NOTE MP-6

BABADAN SCHEME

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOTE MP-6 BABADAN SCHEME

1. Objectives of Scheme

The objectives of the scheme are envisaged as follows;

- Flood control
- Water supply
- Hydropower generation

2. Natural Condition

Location and Topography

The site is selected on Bendokrosok river, 8 km west from the Kediri city. In the left bank there is Mt. Panji of 518 m high. The right bank side is a range of low hill of about 200 m high. At the damsite, a wide valley of about 600 m in width is developed. The catchment area within Bendokrosok river is as small as 19.9 km^2.

Hydrology

The hydrological conditions in Bendokrosok river in the north-eastern mountain side of Mt. Limas are assumed as similar to those in Kuncir river.

The monthly discharge is as follows;

Unit m^3/sec

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
2.3	3.4	3.2	2.8	1.5	0.6	0.3	0.2	0.2	0.4	0.6	2.2

Ten-day runoff is as shown in Table 1.
The specific probable floods are calculated from those of the Kuncir damsite as follows;

Probability	Specific Flood Discharge
One in 2 years	m^3/sec km^2
10	
25	6.3
100	8.1
200	9.1
1,000	11.2
10,000	14.2

Geological Conditions

There is no geological data at this moment. Additional boring investigation is proposed.

According to the reconnaisance survey, the andesite outcrops are

observed in the surface of Mt. Panji. The left bank seems to be composed of the volcanic breccia. The river deposit in the riverbed seems not to be so thick.

3. possible Development

Transbasin Plan

In the 1973 Master Plan, a transbasin plan was envisaged for hydropower development in the north-eastern mountain side of Mt. Limas. Same approach is taken in this study but for the peak cut of floods and storing of water in the Babadan reservoir. From the topographic conditions shown on the 1 to 50,000 scale maps, the following rivers seems to be able to be connected with tunnels as shown in Fig. 1.

River Name	Catchment Area (km^2)	Tunnel length (m)
Left Side		
K. Bambon	13.2	2600
K. Cerme	14.6	1600
K. Sawur	6.5	1000
K. Lome	18.7	5200
K. Putih	3.1	200
K. Tanung	20.3	1800
K. Mundeng	16.6	2800
Sub-total	93.0	15,200
Right Side		
K. Gangsang	30.9	1800
K. Bruno	26.1	2000
K. Cekong	8.4	4000
K. Blimbing	8.6	2400
K. Bruni	15.8	400
Sub-total	89.8	10,600
Total	182.8	25,800

The economic viability of the transbasin plan is examined.

Storage plan

According to the 1 to 50,000 scale topogaphic map, the storage capacity of the Babadan reservoir is estimated at about 100 x 10^6 m^3 in gross at the elevation of EL. 175 m as shown on Fig. MP-2. Since large reservoir sites are scarce in the Brantas basin, examination is made for the case of the topographically maximum reservoir capacity.

Development Scale

The high water level is set at EL. 175.0 m according to the 1 to 50,000 scale map. The effective storage capacity is estimated at

89.7×10^6 m^3. In order to fill up this storage capacity, examination is made to what extent the transbasin is needed. It is assumed that 50% of the rainy season flow in the drought year with the recurrence period of once in 15 years is transferable to the Babadan reservoir. The specific discharge in once in 15 years is as follows;

Unit : $m^3/sec/100\ km^2$

1971		1972				
Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Average
9.2	8.2	9.5	9.2	14.1	12.9	10.5

Since the own catchment area of the damsite is 19.9 km^2, the required transbasin is 89.1 km^2. Then, from the viewpoint of reservoir filling, the transbasin of the following rivers is conceived;

River Name	Catchment Area (km^2)	Tunnel Length (m)
Left Side		
K. Bambon	13.2	2,600
K. Cerme	14.6	1,600
K. Sawur	6.5	1,000
Sub-total	34.3	5,200
Right Side		
K. Gangsang	30.9	1,800
K. Bruno	26.1	2,000
Sub-total	57.0	3,800
Total	91.3	9,000

Ten-day mean runoff with transbasin is estimated as shown in Table MP-2.

Apart from the reservoir filling, there is a possibility to make an high-level diversion for reduction of the flood in the Widas basin. This possibility is examined for 2-year, 10-year and 25-year probable floods by extending the connection tunnel, one by one, as shown in Table 3. From these tables, it is considered that the high-level diversion plan is very expensive. This plan will be assessed after the flood damage study is completed.

4. Preliminary Layout

Based on one profile along the dam axis surveyed by BRBDEO, the dam embankment is drawn as shown in Fig. 3 and 4. Since the available map is only 1 to 50,000 scale map, at this moment, power facilities are not designed. According to the examination on the high-level diversion of flood, the high-level diversion seems to be much costly. Then, the connection tunnels are assumed to be of the minimum diameter which can be excavated.

Principal features are as follows:

PRINCIPAL FEATURES OF BABADAN PROJECT

Location		8 km west of the Kediri city
River Basin		
Stream		Bendokrosek river
Hydrology		
Catchment area		20 km^2
Average runoff	own	1.4 m^3/s
	with transbasin	5.4 m^3/s
10,000 year probable flood		360 m^3/sec
Reservoir		
High water level		EL. 175.0 m
Low water level		EL. 130.0 m
Gross storage capacity		100 x 10^6 m^3
Effective storage capacity		84 x 10^6 m^3
Reservoir surface area at HWL		2.5 km^2

Transbasin Scheme	Catchment Area (km^2)	Tunnel Length (m)
Left side		
K. Babadan	13.2	2,600
K. Cerme	14.6	1,600
K. Sawur	6.5	1,000
Right side		
K. Gangsang	30.9	1,800
K. Baruno	26.1	2,000

D a m	
Type	Zoned Rockfill type
Crest elevation	EL. 179.0 m
Crset length	880 m
High above river bed	75 m
Dam height	80 m
Upstream slope	1 : 2.6
Downstream slope	1 : 2.0
Embankment volume	8.3 x 10^6 m^3
Spillway	
Type	Side channel - Flip bucket type
Crest elevation	EL. 175.0 m
Crest width	55.0 m
Chuteway	280 m long, 8 m wide
Diversion Tunnel	
Type	Circular section
Design discharge	160 m^3/sec.
Diameter	3.5 m dia x 2 nos
Length	900 m (No.1) + 900 m (No.2)

5. Cost estimate

The total construction cost is estimated at Rp. 140,111 million, including the transbasin plan. Breakdown is as shown in Table 4.

6. Anticipated Benefit

Positive Benefit

Water Supply Benefit
84×10^6 m x Rp. 100 /m^3 = Rp. $8,400 \times 10^6$ year

Power Benefit

9,400 kW x Rp. 58.2×10^3 /kW = Rp. 547×10^6 / year

Energy Benefit

28.1×10^6 kWh x Rp. 121 / kWh = Rp. $3,399 \times 10^6$ / year

Negative Benefit

In the reservoir area of 250 ha, the lower parts are used as paddy fileds and yards, and the hill sides are used as upland fields. Therefore, the half is cost as paddy field and other half is as other use. Then, the land cost is;

250 ha x 0.5 x Rp. 1.0×10^6/ha = Rp. 125×10^6 / year

250 ha x 0.5 x Rp. 0.5×10^6/ha = Rp. 62.5×10^6 / year

Net Benefit

The net benefit is estimated at Rp. $12,158 \times 10^6$ per year.

Table 1 (1)

****
* ESTIMATED RUNOFF *
****

SABARMATI

Month	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Jan. 1st	1.18	1.37	2.44	1.79	1.94	1.15	0.62	2.18	1.45	2.70
2nd	1.73	1.74	2.46	2.39	1.52	2.73	1.24	2.08	2.40	3.23
3rd	1.40	2.12	3.15	2.57	1.50	4.89	1.65	1.93	1.78	2.73
Feb. 1st	2.11	2.55	2.82	3.29	1.75	5.45	2.59	3.42	1.34	2.85
2nd	1.74	2.20	2.77	3.84	1.48	5.69	3.48	4.01	2.25	2.76
3rd	1.35	1.25	3.66	5.78	1.26	5.93	3.71	4.52	1.88	2.45
Mar. 1st	2.66	1.35	3.54	3.90	2.43	3.97	3.79	2.51	2.45	2.51
2nd	3.23	1.39	4.00	3.00	3.43	3.76	3.24	2.62	2.35	4.23
3rd	2.39	1.08	3.49	2.16	4.57	3.35	2.35	2.78	3.54	4.57
Apr. 1st	2.82	1.43	3.06	2.35	5.78	5.21	2.71	3.65	3.19	4.17
2nd	3.94	0.80	1.89	1.59	4.04	4.83	2.76	2.38	2.51	3.44
3rd	3.21	0.43	2.92	1.53	2.79	3.38	2.76	1.65	1.95	3.58
May 1st	2.40	0.31	2.21	0.70	3.10	2.50	2.35	0.94	2.59	3.65
2nd	1.53	0.26	1.13	0.42	2.98	1.18	1.97	0.84	1.67	3.51
3rd	0.89	0.22	0.47	0.26	2.36	0.53	2.06	0.73	0.66	2.52
June 1st	0.54	0.23	0.44	0.23	1.95	0.36	1.55	0.82	0.41	1.58
2nd	0.41	0.22	0.30	0.21	1.92	0.29	0.83	0.43	0.30	1.16
3rd	0.30	0.21	0.25	0.20	1.80	0.26	0.43	0.31	0.26	0.95
July 1st	0.26	0.20	0.23	0.19	1.30	0.24	0.30	0.27	0.24	0.34
2nd	0.24	0.19	0.22	0.18	1.12	0.22	0.26	0.24	0.23	0.37
3rd	0.20	0.18	0.18	0.16	0.80	0.19	0.21	0.21	0.20	0.27
Aug. 1st	0.21	0.17	0.20	0.15	0.45	0.20	0.22	0.22	0.20	0.26
2nd	0.20	0.16	0.19	0.16	0.31	0.19	0.21	0.21	0.20	0.24
3rd	0.17	0.14	0.16	0.14	0.24	0.17	0.18	0.18	0.17	0.20
Sep. 1st	0.18	0.15	0.17	0.14	0.24	0.18	0.19	0.19	0.18	0.21
2nd	0.17	0.14	0.16	0.14	0.23	0.17	0.18	0.18	0.17	0.20
3rd	0.35	0.14	0.16	0.13	0.22	0.16	0.17	0.17	0.16	0.22
Oct. 1st	2.37	0.13	0.15	0.13	0.20	0.15	0.16	0.16	0.16	0.20
2nd	2.31	0.13	0.14	0.12	0.19	0.15	0.16	0.44	0.15	0.18
3rd	1.40	0.11	0.13	0.11	0.17	0.13	0.14	1.44	0.13	0.16
Nov. 1st	2.24	0.12	0.13	0.11	0.98	0.14	0.18	1.55	0.14	0.41
2nd	3.15	0.11	0.13	0.11	0.60	0.13	0.75	2.12	0.13	0.65
3rd	2.30	0.23	0.12	0.11	0.93	0.13	0.97	1.76	0.13	0.35
Dec. 1st	1.25	0.24	0.12	0.97	0.84	0.39	0.54	1.52	0.63	1.56
2nd	0.62	0.69	0.15	1.07	1.53	0.72	0.87	2.08	2.22	1.61
3rd	1.03	1.39	0.11	1.15	1.27	0.75	2.03	1.28	2.25	0.83
Mean 1st	1.46	0.69	1.22	1.15	1.62	1.68	1.35	1.46	1.13	1.68

Table 1 (2) ESTIMATED RUNOFF

BEAGAN

Month	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Mean
Jan. 1st	2.46	1.71	2.26	2.26	2.14	2.95	0.14	1.86	2.54	4.01	1.96
2nd	3.05	1.40	2.85	2.68	2.44	3.93	1.26	2.60	3.71	4.82	2.47
3rd	3.22	2.13	2.51	2.97	2.78	3.28	2.07	2.72	3.17	3.44	2.60
Feb. 1st	3.37	2.97	2.90	2.91	3.09	4.50	2.24	2.99	3.28	4.70	3.04
2nd	3.89	3.64	2.55	2.13	5.15	4.16	2.29	2.64	3.16	5.00	3.25
3rd	5.28	3.85	2.78	3.96	6.01	5.29	3.15	3.30	3.53	5.66	3.76
Mar. 1st	3.84	2.79	3.61	3.30	3.95	3.69	2.35	3.49	3.36	3.74	3.16
2nd	3.26	2.98	2.69	3.49	4.92	3.01	1.97	3.44	3.53	6.43	3.37
3rd	2.14	3.36	2.46	3.66	4.70	2.72	1.14	2.55	3.24	5.91	3.11
Apr. 1st	2.16	3.64	2.02	3.46	4.26	3.25	0.78	1.98	3.31	5.39	3.23
2nd	1.65	4.13	1.35	2.26	3.40	3.96	1.07	1.49	2.98	4.35	2.77
3rd	1.05	3.76	0.61	1.63	2.08	4.34	0.69	1.58	2.33	3.56	2.34
May 1st	1.18	3.05	0.37	0.83	1.80	4.25	0.37	1.78	1.21	3.63	1.97
2nd	0.73	3.43	0.29	0.43	1.49	2.74	0.26	1.33	0.55	2.72	1.47
3rd	0.54	2.65	0.24	0.28	1.32	1.44	0.20	0.54	0.31	2.54	1.04
June 1st	0.37	1.68	0.24	0.87	1.53	1.57	0.21	0.35	0.27	1.71	0.85
2nd	0.29	0.73	0.23	0.50	1.31	0.80	0.20	0.27	0.24	0.74	0.57
3rd	0.26	0.41	0.22	0.32	1.53	0.44	0.19	0.42	0.23	0.40	0.45
July 1st	0.24	0.31	0.21	0.26	2.03	0.32	0.18	0.35	0.22	0.29	0.49
2nd	0.23	0.27	0.20	0.23	1.57	0.26	0.17	0.31	0.20	0.25	0.35
3rd	0.45	0.22	0.17	0.20	0.74	0.23	0.39	0.24	0.18	0.21	0.28
Aug. 1st	0.34	0.23	0.18	0.21	0.49	0.24	0.25	0.23	0.19	0.22	0.24
2nd	0.25	0.22	0.17	0.20	0.34	0.23	0.19	0.22	0.18	0.21	0.21
3rd	0.20	0.19	0.15	0.17	0.26	0.20	0.15	0.19	0.15	0.18	0.18
Sep. 1st	0.20	0.20	0.16	0.18	0.26	0.20	0.16	0.20	0.16	0.19	0.19
2nd	0.21	0.24	0.15	0.17	0.24	0.20	0.15	0.19	0.16	0.18	0.18
3rd	0.19	0.20	0.15	0.16	0.23	0.19	0.14	0.61	0.15	0.17	0.20
Oct. 1st	0.52	0.92	0.14	0.16	0.22	0.18	0.14	0.31	0.14	0.16	0.34
2nd	0.29	0.86	0.14	0.15	0.21	0.17	0.13	0.22	0.14	0.16	0.32
3rd	0.59	1.46	0.13	0.13	0.18	0.15	0.12	0.17	0.12	0.77	0.39
Nov. 1st	0.36	1.79	0.13	0.14	0.37	0.16	0.13	0.17	0.13	0.92	0.51
2nd	0.45	2.28	0.15	0.14	0.31	0.15	0.12	0.49	0.12	0.46	0.53
3rd	0.80	2.01	1.29	0.13	0.39	0.14	1.00	1.04	0.12	0.46	0.71
Dec. 1st	1.77	2.24	1.33	0.22	0.95	0.14	0.95	1.81	0.95	0.71	0.96
2nd	2.05	1.92	1.20	0.33	1.28	0.13	0.60	1.65	1.50	0.35	1.14
3rd	1.46	1.08	1.00	1.41	2.53	0.12	1.13	1.31	2.01	1.06	1.26
Mean 1st	1.37	1.80	1.03	1.17	1.84	1.55	0.74	1.26	1.33	2.10	1.39

