood Committee 1929.

THE ONLY PRACTICAL METHOD FOR CONTROL OF MALARIA IN THE COASTAL BELT APPEARS TO BE REMOVAL OF WEEDS BY MANUAL LABOUR USE OF INSECTICIDES BOTH IMMEDIATE AND RESIDUAL (PYRETHRUM AND D.D.T.) AND SUPPRESSIVES LIKE PALUDRINE AND CHLOROQUINE

**Chatrapur**—At Chatrapur the chief breeding places of *A. sudaicus* are the Tampara (a lagoon of water) and certain tanks and borrowpits. It is suggested that the Tampara be drained by removing the dam at its northern end and the land exposed put under rice cultivation, a long stemmed and densely growing variety being selected for the purpose. Removal of weeds is difficult and the cost is likely to be prohibitive. As an alternative the town may be treated with any one of the residual insecticides.

#### **Gopalpur**—

(I) Removal of vegetation from tanks and pools in and around villages.

(II) Filling in of borrowpits and prohibitions of further excavation of earth.

(III) Strengthening of the existing embankments so as to prevent the flooding of ricefields by saline water.

(IV) Construction of a dam across the mouth of Kandla Nala to prevent the entrance of saline water similar to that which already exists at the junction between the old navigation Canal and the creeks. The height of the latter dam should also be raised so as to prevent the entrance of saline water.

#### **IMPOUNDED WATER AND ITS RELATIONS TO MALARIA**

The effect of impounded water on malaria is extremely varied and complex. The main aims of impounding water are flood control, power production, irrigation and navigation. Many such multipurpose schemes are already under execution in India, a notable example being the Hirakud Dam (under construction) in Mahanadi, in the District of Sambalpur.

The impoundage of flowing streams profoundly alters the biology of the affected waters. One of these changes may be a vast increase in the potential for anopheline mosquito breeding unless appropriate control works and procedures are planned, designed and operated. The choice is therefore between the probability of a disastrous "Man made Malaria" or a successful resolution of the adverse biological changes by well planned and designed anti-mosquito measures. The history of Irwin Canal Project in Mysore and Sukur Barrage scheme in Sind affords striking illustrations regarding the sequence of events that may follow by execution of such schemes without appropriate anti-malaria schemes. In both the above localities malaria flared up in an epidemic form thus establishing endemic and hyperendemic conditions, the latter producing a paralysing effect on village economy.

Among the factors which may contribute to high incidence of malaria by Hirakud multipurpose schemes mention must be made of the following—

(1) The construction of the dam will result in the formation of huge lake increasing the sub-soil water level and thus causing water logging in the neighbouring area.

(2) The lake itself and more particularly the edges are likely to become the breeding places of mosquitoes.

(3) The leaks from the dam and also seepages that may crop up are likely to breed dangerous mosquitoes.

(4) Lastly, the introduction of canal system for purposes of irrigation may also profoundly influence the incidence of Malaria.

Again the chief cause of malaria associated with perennial irrigation is increase in sub soil water level causing water logging. Rain falling on waterlogged soil may lead to the formation of innumerable pools which remain as mosquito breeding places for lengthy periods. In the canal itself, mosquito breeding, may be slight when it is running full, but when the supply to the canal is cut off, as for instance, during repairs, the breeding may become profuse. Breaches in the canals, distributaries or

water course whether from natural causes or due to illicit removal of water are responsible for the production of numerous breeding places. The water running off the fields may be particularly dangerous. In the perennial irrigation system there will be almost invariably water standing in fallow fields of almost every depression and ditch in the neighbourhood for several months in the year and these are likely to become a serious danger.

**Control of Malaria**—The basic principles of malaria control on impounded water as are likely to be encountered at Hirakud area are—

(1) Site selection and Reservoir preparation includes removal of all trees, logs, brush and other vegetation; drainage of any marginal depression or marshy areas and clearing beyond the pool level up to a distance extending 10 to 15 ft. inland is desirable. Shore line maintenance is essential.

(2) Water level management which consist of several phases—

- (a) Flood surcharge.
- (b) Constant level pool.
- (c) Periodic fluctuation, if this can be done.
- (d) Seasonal recession.

(3) Reservoir maintenance.

(4) Dyking, dewatering, cut and fill, etc.

(5) Use of larvicides, insecticides and mosquito proofing of houses, etc. Most of the States in U. S. A. have made regulations to control malaria due to impounded water and a typical one is reproduced below—

Any person, corporation, or governmental agency desiring to impound water with more than 1 acre of water surface, or to raise the level of an existing pool, must secure a permit from the State Department of Public Health. In the designing and construction of a reservoir bottom drains or other means must be provided which will permit removal of the impounded water. Flash boards or other means must also be provided for controlling fluctuation of water level at any season of the year.

In the area to be inundated by the impounded water all trees and other growth which would pierce the surface at minimum low water level must be cut off at least 1 foot below such water level to prevent the collection of drift and flottage.

The shore line from minimum low water level to a line 15 feet landward from the normal high water level must be cleared of all brush, trees, undergrowth, and any material which may cause the collection drift or flottage.

Any area which will be inundated by impounded water at the time of maximum water level and in which water will be retained at lower stages of the reservoir must be conducted with the main body of the impounded water so as to permit drainage or access by boat.

The reservoir must not be filled during the breeding season of the malaria-carrying mosquito unless authorised by the State Department of Public Health.

All brush, vegetation, and similar material must be removed annually in the autumn or winter months from the shore line where it might cause the collection of drift or flottage.

Water lilies, water hyacinths, or other aquatic plants which grow above or penetrate the surface of the water must not be planted or transplanted into any reservoir.

The water level of the reservoir must be controlled in a manner satisfactory to the State Department of Public Health.

Larvicides, such as DDT, paris green, and oil must be applied when such measures are required to control the malaria carrying mosquito.

If it is not possible to control adequately the breeding of malaria mosquitoes, or if such control is not practical or economical, the Health Commissioner may require that the person responsible for the reservoir effectively screen all houses with an insecticide when specified, or carry out such other malaria control measures as may be deemed necessary or appropriate for the control of malaria.

After the water is impounded, representatives of the State Department of Public Health must make occasional inspections, and any conditions found to be detrimental to public health, or likely to cause an increase of malaria, should be remedied to the satisfaction of the State Department of Public Health.

In conclusion it must be pointed out that it is advisable to appoint an Expert Committee in order to determine the immediate and future results upon the health and prosperity of the people by the execution of such huge and gigantic schemes. The Committee should consist of the expert representatives of Engineering, Public Health, agricultural, Financial and other interests likely to be affected by such projects. A step in the right direction has been already taken by appointing a Malarialogist in Hirakud area and the survey results achieved by him should be considered by the Committee and appropriate control measures depending on the vector species, applied in time in order to avoid disastrous results which might result in future as a result of negligence.



APPENDIX II

Shri Kanwar Sain, I.S.E.,  
Member (Designs) &  
Chief Engineer, Hirakud Dam Project.

No. W/5000/CE  
Government of India,  
Central Water and Power Commission,  
Hirakud Dam Project,  
P. O. Hirakud; March 2, 1952.

MY DEAR HIRANANDANI,

During the last two months I instructed my Superintending Engineers to scrutinise the provisions in the revised estimate with a view to see whether any items have been omitted inadvertently. As a result of scrutiny I propose the attached additions and alterations in the abstract of expenditure. This was discussed with the members of the Committee and they have accepted these amendments.

Yours Sincerely,  
(Sd.) KANWAR SAIN

Shri M. G. Hiranandani,  
Secretary,  
Hirakud Advisory Committee,  
HIRAKUD.