Table 2 (1)

****
* ESTIMATED RUNOFF *
****

BABADAN WITH TRANSBASIN 89.1 SQ.KM

Month	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Jan. 1st	5.45	6.33	11.24	8.26	8.96	5.30	2.87	10.04	6.68	12.46
2nd	7.96	8.02	11.34	11.03	7.02	12.59	5.71	9.53	11.67	14.88
3rd	6.46	9.79	14.50	11.82	6.93	22.53	7.59	8.91	8.22	12.59
Feb. 1st	9.74	11.73	12.99	15.15	8.00	25.11	12.39	15.74	6.18	13.14
2nd	8.01	10.16	12.77	17.69	6.34	27.10	16.04	18.45	10.38	12.80
3rd	6.21	8.52	16.83	26.62	5.80	27.29	17.07	20.79	8.69	11.29
Mar. 1st	12.26	6.23	16.30	17.95	11.18	18.30	17.43	11.55	11.28	11.55
2nd	14.87	8.26	18.43	13.84	15.79	17.33	14.93	12.07	10.93	19.46
3rd	11.02	4.99	16.08	9.94	21.06	15.41	10.85	12.79	16.32	21.03
Apr. 1st	12.98	6.58	14.11	10.81	26.59	23.98	12.50	16.32	14.67	19.21
2nd	10.16	3.68	8.70	7.32	18.59	22.26	12.69	13.27	11.56	15.84
3rd	14.79	1.99	13.46	7.05	12.84	17.37	12.73	7.61	8.97	16.49
May 1st	2.40	0.31	2.21	0.70	3.19	2.50	2.35	0.94	2.59	3.85
2nd	1.53	0.26	1.13	0.42	2.96	1.18	1.97	0.84	1.67	3.51
3rd	0.89	0.22	0.47	0.26	2.36	0.53	2.06	0.73	0.66	2.52
June 1st	0.54	0.23	0.44	0.23	1.95	0.36	1.55	0.82	0.41	1.58
2nd	0.41	0.22	0.30	0.21	1.92	0.29	0.83	0.43	0.30	1.16
3rd	0.30	0.21	0.25	0.20	1.80	0.26	0.43	0.31	0.26	0.55
July 1st	0.26	0.20	0.23	0.19	1.30	0.24	0.30	0.27	0.24	0.34
2nd	0.24	0.19	0.22	0.18	1.12	0.22	0.26	0.24	0.23	0.37
3rd	0.20	0.16	0.18	0.16	0.80	0.19	0.21	0.21	0.20	0.27
Aug. 1st	0.21	0.17	0.20	0.16	0.45	0.20	0.22	0.22	0.20	0.26
2nd	0.20	0.16	0.19	0.16	0.31	0.19	0.21	0.21	0.20	0.24
3rd	0.17	0.14	0.16	0.14	0.24	0.17	0.18	0.18	0.17	0.20
Sep. 1st	0.18	0.15	0.17	0.14	0.24	0.18	0.19	0.19	0.18	0.21
2nd	0.17	0.14	0.16	0.14	0.23	0.17	0.18	0.18	0.17	0.20
3rd	0.35	0.14	0.16	0.13	0.22	0.16	0.17	0.17	0.16	0.22
Oct. 1st	2.37	0.13	0.15	0.13	0.20	0.15	0.16	0.16	0.16	0.20
2nd	2.31	0.13	0.14	0.12	0.19	0.15	0.16	0.44	0.15	0.18
3rd	1.40	0.11	0.13	0.11	0.17	0.13	0.14	1.44	0.13	0.16
Nov. 1st	10.30	0.57	0.62	0.54	4.51	0.65	0.85	7.13	0.66	1.91
2nd	14.49	0.54	0.61	0.53	2.77	0.62	3.46	9.79	0.63	2.99
3rd	10.59	1.31	0.58	0.52	4.31	0.59	4.92	8.11	0.61	1.62
Dec. 1st	5.75	1.14	0.57	4.50	3.89	1.80	2.51	7.01	2.94	7.18
2nd	2.87	3.21	0.71	4.93	7.05	3.34	4.04	9.58	10.25	7.44
3rd	4.76	6.41	0.54	5.29	5.84	3.48	9.35	5.92	10.38	3.83
Mean 1st	5.39	2.85	4.92	4.93	5.49	7.02	4.96	5.92	4.40	6.16

Table 2 (2)

****
* ESTIMATED RUNOFF *
****

BABADAN WITH TRANSBASIN 89.1 SQ.KM

Month		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Mean
Jan.	1st	11.33	7.87	10.42	10.39	9.86	13.57	0.67	8.57	11.72	18.46	9.92
	2nd	14.03	6.45	13.14	12.36	11.24	13.76	5.81	11.99	17.09	22.18	11.37
	3rd	14.82	9.83	11.58	13.66	12.73	15.11	9.55	12.51	14.59	15.86	11.98
Feb.	1st	15.53	13.67	13.34	11.12	14.24	20.72	10.33	13.79	15.13	21.66	13.98
	2nd	17.91	16.75	11.77	9.81	23.73	19.17	10.55	12.15	14.55	23.03	14.98
	3rd	24.33	17.72	12.80	18.25	27.64	24.35	14.50	15.18	16.51	26.04	17.32
Mar.	1st	17.70	12.86	18.51	15.22	18.17	16.99	10.83	16.09	15.48	17.21	14.36
	2nd	15.04	13.75	12.38	18.06	22.63	13.88	9.09	15.23	16.27	29.61	15.52
	3rd	9.86	15.49	11.31	16.84	21.63	12.51	5.25	11.76	14.91	27.20	14.31
Apr.	1st	9.36	16.78	9.31	15.95	19.62	14.98	3.59	9.14	15.24	24.82	14.38
	2nd	7.52	19.02	6.23	10.40	15.65	18.22	4.93	6.87	13.71	20.03	12.74
	3rd	4.35	17.30	2.84	7.52	9.57	22.27	3.20	7.31	10.74	16.42	10.79
May	1st	1.18	3.05	0.37	0.83	1.80	4.25	0.37	1.78	1.21	3.63	1.97
	2nd	0.73	3.43	0.29	0.43	1.40	2.74	0.26	1.35	0.55	2.72	1.47
	3rd	0.54	2.65	0.24	0.28	1.32	1.44	0.20	0.54	0.31	2.54	1.04
June	1st	0.37	1.88	0.24	0.87	1.53	1.57	0.21	0.35	0.27	1.71	0.85
	2nd	0.29	0.73	0.23	0.50	1.31	0.30	0.20	0.27	0.24	0.74	0.57
	3rd	0.26	0.41	0.22	0.32	1.53	0.44	0.19	0.42	0.23	0.40	0.45
July	1st	0.24	0.31	0.21	0.26	2.68	0.32	0.18	0.35	0.22	0.29	0.40
	2nd	0.23	0.27	0.20	0.23	1.57	0.28	0.17	0.31	0.20	0.25	0.35
	3rd	0.45	0.22	0.17	0.20	0.74	0.23	0.39	0.24	0.18	0.21	0.28
Aug.	1st	0.34	0.23	0.18	0.21	0.49	0.24	0.25	0.23	0.19	0.22	0.24
	2nd	0.25	0.22	0.17	0.20	0.34	0.23	0.19	0.22	0.18	0.21	0.21
	3rd	0.20	0.19	0.15	0.17	0.26	0.20	0.15	0.19	0.15	0.18	0.18
Sep.	1st	0.20	0.20	0.16	0.18	0.25	0.20	0.16	0.20	0.16	0.19	0.19
	2nd	0.21	0.24	0.15	0.17	0.24	0.20	0.15	0.19	0.16	0.18	0.18
	3rd	0.19	0.20	0.15	0.16	0.23	0.19	0.14	0.61	0.15	0.17	0.20
Oct.	1st	0.52	0.92	0.14	0.16	0.22	0.18	0.14	0.31	0.14	0.16	0.34
	2nd	0.29	0.86	0.14	0.15	0.21	0.17	0.13	0.22	0.14	0.16	0.32
	3rd	0.59	1.46	0.13	0.13	0.18	0.15	0.12	0.17	0.12	0.77	0.39
Nov.	1st	1.67	8.26	0.63	0.66	1.74	0.74	0.59	0.89	0.61	4.26	2.38
	2nd	2.08	10.50	0.72	0.65	1.45	0.71	0.57	2.27	0.58	2.14	2.90
	3rd	3.70	9.27	5.54	0.63	1.79	0.68	4.60	4.60	0.57	2.15	3.30
Dec.	1st	8.15	10.30	6.12	1.01	4.41	0.66	4.39	8.35	4.41	3.27	4.42
	2nd	9.44	8.83	5.55	1.54	5.92	0.63	2.79	8.52	6.90	1.83	5.26
	3rd	6.73	5.00	4.64	6.50	11.67	0.55	5.20	6.06	9.23	4.89	5.82
Mean	1st	5.61	6.58	4.40	4.83	6.93	6.21	3.06	5.00	5.64	8.21	5.42

Table 3 (1)

HIGH LEVEL DIVERSION COST
FLOOD NAME 2 YEARS
UNIT DISCHARGE 2.36 CMS
UNIT : RP MILLION

LEFT SIDE

K.BAMBON	8921	14396	16558	19112	19862	24527	28096
K.CARME	0	6231	7780	11648	12235	13639	15938
K.SAWUR	0	0	3125	5805	6218	8679	9077
K.LOWE	0	0	0	21234	23550	37024	39964
K.PUTIH	0	0	0	0	1425	1912	2336
K.TANUNG	0	0	0	0	0	8422	12348
K.MUNDENG	0	0	0	0	0	0	11019
TOTAL	8921	20627	27463	57799	63289	94202	118778

RIGHT SIDE

K.GANGSANG	10999	14207	15571	16919	19292
K.BRUNO	0	10853	13018	15090	16023
K.CEKONG	0	0	9897	15554	24185
K.BLINBING	0	0	0	6426	12272
K.BRUNI	0	0	0	0	2382
TOTAL	10999	25061	38486	53990	74154

DIAMETER OF TUNNEL (M)

K.BAMBON	3.04	4.01	4.34	5.11	5.22	5.87	6.31
K.CARME	0	3.15	3.62	4.59	4.72	5.46	5.96
K.SAWUR	0	0	2.5	3.87	4.04	4.95	5.53
K.LOWE	0	0	0	3.46	3.66	4.69	5.31
K.PUTIH	0	0	0	0	2.5	3.76	4.6
K.TANUNG	0	0	0	0	0	3.57	4.46
K.MUNDENG	0	0	0	0	0	0	3.31
K.GANGSANG	4.18	5.26	5.53	5.8	6.23		
K.BRUNO	0	3.92	4.35	4.73	5.32		
K.CEKONG	0	0	2.56	3.34	4.27		
K.BLINBING	0	0	0	2.59	3.82		
K.BRUNI	0	0	0	0	3.25		

DESIGN DISCHARGE (CMS)

K.BAMBON	31.2	65.6	80.9	125.1	132.4	180.3	219.5
K.CARME	0	34.5	49.8	93.9	101.2	149.2	188.3
K.SAWUR	0	0	15.3	59.5	66.8	114.7	153.9
K.LOWE	0	0	0	44.1	51.4	99.4	138.5
K.PUTIH	0	0	0	0	7.3	55.2	94.4
K.TANUNG	0	0	0	0	0	47.9	87.1
K.MUNDENG	0	0	0	0	0	0	39.2
K.GANGSANG	72.9	134.5	154.3	174.6	211.9		
K.BRUNO	0	61.6	81.4	101.7	139		
K.CEKONG	0	0	19.8	40.1	77.4		
K.BLINBING	0	0	0	20.3	57.6		
K.BRUNI	0	0	0	0	37.3		

Table 3 (2) HIGH LEVEL DIVERSION COST

FLOOD NAME 10 YEARS

UNIT DISCHARGE 5.04 CMS

UNIT : RP MILLION

LEFT SIDE

K.BAMBON	14530	20640	23827	32216	33523	41667	47904
K.CARME	0	9945	12637	16630	17496	22814	26828
K.SAWUR	0	0	4156	8043	8651	12279	14945
K.LOWE	0	0	0	35689	39716	53891	68211
K.PUTIH	0	0	0	0	1425	2336	2961
K.TANUNG	0	0	0	0	0	13734	17654
K.MUNDENG	0	0	0	0	0	0	18154
TOTAL	14530	30586	40621	92577	100812	146721	196657

RIGHT SIDE

K.GANGSANG	15665	23777	26156	28510	32656
K.BRUNO	0	15442	18633	21689	26914
K.CEKONG	0	0	16116	25926	35012
K.BLINBING	0	0	0	10221	17518
K.BRUNI	0	0	0	0	3366
TOTAL	15665	39219	60905	86347	115466

DIAMETER OF TUNNEL (M)

K.BAMBON	4.04	5.34	5.77	6.8	6.94	7.8	8.39
K.CARME	0	4.19	4.81	6.1	6.28	7.26	7.92
K.SAWUR	0	0	3.09	5.14	5.37	6.58	7.35
K.LOWE	0	0	0	4.6	4.87	6.23	7.06
K.PUTIH	0	0	0	0	2.5	5	6.12
K.TANUNG	0	0	0	0	0	4.74	5.93
K.MUNDENG	0	0	0	0	0	0	4.4
K.GANGSANG	5.55	6.98	7.35	7.7	8.28		
K.BRUNO	0	5.21	5.79	6.29	7.07		
K.CEKONG	0	0	3.41	4.44	5.68		
K.BLINBING	0	0	0	3.44	5.08		
K.BRUNI	0	0	0	0	4.32		

DESIGN DISCHARGE (CMS)

K.BAMBON	66.5	140.1	172.9	267.1	282.7	385.1	468.7
K.CARME	0	73.6	106.3	200.6	216.2	318.5	402.2
K.SAWUR	0	0	32.8	127	142.6	244.9	328.6
K.LOWE	0	0	0	94.2	109.9	212.2	295.8
K.PUTIH	0	0	0	0	15.6	117.9	201.6
K.TANUNG	0	0	0	0	0	102.3	186
K.MUNDENG	0	0	0	0	0	0	83.7
K.GANGSANG	155.7	287.3	329.6	373	452.6		
K.BRUNO	0	131.5	173.9	217.2	296.9		
K.CEKONG	0	0	42.3	85.7	165.3		
K.BLINBING	0	0	0	43.3	123		
K.BRUNI	0	0	0	0	79.6		

Table 3 (3)

HIGH LEVEL DIVERSION COST
FLOOD NAME 25 YEARS
UNIT DISCHARGE 6.29 CMS
UNIT : RP MILLION

LEFT SIDE

K.BAMBON	16843	24015	27764	37636	39174	48762	56107
K.CARME	0	11477	12628	19332	20351	26611	31337
K.SAWUR	0	0	4687	9251	9966	14235	17373
K.LOWE	0	0	0	41657	39680	63042	79896
K.PUTIH	0	0	0	0	1440	2565	3300
K.TANUNG	0	0	0	0	0	13725	20529
K.MUNDENG	0	0	0	0	0	0	21100
TOTAL	16843	35493	45079	107875	110612	168939	229641

RIGHT SIDE

K.GANGSANG	18190	27735	30536	33308	38190		
K.BRUNO	0	17921	21674	25270	31419		
K.CEKONG	0	0	18676	30208	40873		
K.BLINBING	0	0	0	11784	20350		
K.BRUNI	0	0	0	0	3772		
TOTAL	18190	45656	70886	100569	134604		

DIAMETER OF TUNNEL (M)

K.BAMBON	4.39	5.8	6.27	7.39	7.54	8.47	9.12
K.CARME	0	4.55	5.23	6.63	6.82	7.89	8.61
K.SAWUR	0	0	3.36	5.59	5.84	7.15	7.98
K.LOWE	0	0	0	5	5.29	6.77	7.67
K.PUTIH	0	0	0	0	2.55	5.44	6.65
K.TANUNG	0	0	0	0	0	5.15	6.45
K.MUNDENG	0	0	0	0	0	0	4.78
K.GANGSANG	6.03	7.59	7.99	8.37	9		
K.BRUNO	0	5.66	6.29	6.83	7.68		
K.CEKONG	0	0	3.7	4.82	6.17		
K.BLINBING	0	0	0	3.73	5.52		
K.BRUNI	0	0	0	0	4.69		

DESIGN DISCHARGE (CMS)

K.BAMBON	83	174.9	215.7	333.4	352.9	480.6	585
K.CARME	0	91.8	132.7	250.3	269.8	397.5	501.9
K.SAWUR	0	0	40.9	158.5	178	305.7	410.1
K.LOWE	0	0	0	117.6	137.1	264.8	369.2
K.PUTIH	0	0	0	0	19.5	147.2	251.6
K.TANUNG	0	0	0	0	0	127.7	232.1
K.MUNDENG	0	0	0	0	0	0	104.4
K.GANGSANG	194.4	358.5	411.4	465.5	564.8		
K.BRUNO	0	164.2	217	271.1	370.5		
K.CEKONG	0	0	52.8	106.9	206.3		
K.BLINBING	0	0	0	54.1	153.5		
K.BRUNI	0	0	0	0	99.4		

Table 4 (1) CONSTRUCTION COST ESTIMATE FOR BABADAN SCHEME

Item No.	Work	Unit	Quantity	Unit Price (10^3Rp)	Amount (10^6Rp)
1.	Civil Works				103,021
1-1	Preparatory Works	L.S.			7,631
1-2	Diversion Works				
	Excavation (earth)	m^3	30,000	3.5	105
	(rock)	m^3	10,000	7.5	75
	(tunnel)	m^3	26,300	65.1	1,712
	Steel support	ton	442	653.3	276
	Concrete	m^3	9,600	124.4	1,194
	Reinforcement bar	ton	480	609.8	293
	Consolidation grout	m.	6,000	72	432
	Sub-total				4,087
1-3	Dam				
	Excavation (earth)	m^3	313,900	3.5	1,099
	(rock)	m^3	313,800	7.5	2,354
	Embankment (random)	m^3	176,900	4.2	743
	(core)	m^3	821,300	5.5	4,517
	(filter)	m^3	529,100	4.8	2,540
	(rock)	m^3	6,788,500	7.8	52,950
	Curtain & blanket grout	m	67,500	72	4,860
	Concrete	m^3	5,100	94.6	482
	Sub-total				69,545
1-4	Spillway				
	Excavation (earth)	m^3	78,000	3.5	273
	(rock)	m^3	117,000	7.5	878
	Concrete	m^3	20,000	94.6	1,892
	Reinforcement bar	ton	400	609.8	244
	Sub-total				3,286
1-5	Waterway	L.S.			326
1-6	Powerhouse	L.S.			1,160
1-7	Transbasin Scheme				
	Intake weir	L.S.			2,605
	Connection tunnel	L.S			14,381
	Sub-total				16,985

- to be continued -

Table 4 (2) CONSTRUCTION COST ESTIMATE FOR BABADAN SCHEME

Item No.	Work	Unit	Quantity	Unit Price (10^3Rp)	Amount (10^6Rp)
2.	Cost of Power	L.S.			2,923
	Total				105,944
3.	Engineering Service				10,594
4.	Administration				5,297
5.	Base Cost				121,835
6.	Physical Contingency				18,275
	Grand Total				140,111