## APPENDIX II

	Provision previously made	Total provi- sion required	Excess
<b>UNIT No. 1</b>			
<i>O—Miscellaneous</i>			
Running of School at Burla and Hirakud .. .. .	2,00,000	6,00,000	4,00,000
Hirakud Research Station .. .. .	10,00,000	14,00,000	4,00,000
<i>K—Buildings</i>			
Electric installation to buildings .. .. .	7,90,000	13,28,000	5,38,000
Additional buildings as per details .. .. .	..	..	10,00,000
<i>C—Works</i>			
Construction of approach road from CWING road to R.D. 14,700 of 640 contour road right bank across the Chandli Dungri Hill.	..	75,000	75,000
Spillway crest gates including hoists and embedded parts .. .. .	35,31,330	49,54,000	14,23,000
			38,36,000
Establishment charges .. .. .	4%	5%	1%
<b>UNIT No. 2</b>			
Surface drains .. .. .	..	25,00,000	25,00,000
Establishment charges .. .. .	8%	9%	1%
<b>UNIT No. 3</b>			
Expenditure due to postponement of Power Channel and Subsidiary Dam ..	..	12,00,000	12,00,000
Excavation of power house foundations .. .. .	..	12,00,000	12,00,000
Earthwork and retaining wall for switch-yard for power house No. 1 ..	..	9,00,000	9,00,000
			33,00,000
Establishment charges .. .. .	4%	6%	2%

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EXCESS PROVISION TO BE MADE UNDER K—BUILDINGS.

(These items were not included in the list sent earlier, proposed to be included in the Revised Estimate)

2 C Type Bungalows for Medical staff	..	..	..	..	..	..	50,000
60 G type quarters for Medical staff	..	..	..	..	..	..	1,20,000
18 F type quarters for Medical staff	..	..	..	..	..	..	92,000
4 D type quarters for Medical staff	..	..	..	..	..	..	34,000
3 E type quarters for Medical staff	..	..	..	..	..	..	21,000
4 G type quarters at Kirba for water supply staff	..	..	..	..	..	..	8,000
4 G type quarters at Kirba Hill side	..	..	..	..	..	..	8,000
1 E type quarter for water supply	..	..	..	..	..	..	7,000
3 F type quarters for water supply	..	..	..	..	..	..	16,000
Construction of two bed-roomed I.B. on the top right hill near Centre Line	..	..	..	..	..	..	80,000
Construction of additional G type shops, 2 blocks of 16 each	..	..	..	..	..	..	1,10,000
Construction of 2 open market sheds 60' x 30' each at Hirakud right	..	..	..	..	..	..	5,000
Construction of 4 meat and fish stalls at Hirakud Right	..	..	..	..	..	..	4,000
Construction of 6 tropical huts for offices	..	..	..	..	..	..	30,000
Construction of Power House at Rajgangpur due to extension of Power House	..	..	..	..	..	..	50,000
Construction of Cattle pond at Hirakud Colony Right and Left	..	..	..	..	..	..	1,000
Care and custody and handling stores	..	..	..	..	..	..	50,000
Recreation ground and park and swimming for colony	..	..	..	..	..	..	50,000
Cremation ground including sheds and well at Hirakud Colony Right	..	..	..	..	..	..	5,000
Erection of 10 M.B. Sheds at Bikaner House, New Delhi, for the use of design staff of Hirakud Project	..	..	..	..	..	..	2,27,000
						Total	9,68,000
Furniture and crockery for Rest Houses and other buildings	..	..	..	..	..	..	32,000
						Total	10,00,000

## APPENDIX III

### ABSTRACTS OF COSTS

#### Unit No. I—Cost of Dam and Appurtenant Works

	Sub-head		Amount in lakhs of rupees
A—Preliminary .. .. .			24.15
B—Land .. .. .			1170.94
C—Works .. .. .			1902.40
K—Buildings .. .. .			157.28
M—Plantation .. .. .			1.08
O—Miscellaneous .. .. .			97.85
R—Communications .. .. .			40.93
	<b>TOTAL</b>		<b>3394.63</b>
P—Maintenance at 1% of above excluding B—Land .. .. .			22.24
<b>6. Special Tools and Plant—</b>			
(a) Tools & Plant .. .. .		610.00	
(b) Stores Equipment .. .. .		15.26	
(c) Workshop Equipment .. .. .		10.52	
(d) Power House Equipment .. .. .		18.47	
	<b>Total 6—Special Tools &amp; Plant</b>	<b>654.25</b>	<b>654.25</b>
Less—special Tools & Plant charged to works .. .. .		(—) 394.31	(—) 394.31
Net cost of special T & P .. .. .		259.94	259.94
<b>7. Losses on Stock</b>			
Unforeseen .. .. .			5.00
			11.50
<b>Total—I—Works</b> .. .. .			<b>3693.31</b>
II—Establishment at 5% of I—Works .. .. .			184.67
III—Tools & Plant at 1% of I—Works .. .. .			36.93
V—Receipts on Capital Account			
(i) Resale value of buildings .. .. .		(—) 35.11	
(ii) a. Residual value of spl. T & P on completion of work .. .. .		(—) 244.47	
b. Resale value of Buildings etc. in stores .. .. .		(—) 9.16	
c. Resale value of Buildings etc. in workshop .. .. .		(—) 6.31	
d. Resale value of buildings etc. in Power House .. .. .		..	
(iii) Miscellaneous receipts from rents, etc. .. .. .		(—) 12.61	
Total—R & R on Capital Account .. .. .		(—) 307.66	(—) 307.66
Total—Direct charges .. .. .			3607.25
<b>INDIRECT CHARGES</b>			
VI— (a) Capitalization of abatement of Land revenue at 20 times the Land revenue .. .. .			7.80
(b) Audit charges .. .. .			2.45
Total—Indirect Charges .. .. .			10.25
Total—Direct and Indirect Charges .. .. .			3617.50
Amount debitable to Navigation .. .. .			20.00
Net Cost of Unit No. I .. .. .			3597.50

## Unit No. II—Main Canal, Branches and Distributaries, etc.

[ AMOUNT IN LAKHS OF RUPEES ]