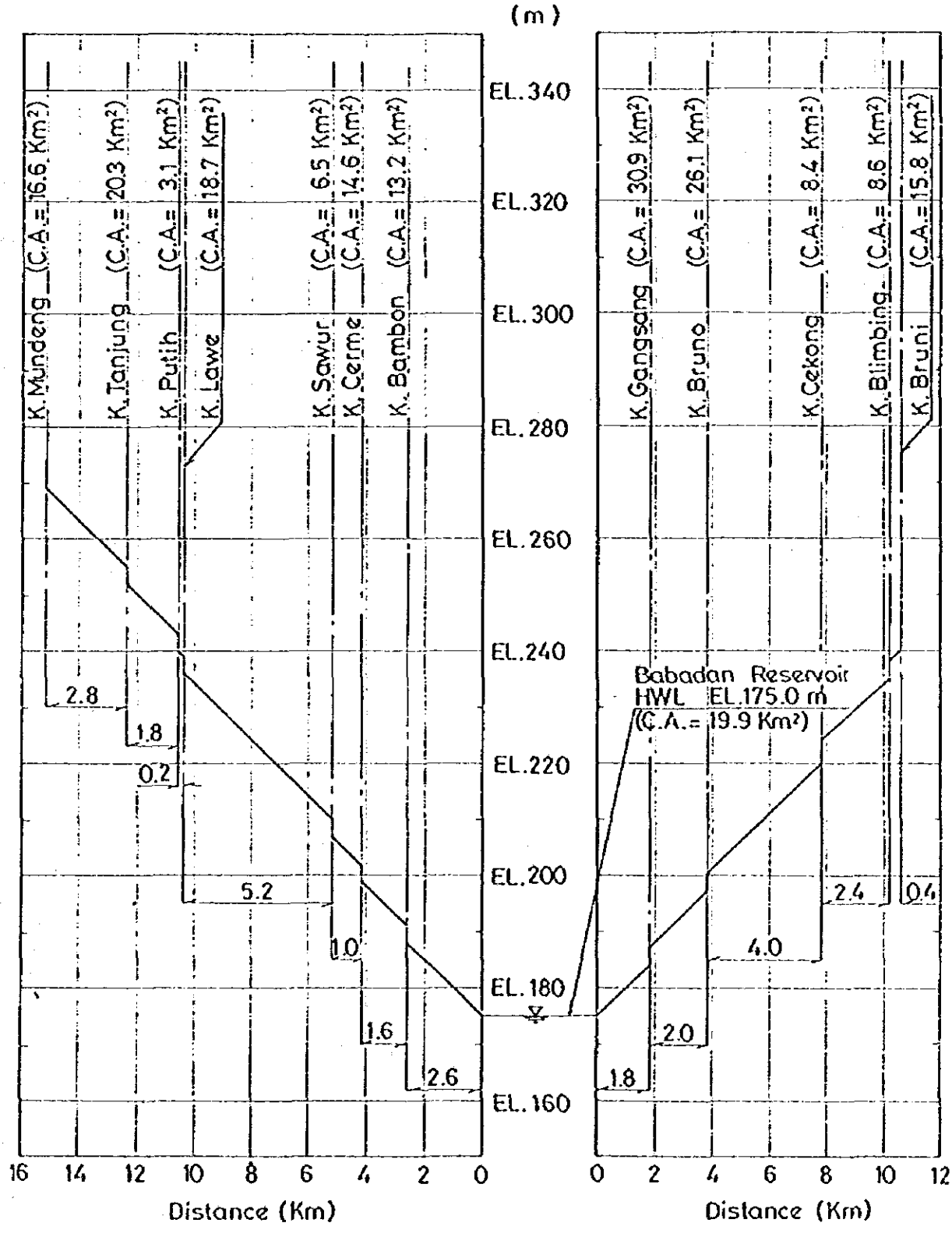


Fig. 1 TRANSBASIN SCHEME OF BABADAN PROJECT

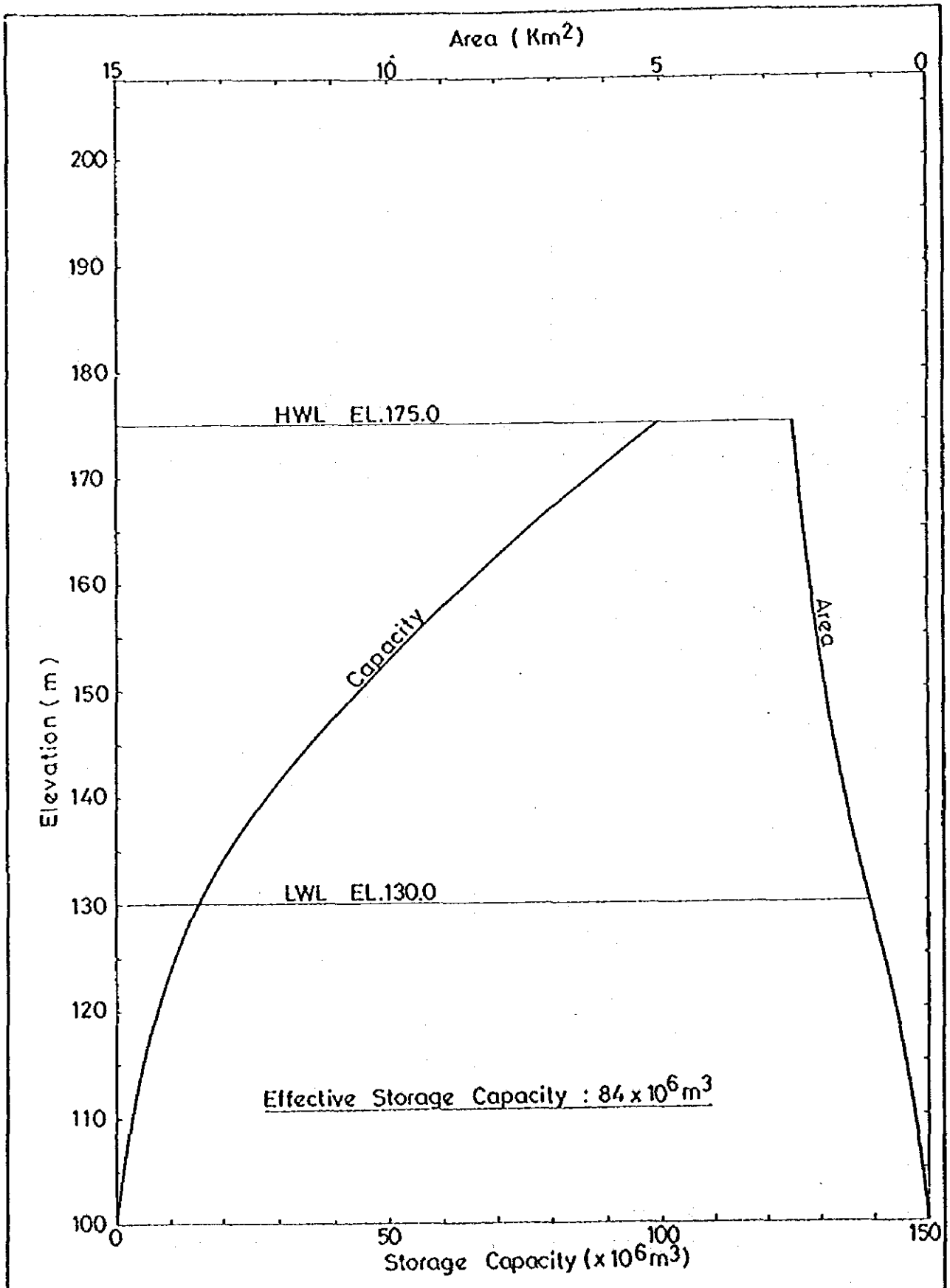


Fig. 2 STORAGE CAPACITY OF BABADAN RESERVOIR

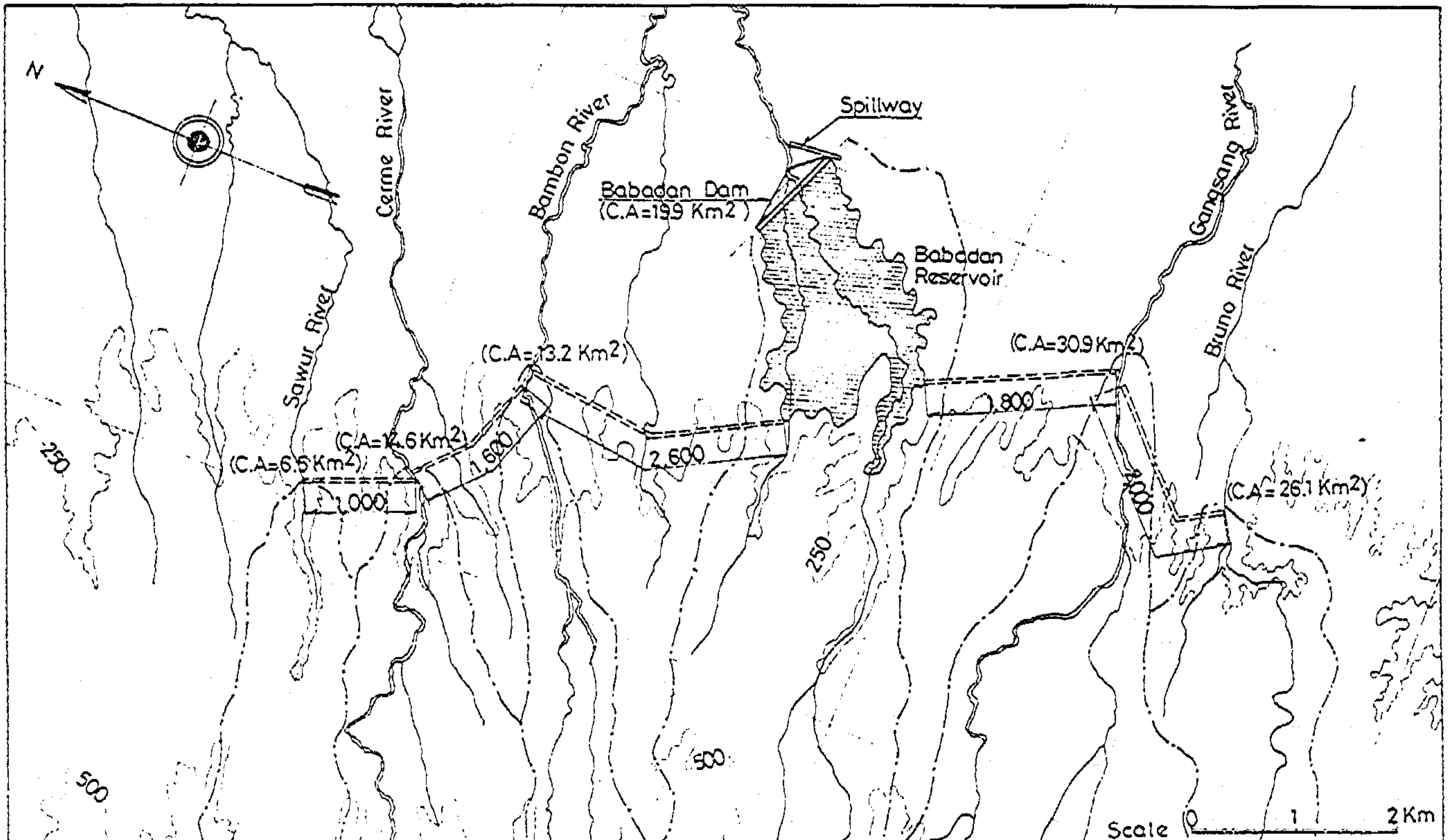


Fig. 3 GENERAL LAYOUT OF BABADAN PROJECT

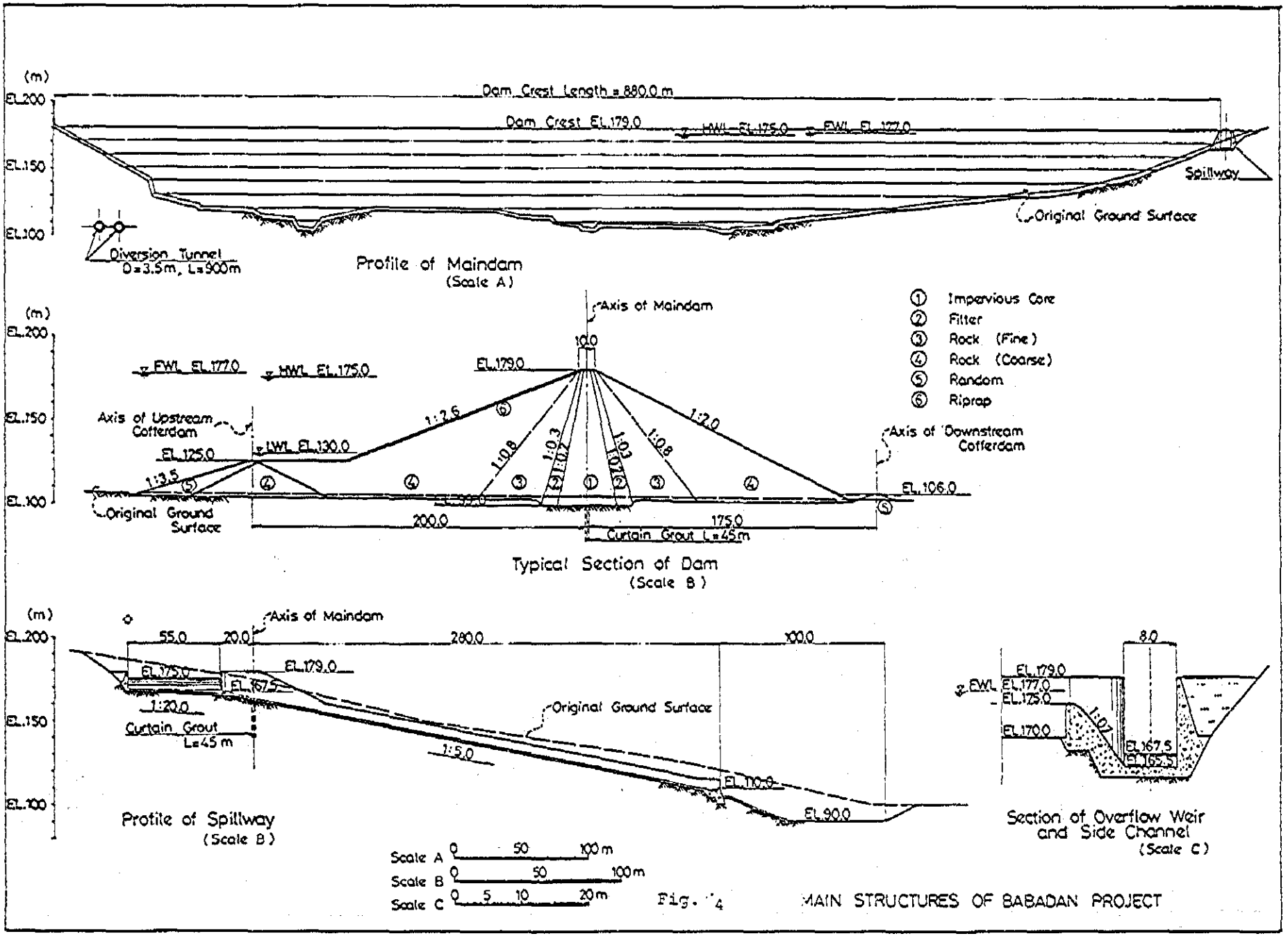


Fig. 4 MAIN STRUCTURES OF BABADAN PROJECT

NOTE MP-7

KUNCIR SCHEME

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOTE MP - 7 KUNCIR SCHEME

1. Objectives of the scheme

- Flood control
- Water supply to irrigation
- Hydropower generation

2. Natural Conditions

Location and Topography

The site is selected on Kuncir river, about 15 km south-west from the Nganjuk town. Kuncir river, originating from the top of Mt. Limas, flows down on the steep mountain slope, and forms a wide alluvial fan composed of sand and gravel at the foot of the mountain. There are several alternative damsites. All the alternative sites are not favourable for dam and reservoir and owing to the topographic conditions with the wide riverbed and the steep river gradient.

Hydrology

low flow is estimated by the Tank Model method as follows;

Unit : m^3/sec

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
8.3	11.9	11.4	9.8	5.3	2.2	1.2	0.8	0.7	1.2	2.2	4.0

Ten-day mean run-off is as shown in Table 1.

The probable floods are estimated as follows;

Probability	Probable Flood Peak Discharge
Once in 25 years	440 m^3/s
100	569
200	634
1,000	782
10,000	993

Geology

The geological investigation by boring has been made at several location of the alternative sites. Along the dam axis studied here, test boring is under way. The geological condition in the proposed site is considered as similar to those in the other sites. The bed rock is composed of the volcanic breccia with the low permeability. The abutments are composed of the weathered volcanic breccia. In the riverbed, the river deposit consisting of sand and gravel is accumulating. It's thickness tends to thin to the upstream ward. The thickness of the river deposit at the proposed site is assumed at around 10 m from the geological profile drawn for the other alternative sites. Since the permeability of the river deposit is in the order of 10^{-4}, it will be necessary to take countermeasures against leakage.

3. Possible Development

Owing to the unfavourable topographic condition, the Kuncir dam is not promising. Anyway, it is commonly said that if the topography is like the Kuncir river basin the storage efficiency becomes higher according to hightening of the dam. In this context, the dam height is set at the topographically maximum. The stage-storage capacity curve is drawn as shown in Fig. 1 based on 1 to 2,500 scale map.

4. Preliminary Layout

Based on 1 to 2,500 scale map, preliminary layout of the scheme is drawn as shown in Fig. 2 to 4. The dam type is assumed as gravel-fill type with the center core, since this is ample river deposit. For control of seepage, the center core is extended to the level of the bedrock The diversion tunnel and spillway are arranged in the right bank.

Principal features are as shown below;

PRINCIPAL FEATURES OF KUNCIR SCHEME

Location	on Kuncir river, 15 km south-west of Nganjuk town
River basin	K. Widas
Stream	K. Kuncir
Hydrology	
Catchment area	70 km^2
Average run-off	4.91 m^3/s
10,000 year probable flood	993 m^3/s
Reservoir	
High water level	EL. 446 m
Low water level	EL. 418 m
Gross storage capacity	30,500,000 m^3
Effective storage capacity	22,500,000 m^3
Reservoir surface area at HWL	1.28 km^2
Dam	
Type	Center core rockfill dam
Crest elevation	EL. 450.5 m
Crest length	870 m
Height above river bed	80 m
Dam height	100 m
Upstream slope	1 : 2.6
Downstream slope	1 : 2.0
Embankment volume	6,850,000 m^3
Spillway	
Type	Side channel type
Crest elevation	EL. 446 m
Crest width	95 m
Chuteway	240 m
Stilling basin plunge pool	125 m
Diversion tunnel	
Type	Circular section
Design discharge	440 m^3/sec

Diameter	6 m
Length	630 m
Intake	
Dimension	7.5 m x 10 m
Sill elevation	EL. 413 m
Penstock	
Type	Steel condit
Diameter	1.0 m - 1.3 m
Length	110 m
Power house	
Type	Open air type
Building dimension	12 m x 15 m x 10 m
Power and Energy	
Max. plant discharge	6.58 m^3/sec
Head gross	88.0 m
rated	79.0 m
Installed capacity	4,300 kW
Dependable capacity	4,300 kW
Annual energy	28.3 Gwh

5. Cost Estimate

The construction cost is estimated at Rp. 75,083 million. Breakdown is as shown in Table 2.

6. Anticipated Benefit

Possitive Benefit

Water supply benefit

22.5×10^6 m^3 x Rp. 100 = Rp. $2,250 \times 10^6$/year

Negative benefit

In the reservoir area of 128 ha, there are few paddy field. Then, the land is cost as other use.

Land 128 ha x Rp. 0.5×10^6/ha = Rp. 64×10^6/year

Net benefit

Rp. $5,859 \times 10^6$/year

Table 1(1)

ESTIMAED RUNOFF

KUNCIR

Month		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Jan.	1st	4.19	4.87	8.64	6.35	6.89	4.98	2.21	7.72	5.14	9.58
	2nd	6.12	6.17	8.72	8.48	5.50	9.68	4.39	7.37	8.51	11.44
	3rd	4.97	7.53	11.15	9.09	5.33	17.32	5.84	6.85	6.32	9.58
Feb.	1st	7.49	9.02	9.99	11.65	6.15	19.30	9.53	12.10	4.75	10.10
	2nd	6.16	7.81	9.82	13.60	5.26	20.83	12.33	14.18	7.98	9.54
	3rd	4.78	6.55	12.94	20.46	4.46	20.93	13.12	15.98	6.68	8.68
Mar.	1st	9.43	4.79	12.53	13.80	8.60	14.07	13.40	8.89	8.67	8.88
	2nd	11.43	6.35	14.17	10.64	12.14	13.32	11.46	9.28	8.33	14.96
	3rd	8.47	3.94	12.36	7.64	16.19	11.95	8.34	9.83	12.35	16.17
Apr.	1st	9.98	5.06	10.85	8.31	20.44	18.43	9.61	12.93	11.28	14.77
	2nd	13.96	2.83	6.69	5.63	14.29	17.11	9.76	10.20	8.89	12.18
	3rd	11.37	1.53	10.35	5.42	9.87	13.74	9.79	5.85	6.90	12.67
May	1st	8.49	1.11	7.82	2.51	10.93	8.35	8.34	3.34	9.16	13.44
	2nd	5.43	0.95	4.02	1.50	10.49	4.15	6.99	3.00	5.93	12.44
	3rd	3.17	0.80	1.69	0.92	3.36	1.89	7.31	2.61	2.35	8.93
June	1st	1.93	0.83	1.56	0.84	6.92	1.30	5.49	2.71	1.46	5.59
	2nd	1.46	0.79	1.03	0.77	6.81	1.03	2.95	1.55	1.09	4.13
	3rd	1.07	0.75	0.91	0.72	6.37	0.92	1.55	1.12	0.94	1.95
July	1st	0.92	0.71	0.83	0.69	4.60	0.86	1.09	0.96	0.87	1.23
	2nd	0.85	0.68	0.78	0.65	3.97	0.81	0.93	0.88	0.82	1.32
	3rd	0.73	0.59	0.67	0.57	2.85	0.70	0.77	0.75	0.71	0.96
Aug.	1st	0.76	0.62	0.71	0.60	1.62	0.73	0.80	0.79	0.74	0.92
	2nd	0.73	0.60	0.68	0.57	1.13	0.70	0.76	0.75	0.71	0.85
	3rd	0.63	0.52	0.59	0.50	0.87	0.61	0.66	0.65	0.62	0.73
Sep.	1st	0.66	0.55	0.62	0.53	0.87	0.64	0.69	0.68	0.65	0.76
	2nd	0.63	0.53	0.59	0.51	0.82	0.61	0.65	0.65	0.62	0.73
	3rd	1.27	0.51	0.57	0.49	0.78	0.58	0.63	0.62	0.59	0.81
Oct.	1st	8.39	0.49	0.55	0.47	0.74	0.56	0.60	0.60	0.57	0.71
	2nd	8.19	0.47	0.52	0.45	0.70	0.54	0.58	1.58	0.55	0.66
	3rd	4.98	0.41	0.46	0.40	0.61	0.47	0.50	5.12	0.48	0.57
Nov.	1st	7.92	0.44	0.48	0.42	3.47	0.50	0.65	5.48	0.51	1.47
	2nd	11.14	0.42	0.47	0.41	2.13	0.48	2.66	7.53	0.49	2.30
	3rd	8.14	1.01	0.45	0.40	3.32	0.46	3.09	6.24	0.47	1.25
Dec.	1st	4.42	0.88	0.44	3.46	2.39	1.39	1.93	5.39	2.26	5.52
	2nd	2.21	2.47	0.55	3.79	5.42	2.57	3.11	7.37	7.88	5.72
	3rd	3.66	4.93	0.42	4.07	4.49	2.68	7.19	4.55	7.98	2.95
Mean	1st	5.17	2.45	4.32	4.09	5.73	5.96	4.71	5.17	4.91	5.37

Table 1(2)

ESTIMATED RUNOFF

KUNDIR

Month		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Mean
Jan.	1st	8.71	6.05	8.31	7.39	7.59	10.43	0.52	6.59	9.01	14.19	6.93
	2nd	10.79	4.97	10.10	9.50	8.64	10.73	4.47	9.22	13.14	17.05	8.74
	3rd	11.39	7.56	8.90	10.50	9.79	11.62	7.34	9.82	11.22	12.19	9.21
Feb.	1st	11.94	10.51	10.26	8.55	10.95	15.93	7.94	10.80	11.63	16.95	10.75
	2nd	13.77	12.88	9.05	7.54	13.24	14.74	8.11	9.34	11.13	17.73	11.51
	3rd	18.70	13.82	9.84	14.03	21.25	18.72	11.15	11.67	12.69	20.02	13.31
Mar.	1st	13.61	9.37	12.77	11.70	13.97	13.06	8.33	12.37	11.90	13.23	11.19
	2nd	11.56	10.57	9.52	12.35	17.40	10.67	6.99	12.17	12.51	22.76	11.93
	3rd	7.53	11.91	8.70	12.95	16.53	9.62	4.04	9.04	11.46	20.91	11.00
Apr.	1st	7.66	12.90	7.15	12.26	15.03	11.52	2.76	7.03	11.72	19.08	11.44
	2nd	5.86	14.62	4.79	8.00	12.03	14.01	3.79	5.28	10.54	15.40	9.79
	3rd	3.75	13.30	2.19	5.78	7.36	17.12	2.46	5.52	8.26	12.62	8.29
May	1st	4.19	10.90	1.39	2.94	6.37	15.05	1.32	6.32	4.31	12.36	6.98
	2nd	2.59	12.14	1.06	1.53	4.97	9.71	0.95	4.71	1.97	9.63	5.20
	3rd	1.91	9.40	0.86	1.00	4.68	5.10	0.74	1.91	1.12	8.95	3.68
June	1st	1.31	5.97	0.89	3.11	5.42	5.58	0.75	1.26	0.98	6.06	3.00
	2nd	1.04	2.50	0.83	1.78	4.66	2.83	0.71	0.96	0.88	2.64	2.03
	3rd	0.93	1.48	0.79	1.15	3.42	1.56	0.68	1.47	0.82	1.44	1.60
July	1st	0.87	1.11	0.75	0.93	7.37	1.15	0.65	1.27	0.78	1.05	1.43
	2nd	0.82	0.96	0.72	0.84	5.57	0.99	0.62	1.11	0.74	0.99	1.24
	3rd	1.61	0.81	0.83	0.72	2.62	0.83	1.39	0.3e	0.64	0.76	1.00
Aug.	1st	1.22	0.84	0.66	0.75	1.74	0.86	0.89	0.34	0.63	0.78	0.87
	2nd	0.91	0.80	0.63	0.71	1.21	0.82	0.68	0.78	0.65	0.75	0.77
	3rd	0.72	0.59	0.55	0.62	0.92	0.71	0.55	0.68	0.56	0.65	0.65
Sep.	1st	0.73	0.73	0.58	0.65	0.93	0.74	0.57	0.72	0.59	0.63	0.67
	2nd	0.75	0.87	0.55	0.63	0.67	0.71	0.54	0.68	0.57	0.65	0.65
	3rd	0.67	0.74	0.54	0.60	0.83	0.68	0.52	2.18	0.55	0.62	0.74
Oct.	1st	1.35	3.28	0.52	0.58	0.79	0.65	0.50	1.13	0.53	0.60	1.20
	2nd	1.03	3.05	0.53	0.55	0.75	0.62	0.48	0.79	0.51	0.57	1.15
	3rd	2.11	5.18	0.46	0.49	0.65	0.54	0.43	0.61	0.44	2.75	1.32
Nov.	1st	1.29	6.35	0.49	0.51	1.34	0.57	0.46	0.62	0.47	3.25	1.83
	2nd	1.60	8.07	0.58	0.50	1.12	0.55	0.44	1.75	0.45	1.65	2.23
	3rd	2.85	7.13	4.26	0.49	1.38	0.53	3.54	3.69	0.44	1.66	2.54
Dec.	1st	6.27	7.92	4.71	0.78	3.39	0.51	3.37	6.42	3.39	2.52	3.39
	2nd	7.26	6.79	4.27	1.19	4.55	0.49	2.15	6.55	5.31	1.26	4.04
	3rd	5.18	3.85	3.57	5.00	8.97	0.43	4.00	4.66	7.14	3.76	4.47
Mean	1st	4.86	6.39	3.66	4.14	6.84	5.84	2.83	4.46	4.71	7.65	4.91

Table 2(1) CONSTRUCTION COST ESTIMATE FOR KUNCIR SCHEME

Item No.	Work	unit	Quantity	Unit Price (10^3Rp)	Amount (10^6Rp)
1.	Civil Works				53,850
1-1	Preparatory works	L.S			3,989
1-2	Diversion Works				
	Excavation (earth)	m^3	28,000	3.5	98
	(rock)	m^3	28,000	7.5	210
	(tunnel)	m^3	24,500	43.4	1,063
	Steel support	ton	230	653.3	150
	Concrete	m^3	8,000	124.4	995
	Reinforcement bar	ton	330	609.8	201
	Consolidation grout	m	3,150	72	227
	Sub-total				2,945
1-3	Dam				
	Excavation (earth)	m^3	450,000	3.5	1,575
	(rock)	m^3	300,000	7.5	2,250
	Embankment (core)	m^3	1,200,000	5.5	2,250
	(filter)	m^3	370,000	4.8	1,776
	(gravel)	m^3	5,220,000	4.2	21,924
	(random)	m^3	72,000	4.2	302
	Concrete	m^3	12,500	94.6	1,183
	Reinforcement bar	ton	380	609.8	232
	Curtain & blanket grout	m	60,000	72	4,320
	Sub-total				40,162
1-4	Spillway				
	Excavation (earth)	m^3	140,000	3.5	490
	(rock)	m^3	210,000	7.5	1,575
	Concrete	m^3	30,000	94.6	2,838
	Reinforcement bar	ton	600	609.8	366
	Sub-total				5,269
1-5	Waterway				
	Excavation (earth)	m^3	9,100	3.5	32
	(rock)	m^3	16,900	7.5	127
	(tunnel)	m^3	700	65.1	46
	Steel support	ton	20	653.3	13
	Concrete	m^3	700	124.4	87

-- to be continued --

Table . 2(2) CONSTRUCTION COST ESTIMATE FOR KUNCIR SCHEME

Item No.	Work	Unit	Quantity	Unit Price (10^3Rp)	Amount (10^6 Rp)
	Reinforcement bar	ton	10	609.8	6
	Consolidation grout	m	220	72	16
	Sub-total				326
1-6	Powerhouse				
	Excavation (earth)	m^3	4,200	3.5	15
	(rock)	m^3	9,800	7.5	74
	Concrete	m^3	3,200	94.6	303
	Reinforcement bar	ton	130	609.8	79
	Backfill	m^3	700	3.5	2
	Architectural works	L.S			333
	Utility works	L.S.			354
	Sub-total				1,160
2.	Metal Works				357
2-1	Gates, Screen	ton	20	5,150	103
2-2	Penstock	ton	36	2,884	104
2-3	Hollow Jet Valve	ton	12		150
3.	Generating Equipment including T/L	L.S.			2,566
	Total				56,733
4.	Engineering Service				5,677
5.	Administration				2,839
6.	Base Cost				65,289
7.	Physical Contingency				9,793
	Grand Total				75,083

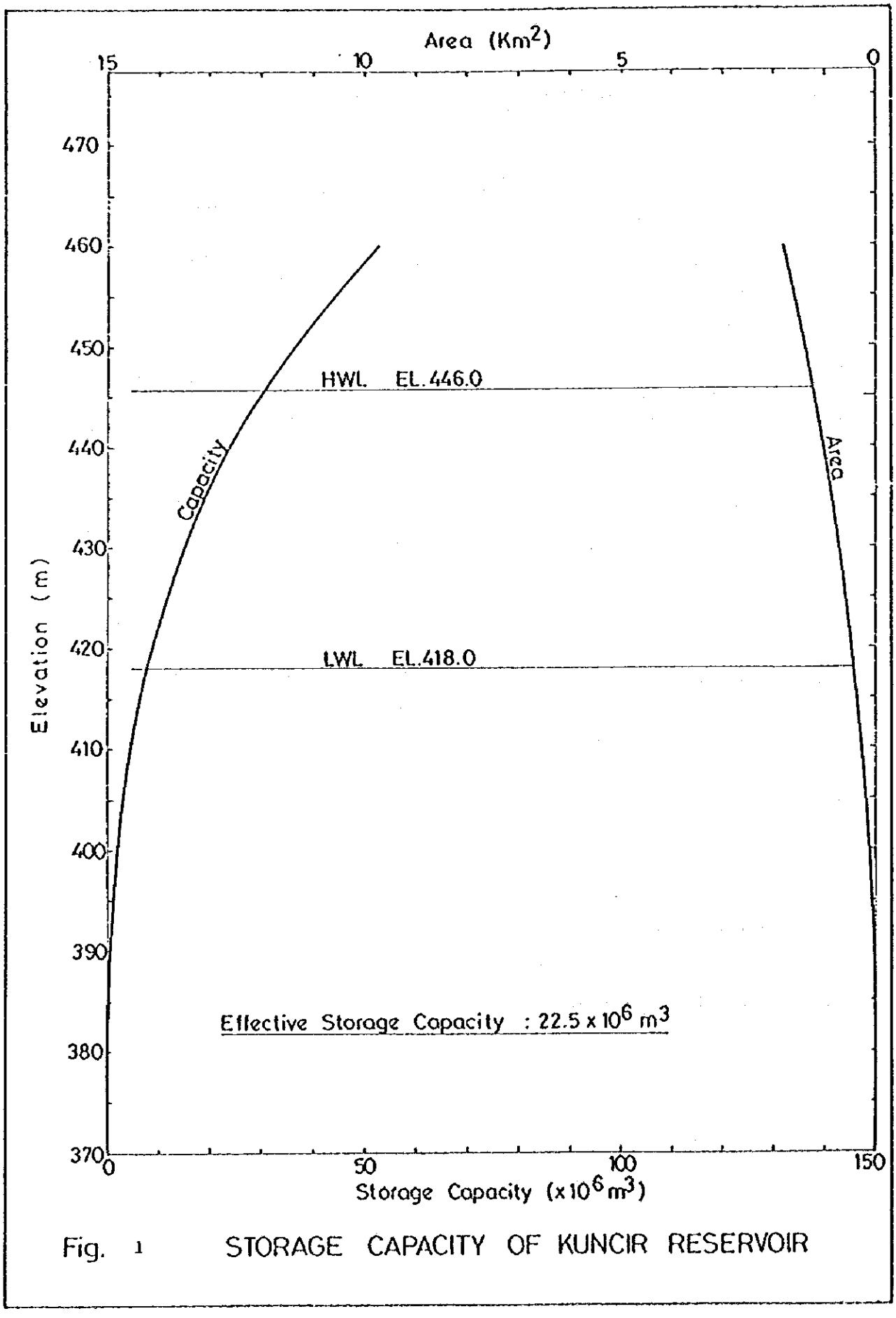


Fig. 1 STORAGE CAPACITY OF KUNCIR RESERVOIR

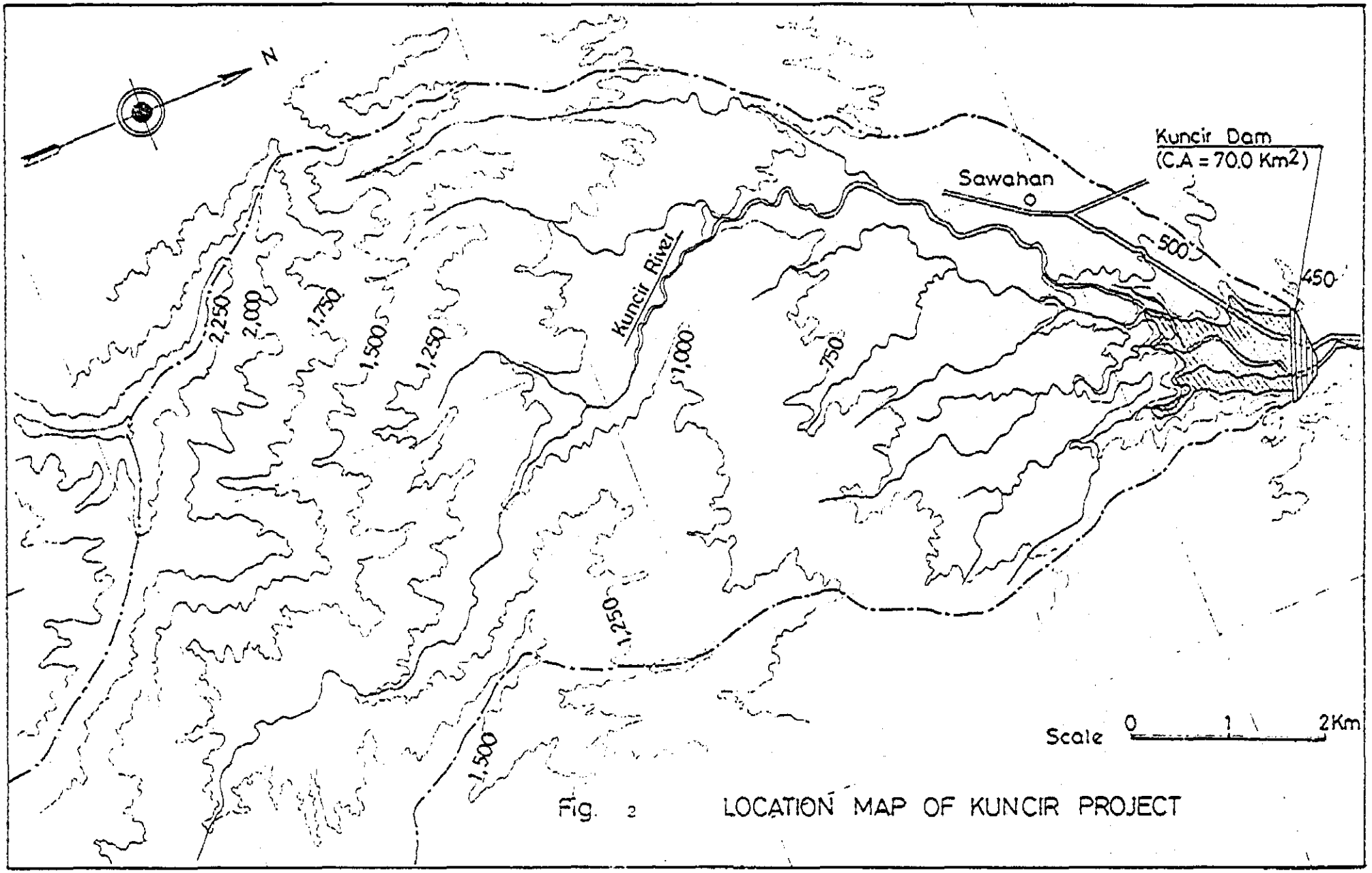
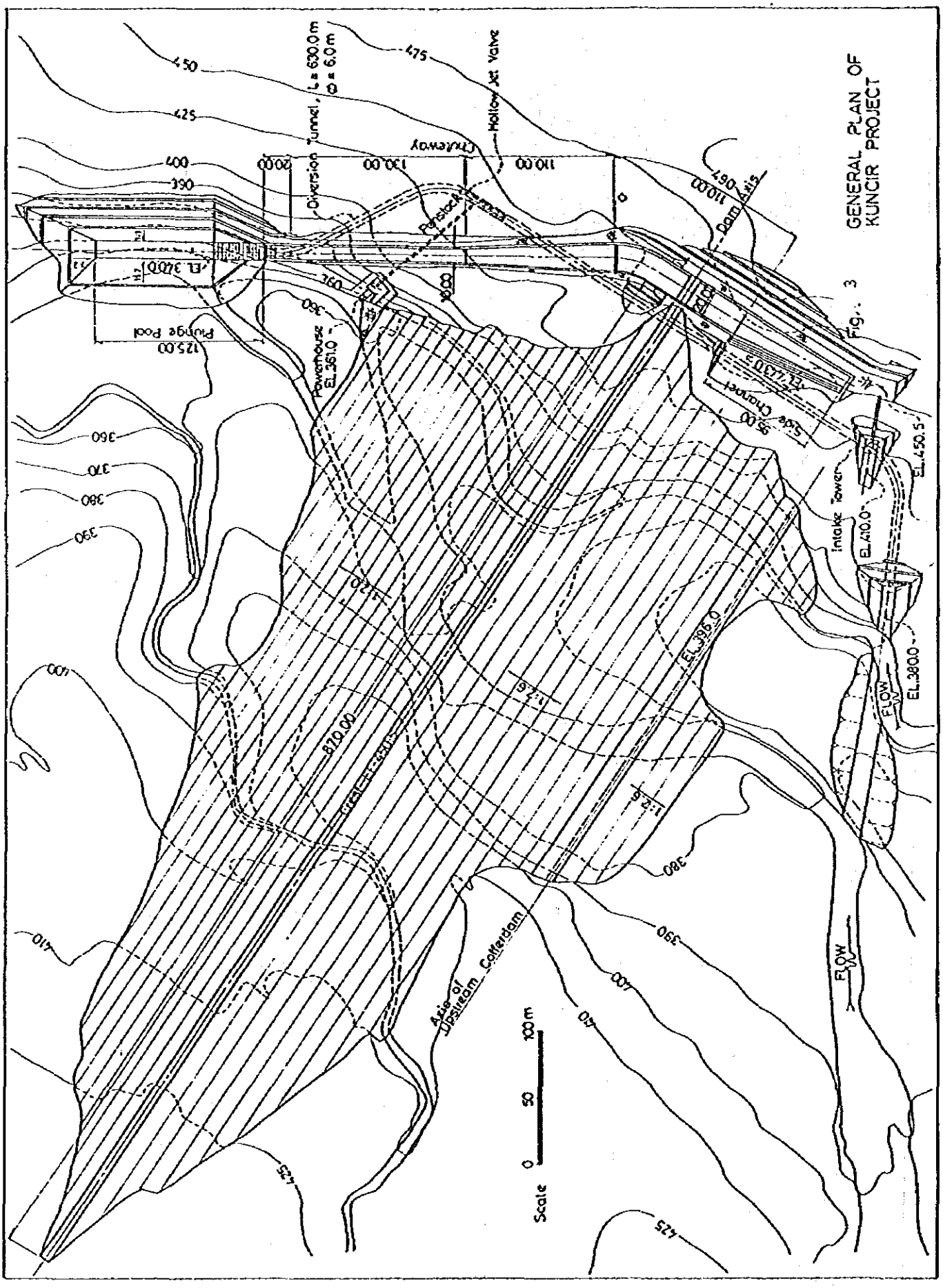