Sub-head 1	Bargarh Canal- system 2	Left side flow canal system 3	Right side lift canal system 4	Delta irrigation 5	Total 6
1. <i>Headworks</i> .. .. .	..	..	..	536.00	536.00
2. <i>Main Canal &amp; Branches</i>					
A—Preliminary .. .. .	6.57	2.41	4.61	0.20	13.79
B—Land .. .. .	23.13	3.34	5.36	13.50	45.33
C—Works .. .. .	..	..	..	..	..
D—Regulators .. .. .	16.85	6.26	1.44	10.00	34.55
E—Falls .. .. .	1.75	..	..	..	1.75
F—Cross Drainage works .. .. .	117.53	24.45	21.66	3.00	166.61
G—Bridges .. .. .	5.51	1.07	1.51	5.00	13.09
H—Escapes .. .. .	2.02	..	2.04	3.00	7.06
K—Buildings .. .. .	32.29	3.13	2.00	6.00	43.42
L—Earthwork .. .. .	170.38	15.87	28.00	39.20	253.45
L <sub>1</sub> —Service and boundary roads .. .. .	1.30	0.33	0.10	0.29	2.02
L <sub>2</sub> —Lining of canals .. .. .	..	..	..	9.00	9.00
M—Plantation .. .. .	0.54	0.13	0.15	0.15	0.97
O—Miscellaneous .. .. .	7.56	5.19	0.07	8.76	21.58
O <sub>1</sub> —Pumps and pipe lines .. .. .	..	3.46	56.33	..	59.79
<b>TOTAL</b> .. .. .	<b>385.43</b>	<b>65.64</b>	<b>123.27</b>	<b>634.10</b>	<b>1208.44</b>
P—Maintenance 1% of above excluding B-land .. .. .	3.62	0.62	1.18	6.21	11.63
<b>TOTAL</b> .. .. .	<b>389.05</b>	<b>66.26</b>	<b>124.45</b>	<b>640.31</b>	<b>1220.07</b>
Remodelling existing canal system .. .. .	..	..	..	41.96	41.96
<b>BRANCHES</b>					
Total 1—Head Works .. .. .	..	..	..	163.15	163.15
2—Main canal & branches .. .. .	389.05	66.26	124.45	845.42	1425.18
3—Distributaries .. .. .	114.00	21.34	27.35	125.70	288.39
4—Drainage and Protective works .. .. .	16.00	3.00	6.00	25.00	50.00
5—Watercourses .. .. .	1.90	0.36	0.46	3.24	5.96
6—Special Tools & Plant .. .. .	..	..	..	20.00	20.00
Less—depreciation charged to works .. .. .	..	..	..	(—) 15.00	(—) 15.00
Net amount of special Tools & Plant .. .. .	..	..	..	5.00	5.00

(Continued)

## APPENDIX III

1	2	3	4	5	6
7—Losses on stock .. .. .	0·10	0·02	0·10	0·10	0·32
Unforeseen .. .. .	1·00	0·20	0·45	8·00	9·65
Total I—Works .. .. .	522·05	91·18	158·81	1012·46	1784·50
II—Establishment at 9% of I—Works ..	26·10	8·21	14·29	91·12	139·72
III—Tools & Plant at 1% of I—Works ..	5·22	0·91	1·59	10·12	17·84
V—Receipts on Capital Account .. ..					
(a) Special Tools & Plant .. ..	..	..	..	(—) 4·62	(—) 4·62
(b) Miscellaneous receipts .. ..	(—) 0·19	(—) 0·03	(—) 0·05	(—) 0·28	(—) 0·55
Total—R & R on Capital Account .. ..	(—) 0·19	(—) 0·03	(—) 0·05	(—) 0·90	(—) 5·17
Total—Direct Charges .. .. .	553·18	100·27	174·64	1108·80	1936·89
INDIRECT CHARGES					
VI—(a) Capitalization of abatement of Land revenue 1% of B—Land.	0·23	0·03	0·05	0·14	0·45
(b) Audit Charges .. .. .	0·38	0·06	0·16	0·53	1·13
Total—Indirect Charges .. .. .	0·61	0·09	0·21	0·67	1·58
Total—Direct & Indirect Charges .. ..	553·79	100·36	174·85	1109·47	1938·47
Extra cost of Bargarh canal due to lift discharges .. .. .	..	..	20·06	..	20·06
Extra cost of lift side flow canal due to lift Branch .. .. .	..	5·09	..	..	5·09
GRAND TOTAL .. .. .	553·79	105·45	194·91	1109·47	1963·62
GENERAL FEATURES					
1. Culturable area .. .. .	3,80,000	71,129	91,155	7,68,000	13,10,284
2. Cost per acre of C.C.A. .. .. .	146	148	214	144	150
3. Intensity .. .. .	148%	148%	135%	148%	..
4. Irrigated area (Annual) .. .. .	5,63,000	1,05,000	1,23,000	11,37,000	19,28,000
5. Cost per acre of irrigated area .. .. .	98	100	158	98	103

Unit No. III—Power  
(a) Civil Works

[ AMOUNT IN LAKHS OF RUPEES. ]

Sub-head	Power Channel	Subsidiary Dam	Total
A—Preliminary .. .. .	0.50	0.20	0.70
B—Land .. .. .	36.54	43.32	79.86
C—Works .. .. .	73.75	503.34*	577.09
G—Bridges .. .. .	21.69	..	21.69
H—Escapes .. .. .	4.00	..	4.00
K—Buildings .. .. .	0.20	17.75	17.95
L—Earth Work .. .. .	133.44	..	133.44
L <sub>1</sub> —Service and boundary roads .. .. .	0.88	..	0.88
M—Plantation .. .. .	0.06	..	0.06
O—Miscellaneous .. .. .	1.00	0.70	1.70
R—Communications .. .. .	0.25	21.78	22.03
<b>TOTAL</b> .. .. .	<b>272.31</b>	<b>587.09</b>	<b>859.40</b>
P—Maintenance at 1% of above excluding B—Land .. .. .	2.36	5.44	7.80
<b>TOTAL</b> .. .. .	<b>274.67</b>	<b>592.53</b>	<b>867.20</b>
7. Losses on stock .. .. .	0.25	0.25	0.50
Unforeseen .. .. .	1.00	1.50	2.50
<b>Total, I—Works</b> .. .. .	<b>275.92</b>	<b>594.28</b>	<b>870.20</b>
II—Establishment at 6% of I—Works .. .. .	16.55	35.66	52.21
III—Tools & Plant at 1% of I—Works .. .. .	2.76	5.94	8.70
<b>Total—Direct Charges</b> .. .. .	<b>295.23</b>	<b>635.88</b>	<b>931.11</b>
<b>INDIRECT CHARGES</b>			
VI (a) Capitalization of abatement of land revenue at 1% of B—Land .. .. .	0.37	0.43	0.80
(b) Audit Charges .. .. .	0.19	0.38	0.57
<b>Total—Indirect Charges</b> .. .. .	<b>0.56</b>	<b>0.81</b>	<b>1.37</b>
<b>Total—Direct and Indirect Charges</b> .. .. .	<b>295.79</b>	<b>636.69</b>	<b>932.48</b>

\* This includes cost of Rs. 20,364,000 for Power House No. 1 at Main Dam.

## UNIT NO. 3—HYDRO-ELECTRIC INSTALLATION

## P—Production (Electrical Works)

## General Abstract

[AMOUNT IN LAKHS OF RUPEES.]

Sub-Heads	POWER HOUSE No. I		POWER HOUSE No. II	Total
	Stage I	Stage II		
<b>I. Works</b>				
(3) Telephone Power & Light system .. ..	13.00	..	4.00	17.00
(4) Buildings .. ..	..	..	1.50	1.50
(5) Power House Equipment .. ..	452.24	..	303.15	755.39
(6) Step-up Sub-Station Equipment .. ..	100.72	15.45	45.06	161.23
(12) Losses on stock .. ..	1.38	0.04	0.87	2.29
(13) Maintenance during construction .. ..	5.53	0.15	3.48	9.16
(14) Miscellaneous .. ..	41.46	0.70	26.11	68.27
<b>Total</b> .. ..	<b>614.33</b>	<b>16.34</b>	<b>384.17</b>	<b>1014.84</b>
5% Contingencies .. ..	30.73	0.82	19.20	50.75
<b>Total for I—Works</b> .. ..	<b>645.06</b>	<b>17.16</b>	<b>403.37</b>	<b>1065.59</b>
<b>II. Establishment</b> .. ..	<b>33.70</b>	<b>1.03</b>	<b>24.20</b>	<b>63.93</b>
<b>III. Tools and Plants</b> .. ..	<b>6.45</b>	<b>0.17</b>	<b>4.03</b>	<b>10.65</b>
<b>IV. Suspense</b> .. ..	<b>..</b>	<b>..</b>	<b>..</b>	<b>..</b>
<b>V. Receipts &amp; Recoveries on Capital Account</b> .. ..	<b>(—)0.50</b>	<b>..</b>	<b>(—)0.40</b>	<b>(—)0.90</b>
<b>VI. Indirect Charges</b> .. ..	<b>0.60</b>	<b>0.10</b>	<b>0.24</b>	<b>1.94</b>
<b>Total</b> .. ..	<b>690.31</b>	<b>18.46</b>	<b>431.44</b>	<b>1140.21</b> Say, Rs. 1140 lakhs.