Fig. 2 LOCATION MAP OF KUNCIR PROJECT

MP-7.9


GENERAL PLAN OF KUNCIR PROJECT
Fig. 3
Diversion Tunnel, L = 630.0 m
Ø = 6.0 m
Hollow Jet Valve
Dam Axis
Penstock
Powerhouse
EL. 361.0
Plunge Pool
Side Channel
EL. 450.5
Intake Tower
EL. 410.0
EL. 395.0
EL. 380.0
FLOW
Axis of Upstream Cofferdam
Scale
0
50
100 m

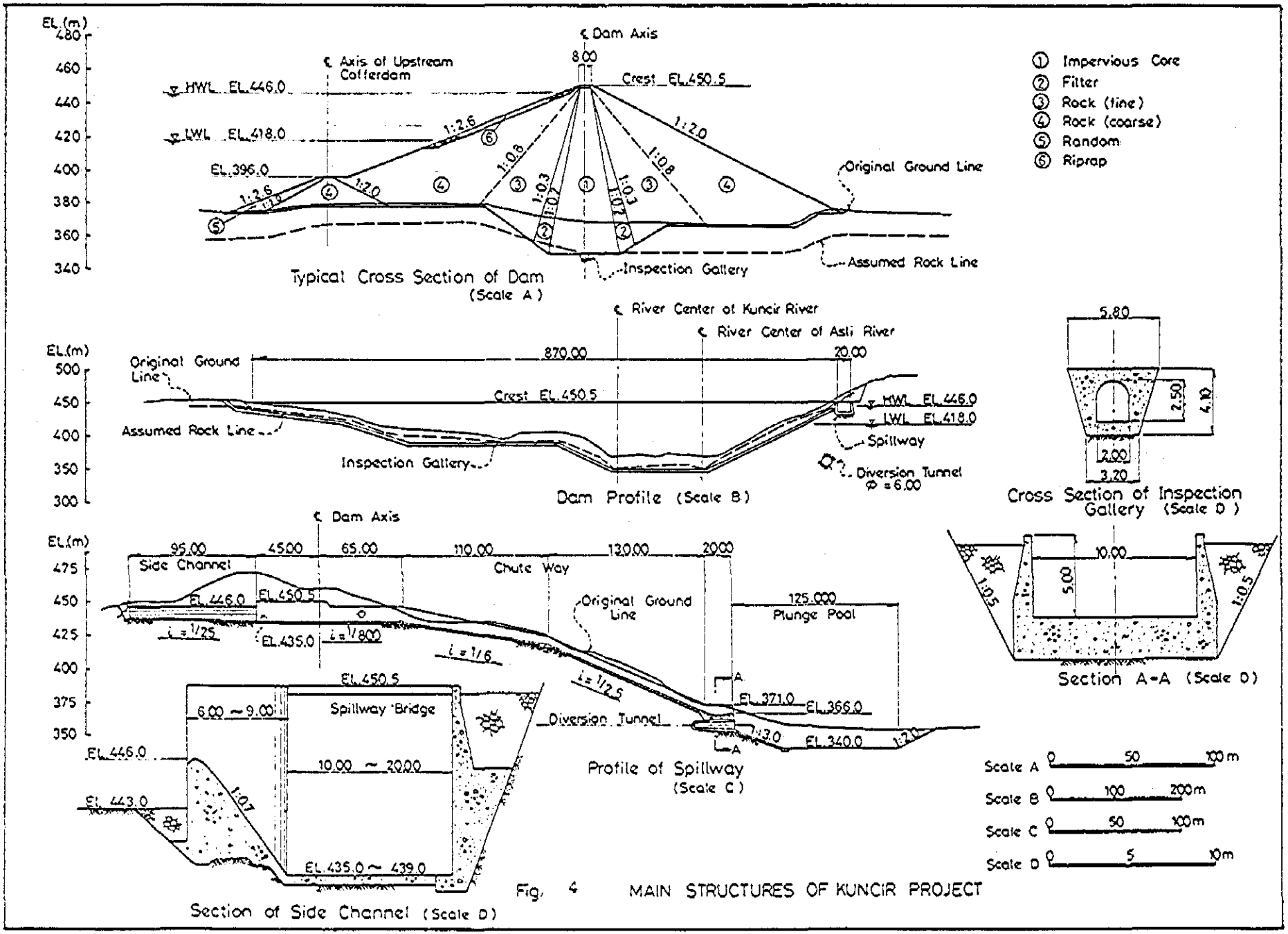


Fig. 4 MAIN STRUCTURES OF KUNCIR PROJECT

NOTE MP-8

SEMANTOK SCHEME

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOTE MP-8 Semantok Scheme

1. Objectives of Scheme

The objectives of scheme are envisaged as follows;

- Water supply to the Widas Extension Area of 2,250 ha
- Flood control

2. Natural Conditions

Location and Topography

The damsite is selected on Semantok river, 10 km upstream from the confluence with Widas river. The catchment area at this site is measured at 61 km^2. The topography of the dam site is very gentle and the low lying hills have elevations ranging from 80 m to 90 m.

Hydrology

Low flow is estimated by the Tank Model method. Monthly mean run-off is as shown below;

Unit : m^3/s

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
3.1	3.4	3.4	2.3	1.6	0.5	0.2	0.2	0.2	0.3	0.9	5.7

Ten-day mean run-off is as shown in Table 1.

Probable floods are estimated by the Nakayasu's Unit Hydrograph method as follows;

Probability	Probable Flood Peak Discharge
Once in 25 years	266 m^3/s
100	349
200	390
1,000	444
10,000	484

Geological Conditions

There is no geological data at this moment. Additional test boring is proposed.

It is presumed that the geology of the Semantok damsite may be similar to that of the Kedungwarak damsite which is composed of the tuffaceous sand stone and volcanic sand stone. Judging from the gentle topography, the extent of weathering in the Semantok damsite may be deeper.

3. Possible Development

The available run-off at the damsite is limited, and fluctuates, from year to year. It is conceived to exploit the water resources

in Semantok river by a carry-over type reservoir which can regulate the natural run-off over the years.

Scale of Development

The stage-storage capacity curve is drawn as shown in Fig. 4 Development of a reservoir with an effective capacity of 40 x 10^6 m^3 is envisaged, which can control the natural run-off fully.

Preliminary Layout

4. Preliminary layout is made on the 1 to 2,500 scale map, as shown on Fig. 1 to 3. The dam is designed as homogeneous earthfill, taking into account difficulty in obtaining rock materials. Long saddle dikes are arranged in the right and left abutments for securing the intended storage capacity. As for the diversion system during construction, an open channel is selected, since the covering over the diversion tunnel is too shallow. Principal features are as follows;

PRINCIPAL FEATURES OF SEMANTOK SCHEME

Location	on K. Semantok, 10 km from the confluence with K. Widas
River Basin	K. Widas
Stream	K. Semantok
Hydrology	
Catchment area	61 km^2
Average run-off	1.5 m^3/s
10,000 year probable flood	619 m^3/s
Reservoir	
High water level	EL. 96.5 m
Low water level	EL. 80 m
Gross storage capacity	43,500,000 m^3
Effective storage capacity	40,000,000 m^3
Reservoir surface area at HWL	4.5 km^2
Dam	
Type	Homogeneous earthfill dam
Crest elevation	EL. 100 m
Crest length	3,570 m
Height above river bed	33 m
Dam height	43 m
Upstream slope	1 : 3.5
Downstream slope	1 : 3.0
Embankment volume	5,284 x 10^3
Spillway	
Type	Center flow concrete gravity
Crest elevation	EL. 96.5 m
Crest width	30 m
Chuteway	30 m wide
Stilling basin	20 m length x 30 m width
Diversion system	
Type	Open channel
Design discharge	266 m^3/sec
Intake	
Sill elevation	EL. 77.5 m

5. Cost Estimate

The construction cost is estimated at Rp. 73,167 million. Breakdown is as shown in Table 2.

6. Anticipated Benefit

Positive benefit

Although the Semantok resrvoir is contemplated in connection with the Widas north irrigation scheme, water suplly benefit is tentatively evaluated by the unit water value of Rp. 100 / m^3.

Water supply

40×10^6 m^3 x Rp. 100 = Rp. $4,000 \times 10^6$ / year

Negative benefit

The reservoir area of 450 ha is used halfly as paddy field equivalent Then the land cost is estimated as follows;

450 ha x 0.5 x Rp. 1.0×10^6 = Rp. 225×10^6 / year
450 ha x 0.5 x Rp. 0.5×10^6 = Rp. 113×10^6/year

Net benefit

Rp. $3,663 \times 10^6$ / year

Table - 1(1)

****
* ESTIMATED RUNOFF *
****

SEMANTOK

Month	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Jan. 1st	1.68	3.64	3.01	2.82	4.72	0.40	1.21	2.32	5.16	4.32
2nd	0.63	1.69	1.08	3.52	2.36	2.43	1.28	4.07	3.85	2.93
3rd	2.87	0.56	1.15	3.66	1.38	3.93	2.86	2.93	1.49	1.18
Feb. 1st	4.96	0.39	0.52	5.58	1.56	3.12	3.88	2.33	2.95	2.26
2nd	3.37	0.21	3.49	5.23	0.74	6.25	2.20	4.47	2.14	7.27
3rd	1.18	0.22	5.35	4.67	0.47	4.91	3.73	5.42	2.00	11.24
Mar. 1st	5.74	0.17	3.50	1.70	2.26	1.38	6.96	2.28	2.18	6.51
2nd	4.96	0.76	2.91	2.18	5.55	2.82	10.16	1.92	2.75	3.72
3rd	1.60	0.31	1.24	2.71	5.26	1.84	6.37	2.71	2.26	3.50
Apr. 1st	3.76	1.63	0.72	3.77	7.09	1.46	5.58	1.63	0.87	2.25
2nd	2.74	0.81	0.42	4.78	3.55	0.77	2.68	0.81	0.38	1.49
3rd	0.95	0.36	0.25	3.72	1.52	0.86	3.13	0.57	0.22	1.71
May 1st	1.43	0.22	0.19	1.30	2.13	0.38	2.51	3.18	6.18	5.52
2nd	0.56	0.18	0.17	0.51	1.74	0.23	1.03	2.74	4.03	7.90
3rd	0.88	0.15	0.14	0.24	1.29	0.16	0.43	2.04	1.28	4.78
June 1st	0.90	0.16	0.19	0.19	0.57	0.16	0.26	2.36	0.53	3.16
2nd	0.86	0.16	0.16	0.18	0.29	0.15	0.19	0.34	0.27	1.10
3rd	0.39	0.16	0.16	0.16	0.20	0.15	0.16	0.37	0.19	0.45
July 1st	0.24	0.16	0.15	0.15	1.26	0.15	0.15	0.22	0.16	0.25
2nd	0.19	0.15	0.15	0.15	1.15	0.15	0.15	0.17	0.15	0.18
3rd	0.16	0.14	0.14	0.14	0.46	0.13	0.13	0.14	0.13	0.14
Aug. 1st	0.17	0.16	0.15	0.15	0.26	0.15	0.15	0.15	0.15	0.15
2nd	0.17	0.16	0.15	0.15	0.19	0.15	0.15	0.15	0.15	0.15
3rd	0.15	0.14	0.14	0.14	0.15	0.13	0.13	0.13	0.13	0.13
Sep. 1st	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
2nd	0.16	0.16	0.15	0.15	0.15	0.15	0.14	0.15	0.14	0.14
3rd	0.16	0.16	0.15	0.15	0.15	0.15	0.14	0.15	0.14	0.14
Oct. 1st	0.62	0.16	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14
2nd	0.30	0.15	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14
3rd	0.19	0.14	0.14	0.13	0.13	0.14	0.13	2.83	0.13	0.13
Nov. 1st	1.67	0.15	0.15	0.15	1.15	0.15	0.18	1.69	0.14	0.14
2nd	0.62	0.15	0.15	0.15	0.75	0.15	0.20	2.20	0.14	0.18
3rd	0.46	0.15	0.30	0.15	0.93	0.19	1.40	0.87	0.14	1.89
Dec. 1st	0.25	0.16	3.85	2.71	1.42	0.16	0.84	0.43	0.14	3.15
2nd	0.19	0.76	4.19	1.42	2.55	2.69	0.37	4.83	1.45	2.40
3rd	3.73	1.93	3.68	4.90	0.86	2.79	1.68	2.23	5.03	1.18
Mean 1st	1.46	0.45	1.07	1.63	1.57	1.09	1.69	1.65	1.30	2.27

Table- 1(2)