## UNIT NO. 3—HYDRO-ELECTRIC INSTALLATION

## T—Transmission

## General Abstract

[AMOUNT IN LAKHS OF RUPEES]

Sub-Heads	Stage I	Stage II	Total
<b>I. Works</b>			
(1) Preliminary .. .. .	6.96	9.06	16.02
(2) Land .. .. .	1.00	1.21	2.21
(3) Telephone System .. .. .	22.30	32.80	55.10
(4) Buildings .. .. .	3.060	29.30	59.90
(6) Grid Sub-Station equipment .. .. .	163.47	175.34	338.81
(7) Trunk or Branch Lines 132 kV or over .. .. .	116.58	325.90	442.48
(8) Trunk or branch lines 66 kV .. .. .	112.12	136.72	248.84
(12) Losses on Stock .. .. .	3.33	5.82	9.15
(13) Maintenance during construction .. .. .	4.52	7.10	11.62
(14) Miscellaneous .. .. .	30.44	51.76	82.20
Total .. .. .	491.32	775.01	1266.33
Contingencies @ 5% .. .. .	24.57	38.75	63.32
<b>Total for I—Works .. .. .</b>	<b>515.89</b>	<b>813.76</b>	<b>1329.65</b>
<b>II. Establishment .. .. .</b>	<b>30.95</b>	<b>48.82</b>	<b>79.77</b>
<b>III. Tools and Plant .. .. .</b>	<b>5.16</b>	<b>8.14</b>	<b>13.30</b>
<b>IV. Suspense .. .. .</b>	<b>..</b>	<b>..</b>	<b>..</b>
<b>V. Receipts &amp; Recoveries on Capital Account .. .. .</b>	<b>(—)1.29</b>	<b>(—)2.04</b>	<b>(—)3.33</b>
<b>VI. Indirect Charges .. .. .</b>	<b>0.50</b>	<b>0.67</b>	<b>1.17</b>
<b>Lump sum Provision for Transmission Lines .. .. .</b>	<b>..</b>	<b>133.00</b>	<b>133.00</b>
<b>Total .. .. .</b>	<b>551.21</b>	<b>1002.35</b>	<b>1553.56</b> Say, Rs. 15.54 crores.

## APPENDIX IV (i)

### NOTES ON THE DISPOSAL OF FLOODS AND SUGGESTIONS FOR ALTERNATIVE ARRANGEMENT FOR IRRIGATION IN THE DELTA AREA.

#### DISPOSAL OF FLOODS IN THE DELTA AREA

1. In Section II, under the heading "Irrigation in the Delta Areas", the Committee has expressed an opinion that the Kaukhai system of the delta area which was proposed to be closed according to the revised project, should not be closed, for the reasons stated there. It is further stated there, that the detailed suggestions regarding the disposal of floods in the delta area are given in a separate note in Appendix IV. The following are only tentative suggestions subject to corrections after detailed investigation.

2. It is ascertained from the records that the peak discharge of the Mahanadi at Naraj can be of the order of 15 lakh cusecs, when the Naraj gauge is somewhere near R. L. 91.70. It causes widespread flooding due to spills from the various channels in the delta.

3. It has been found from experience that so long as the Naraj gauge does not go above R. L. 89.0, there is no serious damage due to flooding. The construction of the Hirakud Dam ensures that the peak flood can be reduced by 3 lakh cusecs, and the flood at Naraj can always be kept below R. L. 89, and under 12 lakh cusecs, by using the flood detention capacity at Hirakud.

4. Thus due to the construction of the Hirakud Dam, flood relief in the delta area to the extent of three lakh cusecs will be obtained. The question now, is as to how the relief should be distributed between the various channels in the delta.

5. This question was discussed with the Chief Engineer, Orissa, Mr. Shaw, who from his local knowledge, recommended that this relief should be roughly distributed as follows :

	Lakh cusecs
Mahanadi .. .. .	0.75
Katjuri .. .. .	0.75
Kuakhai .. .. .	1.50
Total .. .. .	3.00

As regards the branches of Kuakhai, he is of the opinion that if the escapes on these branches can be closed, and only restricted discharges are admitted in them, danger of damage due to floods will mostly be removed.

6. The main escapes are as follows :

	Discharge in lakh cusecs in a 15 lakh flood
(a) Kushabhadra :	
Jogisahi .. .. .	0.31
Ramo Kandrapur .. .. .	0.08
(b) Bhargavi :	
Achutpur .. .. .	0.19
(c) Daya :	
Belmora .. .. .	0.15
Madhipur .. .. .	0.08
Kanti .. .. .	0.34

Thus, if the floods in Kushabhadra, Bhargavi and Daya are reduced by these arrangements, the damage due to floods will stop.

7. Herewith is attached a schematic blue print plan of the channels in the Mahanadi delta, the figures given in white represent the disposal of a 14.54 lakh cusecs flood, which occurred in 1940, through the various channels in the delta. These figures were worked out by the Orissa P.W.D. by discharge observations by current meter from the railway bridges. So they can be taken as fairly reliable.