****
*** ESTIMATED RUNOFF ***
****

SEMANTOK

Month	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Mean
Jan. 1st	1.68	3.59	2.88	2.55	7.67	9.00	0.14	5.47	2.52	5.70	3.51
2nd	2.05	5.38	2.53	2.01	7.04	5.63	2.84	3.54	2.04	5.43	3.11
3rd	0.91	3.51	0.83	2.93	5.06	5.39	2.73	4.17	1.32	4.13	2.67
Feb. 1st	3.84	5.68	0.39	4.09	4.62	3.53	1.57	3.39	2.94	4.71	3.09
2nd	2.52	3.87	0.38	2.62	5.66	1.42	1.19	2.31	2.42	3.78	3.08
3rd	2.97	4.03	4.82	1.22	4.16	4.62	4.01	1.33	3.15	9.83	3.96
Mar. 1st	3.97	3.16	8.84	0.55	2.51	3.04	3.30	2.53	4.25	5.97	3.60
2nd	3.28	1.80	7.09	0.62	2.38	3.09	3.96	1.59	5.00	4.98	3.57
3rd	1.99	4.05	2.93	2.50	0.33	2.53	3.05	2.46	3.36	3.92	2.95
Apr. 1st	2.10	5.08	1.99	3.60	0.42	3.76	2.66	2.22	1.86	4.11	2.82
2nd	4.43	6.11	0.72	1.36	0.24	6.25	2.51	0.98	1.02	2.97	2.25
3rd	2.00	5.93	0.33	1.49	0.18	4.84	1.25	0.86	1.98	1.98	1.71
May 1st	2.16	4.19	0.21	0.56	0.16	5.34	0.52	3.04	0.71	2.83	2.15
2nd	3.12	2.07	0.17	0.28	0.15	3.31	0.27	1.19	0.33	4.31	1.71
3rd	1.15	0.70	0.14	0.13	0.13	1.40	0.17	0.43	0.19	3.99	0.98
June 1st	0.50	0.35	0.15	0.62	1.24	3.34	0.16	0.25	0.17	1.79	0.85
2nd	0.26	0.22	0.15	0.30	0.48	1.38	0.15	0.18	0.15	0.66	0.40
3rd	0.17	0.17	0.15	0.23	0.28	0.54	0.15	1.51	0.15	0.31	0.39
July 1st	0.16	0.16	0.15	0.17	0.76	0.28	0.15	0.61	0.15	0.20	0.28
2nd	0.15	0.15	0.15	0.16	0.34	0.19	0.14	0.30	0.15	0.17	0.22
3rd	0.14	0.14	0.13	0.14	0.19	0.15	0.13	0.18	0.13	0.14	0.15
Aug. 1st	0.73	0.15	0.15	0.15	0.16	0.15	0.14	0.16	0.15	0.15	0.18
2nd	0.33	0.15	0.15	0.15	0.15	0.15	0.14	0.15	0.15	0.15	0.16
3rd	0.18	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Sep. 1st	0.16	0.15	0.15	0.15	0.15	0.15	0.14	0.15	0.14	0.15	0.15
2nd	0.20	0.15	0.15	0.15	0.14	0.15	0.14	0.14	0.14	0.15	0.15
3rd	0.16	0.15	0.15	0.15	0.14	0.15	0.14	0.14	0.14	0.14	0.14
Oct. 1st	0.44	1.75	0.15	0.15	0.14	0.15	0.14	0.14	0.14	0.14	0.26
2nd	0.24	0.63	0.15	0.14	0.14	0.15	0.14	0.14	0.14	0.88	0.21
3rd	0.87	1.97	0.13	0.13	0.13	0.13	0.13	0.12	0.13	0.50	0.40
Nov. 1st	0.30	1.18	0.49	0.14	0.18	0.15	0.14	0.14	0.14	2.82	0.56
2nd	1.36	1.35	0.25	0.14	0.22	0.14	1.13	1.26	0.14	1.75	0.62
3rd	0.93	2.41	4.13	1.37	0.17	0.14	3.43	1.77	0.14	3.69	1.48
Dec. 1st	4.64	4.76	4.01	1.75	2.55	0.14	9.22	1.96	0.14	2.69	2.25
2nd	5.76	2.59	1.65	1.50	2.92	0.14	6.43	1.12	1.31	0.92	2.27
3rd	3.71	0.95	0.73	5.69	10.41	0.13	6.72	1.94	4.37	4.66	3.36
Mean 1st	1.64	2.18	1.32	1.11	1.72	1.93	1.78	1.33	1.15	2.52	1.55

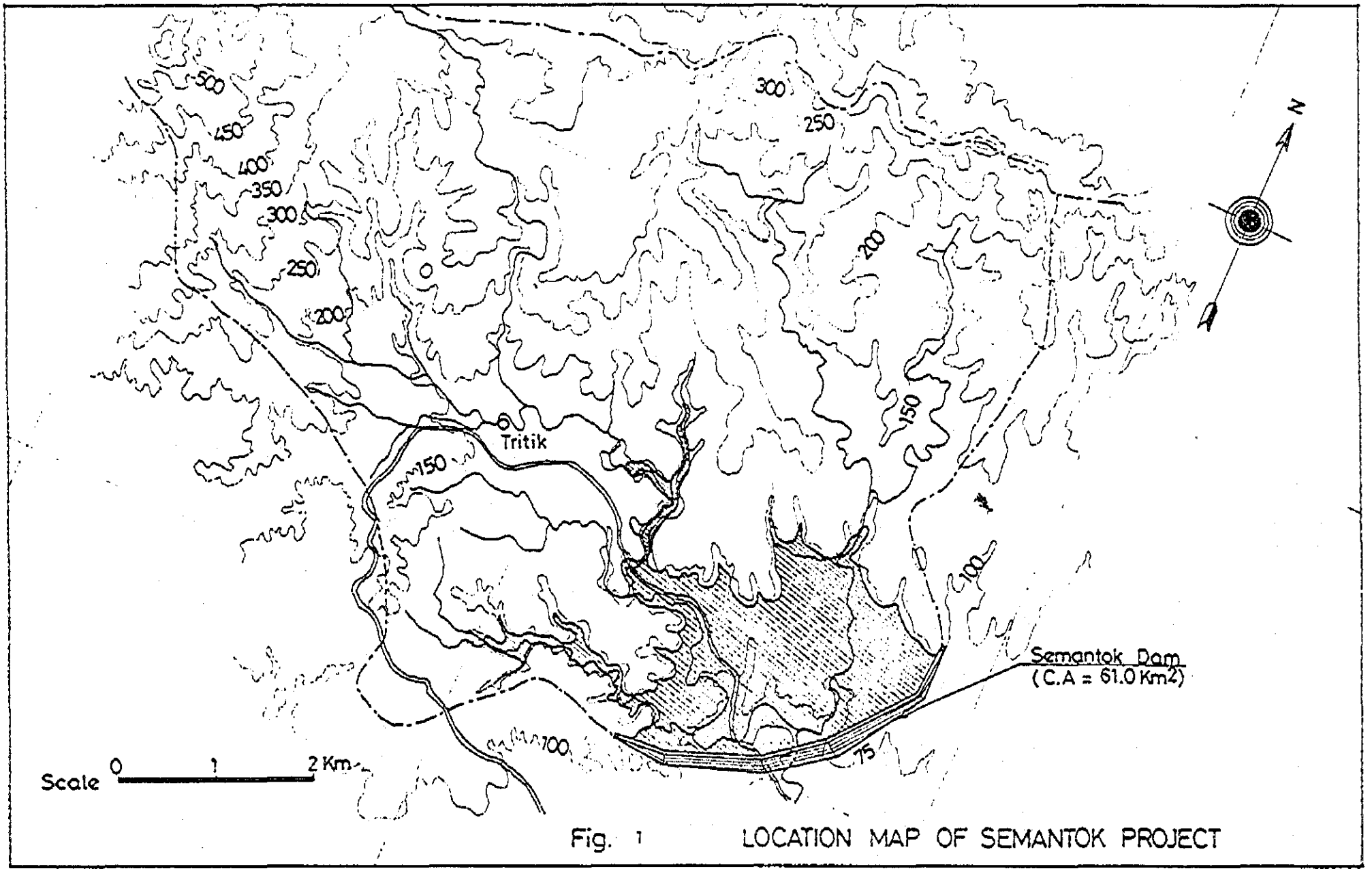


Fig. 1 LOCATION MAP OF SEMANTOK PROJECT

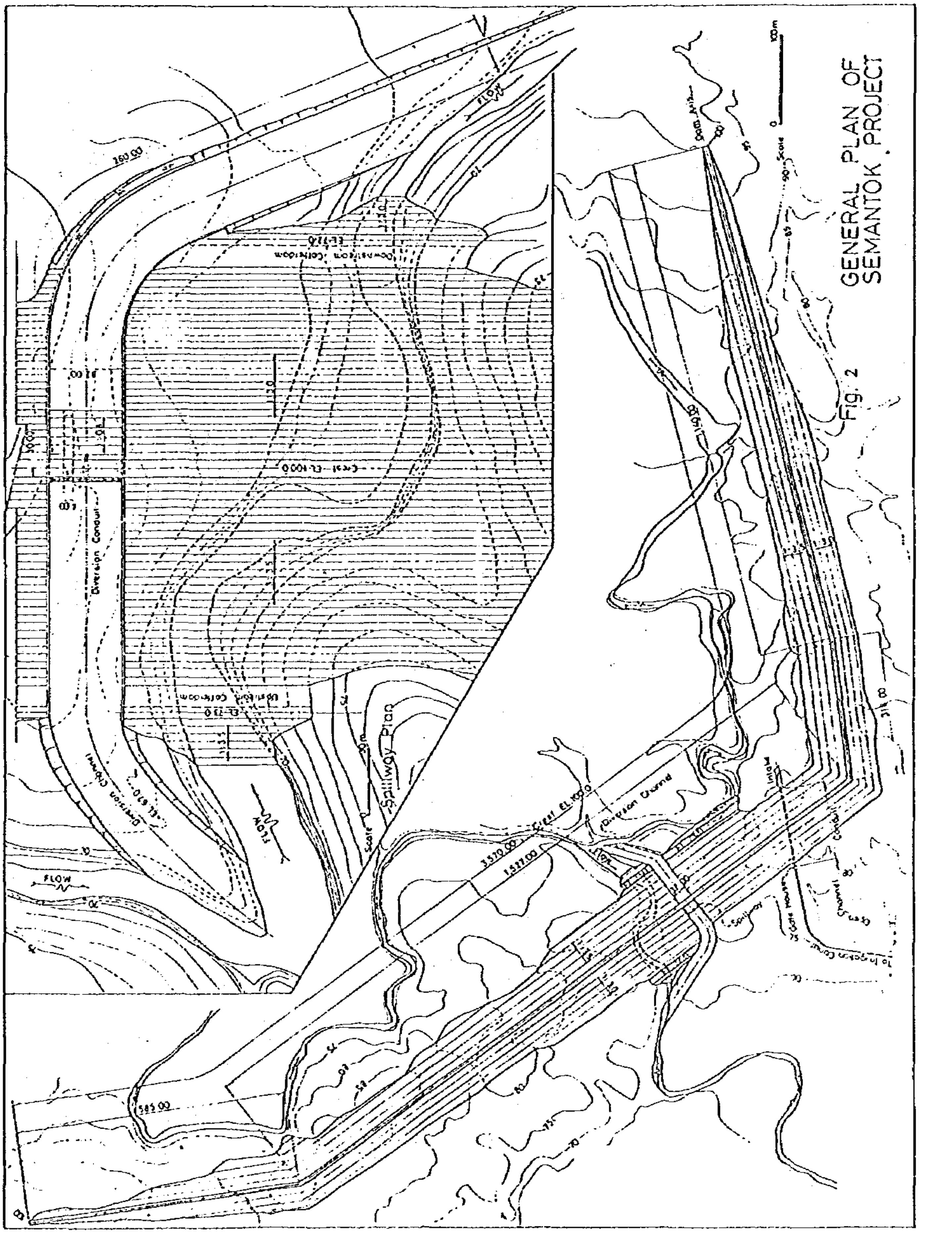


Fig. 2 GENERAL PLAN OF SEMANTOK PROJECT

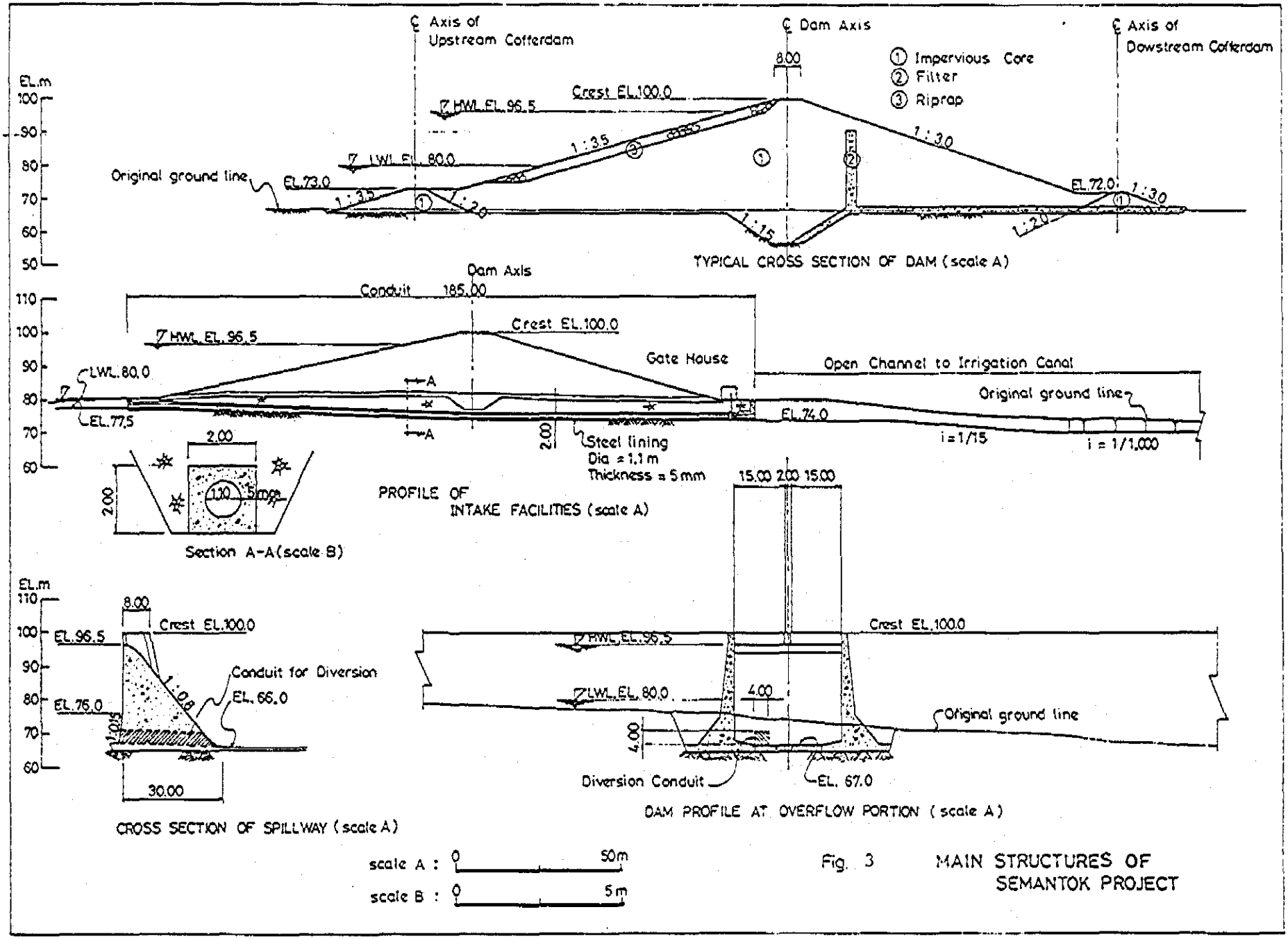


Fig. 3 MAIN STRUCTURES OF SEMANTOK PROJECT

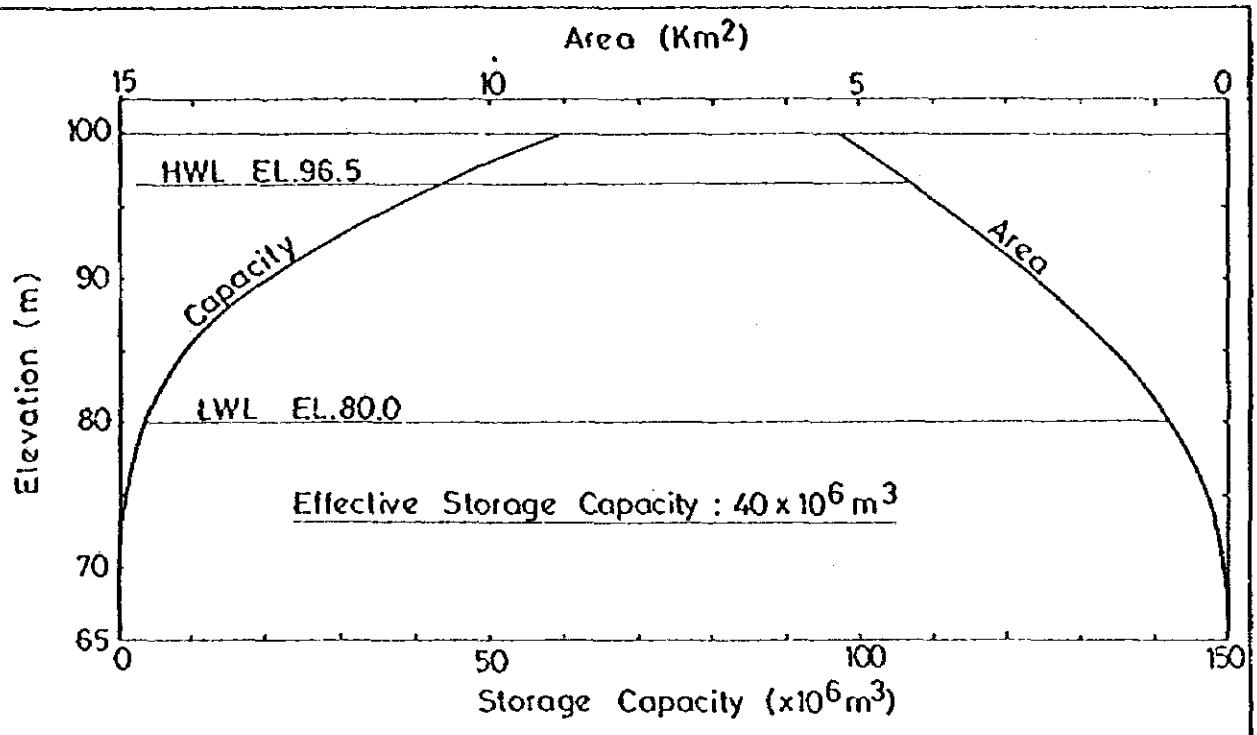


Fig. 4 STORAGE CAPACITY OF SEMANTOK RESERVOIR

NOTE MP-9

KEDUNGWARAK SCHEME

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOTE MP - 9 Kedungwarak Scheme

1. Objectives of Scheme

This scheme has an unsolvable problem of the limited available runoff, even the topographic conditions at the damsite and in the reservoir area are favourable for large-scale development of a storage reservoir. Therefore, the following objectives are tentatively set out:

- Water supply with the pumped up water in the rainy season.