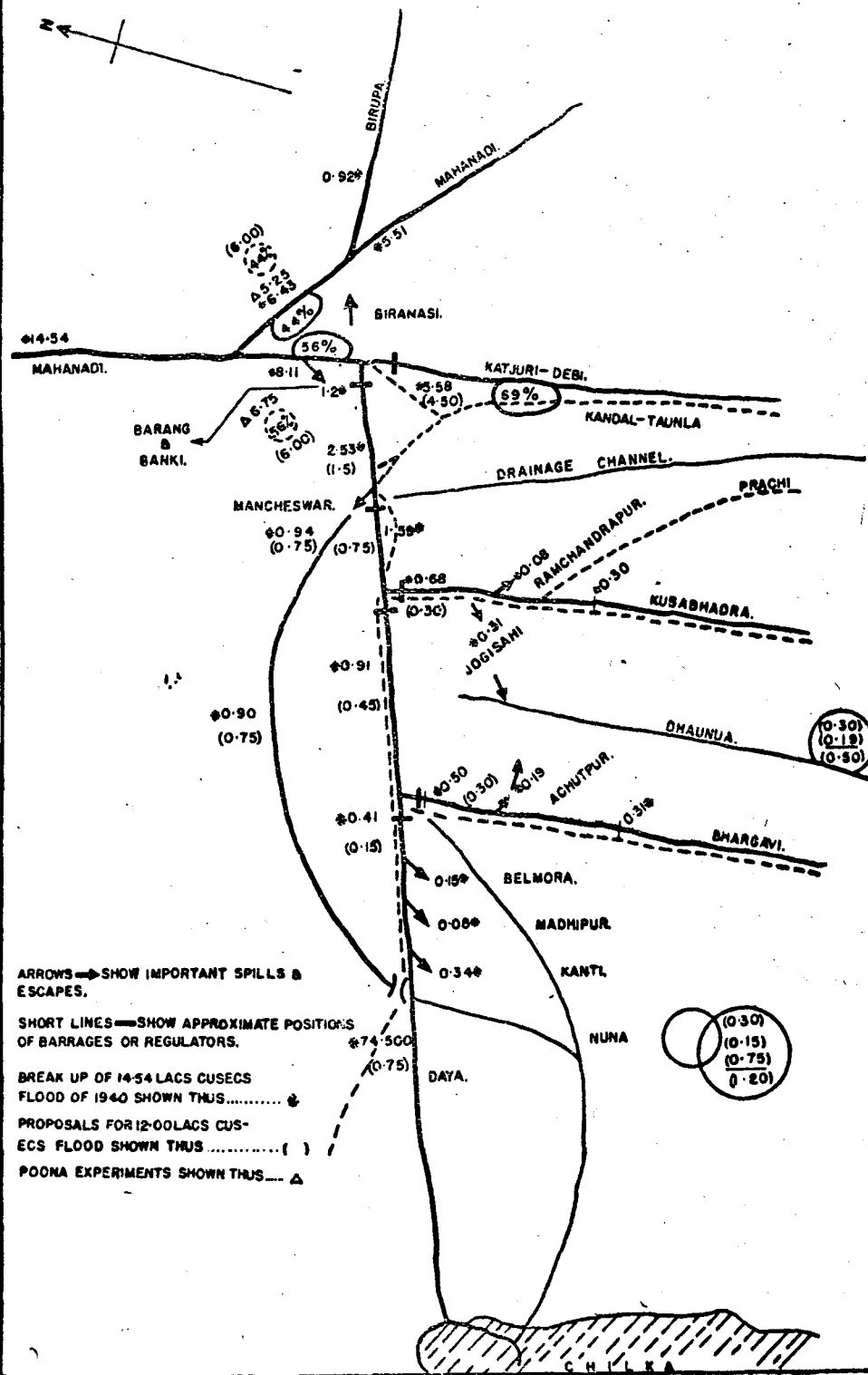
These figures show that at high flood of 14.54 lakh cusecs, Mahanadi takes 44% and Katjuri 56%. The Poona Experimental Station found that at 12 lakh cusecs flood also the distribution will be of the same order. These figures are shown in red, in the plan.

8. The figures in yellow represent the discharges which should be pushed in each channel, with a 12 lakh cusecs flood. Regulation of these discharges to the figures proposed now, is to be done with the help of the barrages which are proposed now, and which are shown roughly on the plan. It will be seen that the distribution of relief, contemplated in paragraph 5 above is roughly achieved with this arrangement.

- (a) Thus Mahanadi which gets 6.75 lakh cusecs in a 15 lakh flood, will get 6 lakhs in a 12 lakh cusecs flood ; so it gets a relief of 0.75 lakh cusecs.
- (b) Katjuri gets 5.50 lakh cusecs in a 15 lakh cusecs flood. It will get according to these proposals 4.50 lakh cusecs. Thus it gets relief of nearly 1 lakh cusecs.

# MAHANADI DELTA

## SCHEMATIC PLAN SHOWING DISPOSAL OF 12 LACS CUSECS FLOOD IN VARIOUS BRANCHES.



## APPENDIX

In a 12 lakh cusecs flood Katjuri will draw 6.75 lac cusecs, unless modifications are done to Naraj weir. As we want to restrict discharge of Katjuri at head to 6.0 lakh cusecs, modifications to Naraj weir will have to be made, though Biransai spill may pass some discharge from Katjuri to Mahanadi. The details will have to be rested on model experiments.

- (c) Kushabhadra's share in a 15 lakh cusec flood is 0.68 lac cusecs. It will be controlled now to 0.30 lakh cusecs and thus gets a relief of 0.38 lac cusecs.
- (d) Bhargavi discharge will be controlled to 0.30 lakh cusecs, against 0.50 lac cusecs, its share in a 15 lakh flood. Thus it gets a relief of 0.20 lakh cusecs.
- (e) Mancheswar spill channel is an important channel, and should be maintained in an efficient condition. It takes about 0.95 lakh cusecs in a 15 lakh flood. Its discharge will be controlled now to 0.75 lakh cusecs.

As a matter of fact it will be the principal channel, carrying nearly 50% of the Kua-khai discharge, and should be maintained in efficient condition.

It will be seen from the figures given above that Kushabhadra and Bhargavi get relief to the extent of the combined discharges of their escapes. On Daya, Madhipur and Kanti escapes can probably be closed. The 0.75 lakh cusecs carried in Mancheswar spill, will have to be carried by Daya to the Chilka lake. This will help in keeping waters of the Chilka lake sufficiently fresh.

9. Silt-laden waters enrich the lands, and cultivators like their fields to be flooded by silt-laden water as long as the flooding is not excessive. It will be a beneficial thing if the floods in Kushabhadra and Bhargavi are left through escapes, whose positions are marked by blue circles on the 5 ft. contour map of the delta, attached with the note on "Alternative Arrangement of Irrigation in the Delta" in this appendix.

APPENDIX IV (ii)

**SUGGESTIONS FOR ALTERNATIVE ARRANGEMENT FOR IRRIGATION IN THE DELTA AREA**

1. In the revised Hirakud Dam Project the area in the delta to the south of Katjuri is proposed to be irrigated by means of a canal taking off the existing Taldanda canal in its second mile, crossing Katjuri below offtake of Kuakhai, then going parallel to Kuakhai up to off take of Bhargavi crossing Kushabhadra on the way. In the revised project Kuakhai is proposed to be closed and the canal is to cross Katjuri by means of a siphon.

2. The Committee has expressed its definite opinion in Section II, that Kuakhai system should not be closed. It has also recommended that the proposed canal should cross the various streams of the Kuakhai system by means of barrages and regulators i.e., by level crossings. As the crossings of the canal across these streams are near their offtakes from Kuakhai, regulators will be required across Kuakhai also at all these points, as the bed of Kuakhai is lower than the canal F. S.

3. It will be seen from paragraph 8 (e) of the note on Disposal of Floods in the Delta Area given in this appendix, that under the new proposals, the Mancheswar spill channel of the Kuakhai system will be the principal channel of that system and will carry half the discharge of Kuakhai direct to Daya, and through it to the Chilka lake, the other half will be distributed in Kushabhadra and Bhargavi and Belmore spill.

4. With the main canal as proposed in the revised project, and with the proposal to keep open all the channels of the Kuakhai system, branches of the main canal will have to be constructed on both sides of Kushabhadra and Bhargavi to irrigate lands satisfactorily on both sides of them, as both these streams are flowing on ridges built up by themselves. So also Prachi is flowing on a mature ridge, and two branches will have to be constructed on two sides of it, if Prachi is to be kept open.

5. As is well known, the active channels in a delta go on raising their courses till they flow practically on the ridges built by themselves, leaving hollow places between them. When the channel beds rise very high, the channels suddenly avalanche into these low drainage channels, through some spills. The new courses similarly rise in time and the river avalanches again. Through this process the delta is slowly built up.

6. It will be seen from the 5' contour map of the delta attached herewith, that Kuakhai and Daya up to Madhipur spill, Kushabhadra, Bhargavi, Prachi, and even Kandal-Taunda, are flowing on defined ridges. Daya below Madhipur spill runs

off sidelong ground. If things are left to themselves, it is evident that Kushabhadra would avalanche into Dhaunua, which is the low drainage channel between Kushabhadra and Bhargavi, and Bhargavi would avalanche into Nuan, which is the low drainage channel between Bhargavi and Daya.

7. Even with controlled floods, beds of Kushabhadra and Bhargavi will go on rising, making upkeep of flood embankments more and more difficult. Also maintaining these two channels as flood channels necessitates construction of canals on both sides of them for major irrigation of lands in the delta.

8. It is suggested that a better arrangement would be to anticipate nature, and to divert Bhargavi into Nuan Nadi and Kushabhadra into Dhaunua stream.

9. Even now, during 15 lakh cusecs flood, Nuan Nadi gets spills as follows :

	Lakh Cusecs
Balmora spill	0.15
Madhipur	0.08
Kanti	0.34
	0.57







Now if Bhargavi and Daya are diverted into Nuan Nadi it will get only 0.45 lakh cusecs ; which will not cause more flooding than it is used to.

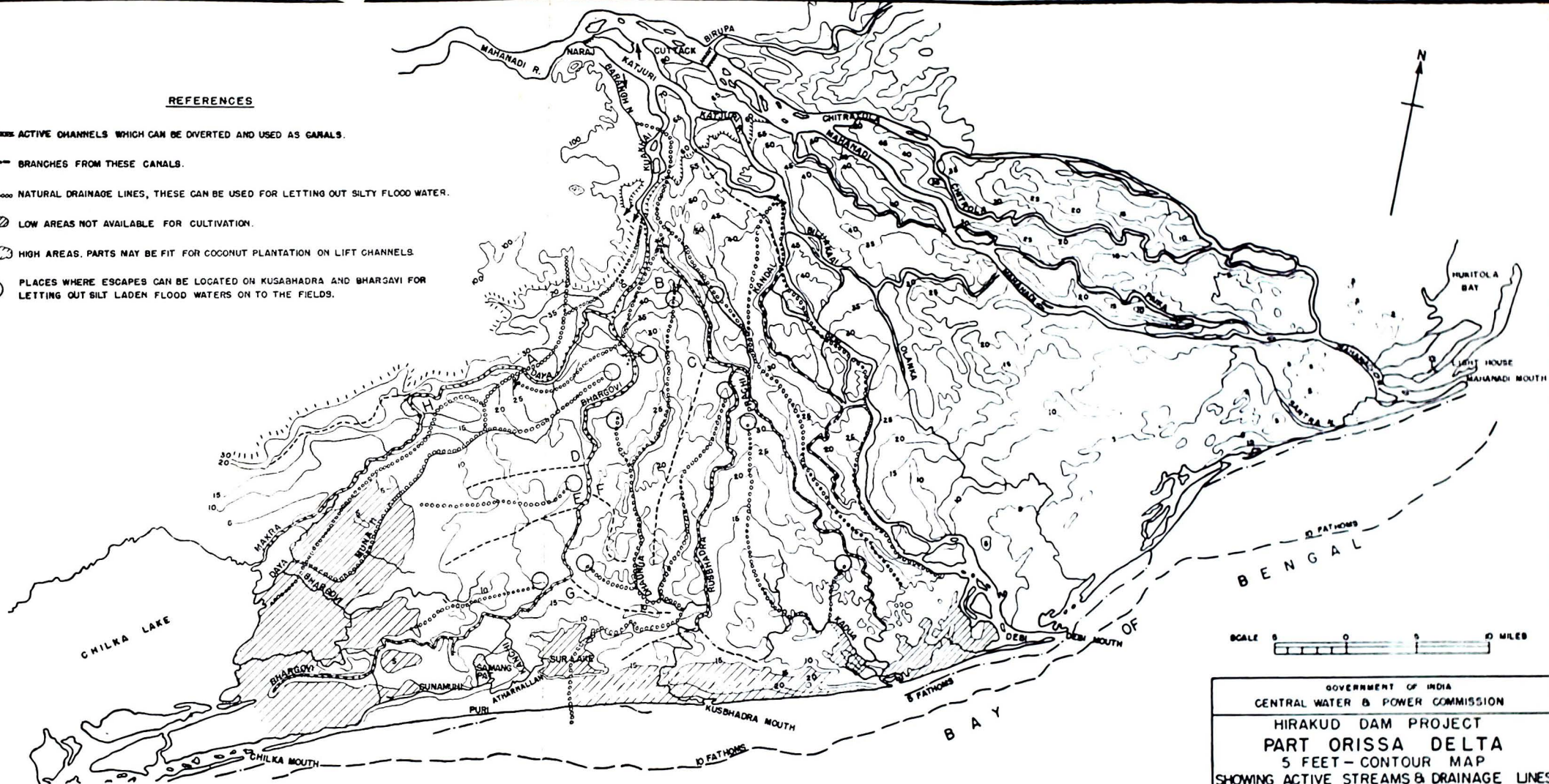
10. Daya from the point where the Mancheswar spill meets it again (point A on 5' contour map) is a contour channel and will be difficult to maintain. Point A is the point of the Kanti spill. So the Mancheswar spill of 0.75 lakh cusecs also should be let into Nuan Nadi through the Kanti spill. This is not likely to cause harmful flooding as all that water will ultimately find its way to the Chilka lake.

11. Similarly Kushabhadra with its controlled flood of 0.30 lakh cusecs may be diverted in Dhaunua channel. This channel gets at present spill of 0.31 lakh cusecs through Jogisahi escape and of 0.19 lakh cusecs through the Achutpur escape. So really 0.50 lakh cusecs can be put in to this drainage channel without causing more flooding than it is used to. If 0.50 lakh cusecs are put in this channel it will reduce the load on Nuan to the extent of 0.20 lakh cusecs.

12. If these suggestions are adopted, then the channels of Kushabhadra and Bhargavi can be used as canals. Only regulators will have to be put across them at intervals. Soon these channels will silt up their sections to suit the canal discharges. In Sind many such old courses of the river were used as canals and ultimately silted up to canal sections.

REFERENCES

-  ACTIVE CHANNELS WHICH CAN BE DIVERTED AND USED AS CANALS.
-  BRANCHES FROM THESE CANALS.
-  NATURAL DRAINAGE LINES, THESE CAN BE USED FOR LETTING OUT SILTY FLOOD WATER.
-  LOW AREAS NOT AVAILABLE FOR CULTIVATION.
-  HIGH AREAS. PARTS MAY BE FIT FOR COCONUT PLANTATION ON LIFT CHANNELS.
-  PLACES WHERE ESCAPES CAN BE LOCATED ON KUSABHADRA AND BHARSANI FOR LETTING OUT SILT LADEN FLOOD WATERS ON TO THE FIELDS.



GOVERNMENT OF INDIA CENTRAL WATER & POWER COMMISSION		
HIRAKUD DAM PROJECT PART ORISSA DELTA 5 FEET-CONTOUR MAP SHOWING ACTIVE STREAMS & DRAINAGE LINES		
CHIEF ENGINEER & MEMBER DESIGNS		
	HIRAKUD MARCH, 1952	

13. Prachi can be used as a branch off Kushabhadra. Another branch can be thrown from Kushabhadra from point.

14. Similarly branches can be thrown from Bhargavi at points D, E, F, and G.

15. Daya also can be used as an irrigation channel. A branch off it can be thrown at point H, to irrigate lands to the south-west of it.

16. Even it may be possible, to use Kandal-Taunla as an irrigation channel and to irrigate lands up to Debi river. Of course flood embankments will have to be thrown on the right bank of Debi.

17. The drainage channels Nuan Nadi and Dhaunua being low, will give a long service and it is

considered that if irrigation is arranged as suggested in this note, it will be an efficient system. Also there may be considerable savings in canal costs.

So these suggestions may be considered before the final plans for irrigation in the delta are drawn up.

18. In the accompanying contour plan, the low areas below contour 5 are hatched yellow, and probably will not be available for irrigation.

Similarly areas hatched red along the coast at the tail of Kushabhadra are high and may not be properly commanded.

Cocoonut plantations on lift channels in this area may be a possibility.



APPENDIX V

Statement showing Financial Returns from Irrigation and Power Combined

Year	Sum at charge at end of the year (Irrigation)	Sum at charge at end of the year (Power)	Sum at charge at end of the year (Irrigation and Power— Col. 2+3)	NET REVENUE DURING THE YEAR			Percent- age Return on sum at Charge Col.7×100	Remarks
				Irrigation	Power	Total Irrigation & Power		
				1	2	3	4	
1948-49	37,80,000	12,46,300	50,26,000	..	..	..	..	
49-50	2,79,24,000	90,03,000	3,69,27,000	..	..	..	..	
50-51	6,32,95,000	2,27,60,000	8,60,55,000	..	..	..	..	
51-52	12,58,04,000	5,02,36,000	17,60,40,000	..	..	..	..	
52-53	20,72,93,000	9,25,65,000	29,98,58,000	..	..	..	..	
53-54	29,99,92,000	14,15,22,000	44,15,14,000	..	..	..	..	
54-55	39,59,25,000	19,53,19,000	59,12,44,000	..	..	..	..	
55-56	45,02,71,000	23,15,69,000	68,18,40,000	11,18,000	(--17,85,000)	(--6,67,000)	..	
56-57	50,18,79,000	24,40,45,000	74,59,24,000	42,76,000	18,28,000	61,04,000	0.82	
57-58	54,20,33,000	25,31,04,000	79,51,37,000	70,42,000	24,32,000*	94,74,000	1.19	
58-59	55,28,12,000	26,00,75,000	81,28,87,000	1,04,44,000	31,97,000	1,36,41,000	1.68	
59-60	55,14,54,000	26,67,65,000	81,82,19,000	1,44,56,000	39,95,000	1,84,51,000	2.25	
60-61	54,63,57,000	28,60,44,000	83,24,01,000	1,65,22,000	54,64,000	2,19,86,000	2.64	
61-62	53,69,18,000	32,26,02,000	85,95,20,000	1,81,19,000	65,55,000	2,46,74,000	2.87	
62-63	52,37,68,000	36,46,54,000	88,84,22,000	1,94,77,000	72,71,000	2,67,48,000	3.01	
63-64	50,76,25,000	41,65,93,000	92,42,18,000	2,07,01,000	97,28,000	2,86,29,000	3.10	
64-65	48,89,46,000	46,05,17,000	94,94,63,000	2,17,64,000	86,29,000	3,03,93,000	3.20	
65-66	46,88,78,000	48,31,69,000	95,20,47,000	2,17,64,000	1,09,09,000	3,26,73,000	3.43	
66-67	44,74,20,000	49,85,26,000	94,59,46,000	2,17,64,000	1,21,28,000	3,38,92,000	3.58	
67-68	42,45,77,000	51,02,94,000	93,48,71,000	2,17,64,000	1,36,84,000	3,54,48,000	3.70	
68-69	40,11,51,000	51,90,72,000	92,02,23,000	2,17,64,000	1,52,29,000	3,69,93,000	4.02	
69-70	37,71,42,000	52,19,01,000	89,90,43,000	2,17,64,000	1,68,42,000	3,86,06,000	4.2	
70-71	35,25,50,000	51,99,60,000	87,25,10,000	2,17,64,000	1,86,33,000	4,03,97,000	4.03	
71-72	32,73,74,000	51,49,83,000	84,23,57,000	2,17,64,000	2,14,48,000	4,32,12,000	5.03	
72-73	30,16,15,000	51,00,06,000	81,16,21,000	2,17,64,000	2,14,48,000	4,32,12,000	5.32	
73-74	27,82,90,000	50,50,29,000	78,33,19,000	2,17,64,000	2,14,48,000	4,32,12,000	5.52	
74-75	25,62,64,000	50,00,52,000	75,63,16,000	2,17,64,000	2,14,48,000	4,32,12,000	5.70	
75-76	23,53,26,000	49,50,75,000	73,04,01,000	2,17,64,000	2,14,48,000	4,32,12,000	5.92	
76-77	21,65,50,000	49,00,98,000	70,66,48,000	2,17,64,000	2,14,48,000	4,32,12,000	6.12	
77-78	19,95,45,000	48,51,21,000	68,46,66,000	2,17,64,000	2,14,48,000	4,32,12,000	6.31	
78-79	18,37,26,000	48,01,44,000	66,38,70,000	2,17,64,000	2,14,48,000	4,32,12,000	6.21	
97-80	16,87,97,000	47,51,67,000	64,39,64,000	2,17,64,000	2,14,48,000	4,32,12,000	6.21	
80-81	15,46,72,000	47,01,90,000	62,48,62,000	2,17,64,000	2,14,48,000	4,32,12,000	6.92	
81-82	14,13,55,000	46,52,13,000	60,65,68,000	2,17,64,000	2,14,48,000	4,32,12,000	7.12	
82-83	12,88,40,000	46,02,36,000	58,90,76,000	2,17,64,000	2,14,48,000	4,32,12,000	7.34	
83-84	11,63,25,000	45,52,59,000	57,15,84,000	2,17,64,000	2,14,48,000	4,32,12,000	7.56	
84-85	10,38,10,000	45,02,82,000	55,40,92,000	2,17,64,000	2,14,48,000	4,32,12,000	7.80	



*Estimate of Percentage Return (Power)*

Year	Total cumulative capital outlay to end of the year	Simple interest on Direct outlay from Table XV	Cumulative interest to end of the year	Net Revenue during the year	Cumulative Revenue to end of year	Sum at charge to end of year (2) + (4) - (6)	Percentage return on sum at charge
1	2	3	4	5	6	7	8
1948-49	12.23	0.229	0.229	..	..	12.459	..
1949-50	87.92	1.877	2.106	..	..	90.026	-
1950-51	219.73	5.766	7.872	..	..	227.602	..
1951-52	481.35	13.133	21.005	..	..	502.355	..
1952-53	879.18	25.467	46.472	..	..	925.652	..
1953-54	1327.44	41.311	87.783	..	..	1415.223	..
1954-55	1806.74	58.671	146.454	..	..	1953.194	..
1955-56	2078.65	72.735	219.189	(-)17.85	(-)17.85	2315.689	..
1956-57	2142.66	79.026	298.215	18.28	00.43	2440.445	0.75
1957-58	2176.71	80.861	379.076	24.32	24.75	2531.036	0.96
1958-59	2196.71	81.639	460.715	31.97	56.72	2600.745	1.23
1959-60	2217.71	85.892	546.607	39.95	96.67	2667.647	1.50
1960-61	2370.33	94.809	641.416	54.64	151.31	2860.436	1.92
1961-62	2693.67	107.793	749.209	65.55	216.86	3226.019	2.02
1962-63	3063.57	123.334	872.543	72.71	289.57	3646.543	2.00
1963-64	3523.25	138.987	1011.530	79.28	368.85	4165.930	1.89
1964-65	3899.36	149.417	1160.947	86.29	455.14	4605.167	1.87
1965-66	4080.10	154.876	1315.823	109.09	564.23	4831.693	2.26
1966-67	4196.06	158.890	1474.713	121.28	685.51	4985.263	2.43
1967-68	4288.54	162.036	1636.749	136.84	822.35	5102.939	2.69
1968-69	4364.54	164.070	1800.819	152.29	974.64	5190.719	2.93
1969-70	4396.54	164.711	1965.530	168.42	1143.06	5219.010	3.22
1970-71	4398.75	164.711	2130.241	186.33	1329.39	5199.601	3.57
1971-72	4398.75	164.711	2294.952	214.48	1543.87	5149.832	4.17
1972-73	4398.75	164.711	2459.663	214.48	1758.35	5100.063	4.2
1973-74	4398.75	164.711	2624.374	214.48	1972.83	5050.294	4.26

NOTE—(a) Column (5) is same as Column (7) of Table XIV.

(b) Column (8) is percentage of Column (5) on Column (7).

## APPENDIX V

Statement showing Financial Returns from Irrigation  
(With Betterment Levy)

Year	Net cumulative Capital outlay Direct & Indirect to end of the year	Annual Receipts from Betterment levy	Simple Interest @ 3-75% on Direct outlay	Simple interest @ 3-5 % on Receipts from Betterment levy	Net Simple Interest dur- ing the year (Col. 4-5)	Cumulative Simple Interest to end of the year	Net Revenue during the year	Cumulative net Revenue to end of the year	Net sum at charge at end of the year. (Col. 2+7-9)	Percent- age Return Col. 8x100 Col. 10
1	2	3	4	5	6	7	8	9	10	11
1948-49	37,10,000	..	70,000	..	70,000	70,000	..	..	37,80,000	..
49-50	2,72,74,000	..	5,80,000	..	5,80,000	6,50,000	..	..	2,78,24,000	..
50-51	6,09,92,000	..	16,53,000	..	16,53,000	23,03,000	..	..	6,32,95,000	..
51-52	12,01,10,000	..	33,91,000	..	33,91,000	56,94,000	..	..	12,58,04,000	..
52-53	10,50,88,000	..	59,11,000	..	59,11,000	1,16,05,000	..	..	20,72,93,000	..
53-54	27,04,06,000	..	88,01,000	..	88,91,000	2,04,96,000	..	..	29,99,92,000	..
54-55	30,34,02,000	..	1,20,27,000	..	1,20,27,000	3,25,23,000	..	..	39,59,25,000	..
55-56	40,45,00,000	..	1,43,66,000	..	1,43,66,000	4,68,89,000	11,18,000	11,18,000	45,02,71,000	0-25
56-57	44,45,00,000	..	1,58,84,000	..	1,58,84,000	6,27,73,000	42,76,000	53,94,000	50,18,79,000	0-83
57-58	47,45,00,000	..	1,71,96,000	..	1,71,96,000	7,99,69,000	70,42,000	1,24,36,000	54,20,33,000	1-30
58-59	47,78,98,000	29,04,000	1,78,77,000	52,000	1,78,25,000	9,77,94,000	1,04,44,000	2,28,80,000	55,28,12,000	1-89
59-60	47,31,03,000	47,05,000	1,78,85,000	82,000	1,78,03,000	11,55,97,000	1,44,56,000	3,73,36,000	55,14,54,000	2-60
60-61	46,70,18,000	61,75,000	1,77,08,000	1,08,000	1,76,00,000	13,31,97,000	1,65,22,000	5,38,58,000	54,63,57,000	3-02
61-62	45,83,73,000	86,45,000	1,74,77,000	1,52,000	1,73,25,000	15,05,22,000	1,81,10,000	7,19,77,000	53,69,18,000	3-37
62-63	44,77,33,000	1,06,40,000	1,71,53,000	1,86,000	1,69,67,000	16,74,89,000	1,94,77,000	9,14,54,000	52,37,68,000	3-72
63-64	43,57,47,000	1,19,66,000	1,67,64,000	2,10,000	1,65,54,000	18,40,33,000	2,07,01,000	11,21,55,000	50,76,25,000	4-06
64-65	42,27,55,000	1,29,92,000	1,63,04,000	2,27,000	1,60,77,000	20,01,10,000	2,17,64,000	13,39,19,000	48,89,46,000	4-45
65-66	40,88,77,000	1,38,78,000	1,58,17,000	2,43,000	1,55,74,000	21,56,84,000	2,17,64,000	15,56,83,000	46,88,78,000	4-64
66-67	39,41,44,000	1,47,33,000	1,52,97,000	2,58,000	1,50,39,000	23,07,23,000	2,17,64,000	17,74,47,000	44,74,20,000	4-86
67-68	37,85,93,000	1,55,51,000	1,47,44,000	2,72,000	1,44,72,000	24,31,95,000	2,17,64,000	19,92,11,000	42,45,77,000	5-12
68-69	36,30,42,000	1,55,51,000	1,41,61,000	2,72,000	1,38,89,000	25,90,84,000	2,17,64,000	22,09,75,000	40,11,51,000	5-42
69-70	34,74,91,000	1,55,51,000	1,35,78,000	2,72,000	1,33,06,000	27,23,90,000	2,17,64,000	24,27,39,000	37,71,42,000	5-78
70-71	33,19,40,000	1,55,51,000	1,29,95,000	2,72,000	1,27,23,000	28,51,13,000	2,17,64,000	26,45,03,000	35,25,50,000	6-17
71-72	31,63,89,000	1,55,51,000	1,24,11,000	2,72,000	1,21,39,000	29,72,52,000	2,17,64,000	28,62,67,000	32,73,74,000	6-65
72-73	30,08,38,000	1,55,51,000	1,18,28,000	2,72,000	1,15,56,000	30,88,08,000	2,17,64,000	30,80,31,000	30,16,15,000	7-22
73-74	28,52,82,000	1,25,86,000	1,12,45,000	2,20,000	1,10,25,000	31,98,33,000	2,17,64,000	32,97,95,000	27,82,90,000	7-82
74-75	27,74,07,000	1,08,45,000	1,07,73,000	1,90,000	1,05,83,000	33,04,16,000	2,17,64,000	35,15,59,000	25,62,64,000	8-49
75-76	26,80,31,000	93,76,000	1,03,60,000	1,64,000	1,02,02,000	34,06,18,000	2,17,64,000	37,33,23,000	23,53,26,000	9-25
76-77	26,11,23,000	69,06,000	1,00,15,000	1,21,000	98,94,000	35,05,12,000	2,17,64,000	39,50,87,000	21,65,50,000	10-05
77-78	25,62,14,000	49,11,000	97,50,000	86,000	96,70,000	36,01,82,000	2,17,64,000	41,68,51,000	19,95,45,000	10-91
78-79	25,20,48,000	35,65,000	95,73,000	62,000	95,10,000	36,96,92,000	2,17,64,000	43,86,15,000	18,37,26,000	11-84
79-80	25,00,91,000	25,58,000	94,33,000	45,000	93,93,000	37,90,85,000	2,17,64,000	46,02,79,000	16,87,97,000	12-89
80-81	24,84,17,000	19,74,000	93,42,000	29,000	93,13,000	38,83,98,000	2,17,64,000	48,21,43,000	15,46,72,000	14-07
81-82	24,75,00,000	8,18,000	92,79,000	14,000	92,65,000	39,76,63,000	2,17,64,000	50,39,07,000	14,13,55,000	15-39
82-83	24,75,00,000	..	92,49,000	..	92,49,000	40,69,12,000	2,17,64,000	52,56,71,000	12,88,40,000	16-90
83-84	24,75,00,000	..	92,49,000	..	92,49,000	41,61,61,000	2,17,64,000	54,74,35,000	11,63,25,000	18-71
84-85	24,75,00,000	..	92,49,000	..	92,49,000	42,54,10,000	2,17,64,000	56,91,99,000	10,38,10,000	20-87