2. Natural Conditions

Location and Topography

The site is selected on Kedungwarak river, 13 km from the confluence with Widas river. At the proposed damsite, the catchment area is 32 km^2, based on the 1 to 50,000 scale map. The damsite is a narrow valley with the opening of 115 m at the elevation of 173 m. The reservoir is a wide and flat valley enclosed by low hills.

Hydrology

Low flow is estimated by the Tank Model method. The monthly mean runoff is as follows;

Unit : m^3/s

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1.4	1.5	1.5	1.0	0.7	0.2	0.1	0.1	0.1	0.1	0.4	1.2

Ten-day mean runoff is estimated as shown in Table 1.

The probable floods are estimated as follows:

Probability	Probable Flood Peak Discharge
Once in 25 years	198 m^3/s
100	258
200	287
1,000	355
10,000	451

Geology

In the Kedungwarak damsite area, boring investigation has been carried out by BRBDEO. According to the investigation, the geology of the dam site consists of the tuffaceous sandstone and volcanic sandstone. The strength of the foundation rock is assumed to be in an order to allow fill-type dam of several tens meter high.

3. Possible Development

The Kedungwarak damsite has the following characteristics;

- Narrow valley
- Huge potential reservoir capacity
- Little inflow into the reservoir

There are two alternatives; one is small scale development within the limit of hydrology and the other is larger scale development using the topographic advantages fully. In this study, the latter is examined from the viewpoint of water supply in the entire Brantas Basin. The hydrological limit is assumed to be solved by pumping up of the excess water in the rainy season.

4. Development Scale

The topographically possible maximum height of the Kedungwarak dam is measured as EL. 194 m on the 1 to 2,500 scale map. By setting the high water level at EL. 190 m, it is possible to attain a storage capacity of 224 x 10^6 m^3. If this large reservoir is to be filled in 151 days in the rainy season, the necessary discharge is 17.2 m^3/sec. If water is taken from the lower reaches of Widas river, it may be possible. However, the water way will become long and the scheme will be costly. To make the scheme economical, it is necessary of shorten the water way as much as possible. Then, storage capacity is limited by the average runoff at the nearest point of Widas river. The average runoff at the nearest point is estimated at 4.5 m^3/sec.

Then, the storage capacity is set at 54 x 10^6 m^3 as shown on Fig.1.

The distance between the Kedungwarak damsite and Widas river is about 12,600 m. In order to keep the cost minimum, combination of open canal and pipe line is conceived. The open canal covers the first section of about 7,600 m and the pipeline covers the remaining 5,000 m. Least cost analysis of pump from river to open canal, open canal and pump and pipeline from canal to reservoir is as shown in Table 2 to 4. Results are as follows;

1.	River to Canal	(= 50 m)
	EL. 44 m	EL. 53.5 m
	Pipe dia	1,900 mm
	Pump	515 KM
	Annual energy	1,866 Mwh
2.	Open Canal	(= 7,7600 m)
	Base width	2 m
	Slope	1 / 5,000
3.	Canal to Reservoir	(= 5,000 m)
	EL. 51.98	EL. 170 m

Pipe dia	1,500 mm
Pump	7,160 kW
Annual energy	25,752 Mwh

5. Preliminary Layout

Preliminary layout is drawn based on 1 to 2,500 scale map as shown in Fig.2 to 4. The dam is designed as homogeneous earthfill type, taking into account difficulties in obtaining suitable rock materials within an economical distance.

Principal features are as follows;

PRINCIPAL FEATURES OF KEDUNGWARAK SCHEME

Location	on K. Kedungwarak, 12 km from the confluence with the Widas
River Basin	K. Widas
Stream	K. Kedungwarak
Hydrology	
Catchment area	32 km^2
Average runoff	0.68 m^3/s
10,000 year probable flood	451 m^3/sec
Reservoir	
High water level	EL. 170 m
Low water level	EL. 152 m
Gross storage capacity	57,000,000 m^3
Effective storage capacity	54,000,000 m^3
Reservoir surface area at HWL	6.5 km^2
Pumping Up Scheme	
Water source	K. Widas
Pump-up Discharge	4.2 m^3/s
Pump from river to canal	
Capacity	515 kW
Head	9.5 m
Open canal	
Length	7,600 m
Pump from canal reservoir	
Capacity	7,160 kW
Head	118.02 m
Pipeline	
Length	5,000 m
Diameter	1,500 mm
Dam	
Type	Homogeneous Earthfill dam
Crest elevation	EL. 173 m
Crest length	115 m
Dam height	32 m
Upstream slope	1 : 3.5
Downstream slope	1 : 3.0
Embankment volume	216 x 10^3 m^3

Spillway	
Type	Side channel
Crest elevation	EL. 170 m
Crest width	20 m
Chuteway	85 m x 5 m
Stilling basin	30 m length x 5 m width
Diversion Tunnel	
Type	Circular section
Design discharge	198 m^3/sec
Diameter	5.0 m
Length	300 m

6. Cost Estimate

The construction cost of the dam is estimated at Rp. 5,894 million. Breakdown is as shown in Tabel 5. Including costs of pipeline and pumps station, the total cost is estimated at Rp. 41,503 million.

7. Anticipated Benefits

Positive Benefit

The anticipated benefits are as follows:

Water Supply

$54 \times 10^6\ m^3 \times Rp.100/m^3 = Rp.\ 5,400 \times 10^5$ / year

Energy Benefit

The usable capacity for hydropower generation is the capacity between EL. 157.6 m and EL. 170 m, or $49 \times 10^6\ m^3$. Then possible energy production is

$9.8 \times 24.5\ m \times 49 \times 10^6\ m^3$ / 3600 sec x $0.85 = 3,004 \times 10^3$ kWh.
$3,004 \times 10^3$ kWh x Rp.121 / kWh = Rp.363 x 10^6 / year

Reduction of Inundation Area in Retarding Basin

This benefit will be studied later.

Negative Benefit

Land;

The land to be submerged is 640 km^2. A half of this area is assumed as equivalent to paddy field.

640 ha x 0.5 x Rp. 1 x 10^6 = Rp. 320 x 10^6 / year
640 ha x 0.5 x Rp.0.5 x 10^6 = Rp.160.5 x 10^6 / year

The total land value to be lost is Rp.480.5 x 10^6 / year.

Pumping-up

The total pump capacity is 7,700 kW and the annual energy consumption is 27,618 MWh. Since the pumping facilities will be used continuously, the costs are estimated based on the base thermal plant as follows;

Capacity Cost of base thermal

7,700 kW x Rp. 205.4 x 10^3 = Rp. 1,581.6 x 10^6 / year

Energy

27.6 x 10^6 kWh x Rp. 24/kWh = Rp. 662.4 x 10^6 / year

Net Benefit

The net benefit is calculated at RP. 3,039 x 10^6 / year

Table - 1(1)

ESTIMATED RUNOFF

KEDUNGBARAK

Month	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Jan. 1st	0.74	1.61	1.33	1.25	2.18	0.18	0.54	0.89	2.28	1.91
2nd	0.23	0.73	0.48	1.80	1.64	1.08	0.57	1.80	1.70	1.30
3rd	1.27	0.25	0.51	1.62	0.32	1.74	1.27	1.39	0.65	0.52
Feb. 1st	2.19	0.13	0.23	2.47	0.74	1.38	1.72	1.03	1.13	1.00
2nd	1.36	0.09	1.54	2.53	0.33	2.77	0.97	1.98	0.95	3.22
3rd	0.52	0.10	2.37	2.77	0.21	2.17	1.65	2.40	0.88	4.98
Mar. 1st	2.98	0.07	1.55	0.75	1.27	0.61	3.08	1.01	0.96	2.89
2nd	2.19	0.33	1.29	0.97	2.45	1.25	4.50	0.65	1.22	1.64
3rd	2.04	0.14	0.55	1.20	2.60	0.81	2.82	1.20	1.90	1.55
Apr. 1st	1.67	0.72	0.32	1.67	3.10	0.65	2.47	0.72	0.39	0.99
2nd	1.21	0.36	0.19	2.11	1.57	0.34	1.19	0.36	0.17	0.66
3rd	0.42	0.16	0.11	1.65	0.67	0.38	1.41	0.25	0.10	0.76
May 1st	0.63	0.10	0.08	0.58	0.97	0.17	1.11	1.41	2.74	2.44
2nd	0.25	0.08	0.07	0.25	0.77	0.10	0.46	1.21	1.73	3.50
3rd	0.30	0.07	0.06	0.11	0.57	0.07	0.19	0.90	0.57	2.11
June 1st	0.40	0.07	0.08	0.08	0.25	0.07	0.11	1.04	0.24	1.49
2nd	0.38	0.07	0.07	0.07	0.13	0.07	0.08	0.37	0.12	0.49
3rd	0.17	0.07	0.07	0.07	0.09	0.07	0.07	0.15	0.08	0.20
July 1st	0.11	0.07	0.07	0.07	0.57	0.07	0.07	0.10	0.07	0.11
2nd	0.08	0.07	0.07	0.07	0.51	0.07	0.07	0.08	0.07	0.08
3rd	0.07	0.06	0.06	0.06	0.20	0.06	0.06	0.06	0.06	0.06
Aug. 1st	0.07	0.07	0.07	0.07	0.12	0.07	0.06	0.07	0.06	0.07
2nd	0.07	0.07	0.07	0.07	0.08	0.07	0.06	0.07	0.06	0.07
3rd	0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.06	0.06
Sep. 1st	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06
2nd	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06
3rd	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06
Oct. 1st	0.27	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06
2nd	0.13	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06
3rd	0.08	0.06	0.06	0.06	0.06	0.06	0.06	1.25	0.06	0.06
Nov. 1st	0.74	0.07	0.07	0.06	0.51	0.07	0.08	0.75	0.06	0.06
2nd	0.27	0.07	0.07	0.06	0.33	0.06	0.09	0.98	0.06	0.08
3rd	0.20	0.37	0.13	0.06	0.41	0.08	0.62	0.38	0.06	0.83
Dec. 1st	0.11	0.07	1.70	1.20	0.63	0.07	0.37	0.19	0.06	1.39
2nd	0.08	0.34	1.66	0.63	1.13	1.49	0.16	2.14	0.65	1.06
3rd	1.65	0.86	1.63	2.17	0.38	1.23	0.74	0.99	2.23	0.52
Mean 1st	0.64	0.20	0.47	0.72	0.69	0.48	0.75	0.73	0.57	1.00

Table - 1(2)

ESTIMATED RUNOFF

KEDUNEBARAK

Month	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Mean
Jan. 1st	0.74	1.55	1.27	1.13	3.39	3.98	0.06	2.42	1.12	2.52	1.65
2nd	0.91	2.38	1.16	0.89	3.12	2.49	1.17	1.56	0.59	2.40	1.37
3rd	0.40	1.56	0.37	1.39	2.24	2.38	1.21	1.84	0.58	1.83	1.18
Feb. 1st	1.79	2.51	0.17	1.31	2.05	1.56	0.69	1.50	1.30	2.09	1.37
2nd	1.12	1.71	0.17	1.16	2.50	0.63	0.53	1.02	1.07	1.67	1.36
3rd	1.31	1.79	2.13	0.54	1.84	2.05	1.78	0.59	1.39	4.35	1.75
Mar. 1st	1.76	1.40	3.82	0.24	1.11	1.35	1.45	1.12	1.32	2.60	1.59
2nd	1.45	0.30	3.14	0.27	1.06	1.37	1.71	0.70	2.21	2.20	1.58
3rd	0.88	1.79	1.29	1.11	0.37	1.12	1.35	1.10	1.49	1.73	1.30
Apr. 1st	0.93	2.25	0.38	1.59	0.19	1.66	1.19	0.98	0.82	1.32	1.25
2nd	1.76	2.71	0.32	0.60	0.11	2.76	1.11	0.43	0.45	1.31	0.99
3rd	0.83	2.62	0.15	0.66	0.08	2.14	0.60	0.38	0.35	0.58	0.78
May 1st	0.76	1.26	0.09	0.25	0.07	2.58	0.23	1.34	0.32	1.25	0.95
2nd	1.38	0.92	0.08	0.12	0.07	1.46	0.12	0.52	0.15	1.91	0.76
3rd	0.51	0.31	0.06	0.08	0.06	0.62	0.08	0.19	0.08	1.76	0.43
June 1st	0.22	0.15	0.07	0.27	0.55	1.48	0.07	0.11	0.07	0.79	0.37
2nd	0.12	0.10	0.07	0.13	0.21	0.61	0.07	0.08	0.07	0.29	0.18
3rd	0.08	0.08	0.07	0.10	0.11	0.24	0.06	0.71	0.07	0.14	0.13
July 1st	0.07	0.07	0.07	0.08	0.34	0.12	0.06	0.27	0.07	0.09	0.12
2nd	0.07	0.07	0.07	0.07	0.15	0.08	0.06	0.12	0.06	0.07	0.10
3rd	0.06	0.06	0.06	0.06	0.08	0.07	0.06	0.08	0.06	0.06	0.07
Aug. 1st	0.32	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.06	0.07	0.08
2nd	0.14	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.06	0.06	0.07
3rd	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Sep. 1st	0.07	0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.06	0.06
2nd	0.09	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
3rd	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Oct. 1st	0.20	0.78	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.11
2nd	0.11	0.28	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.39	0.09
3rd	0.25	0.87	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.22	0.17
Nov. 1st	0.13	0.52	0.22	0.06	0.03	0.06	0.06	0.06	0.06	1.25	0.24
2nd	0.50	0.60	0.11	0.06	0.19	0.06	0.50	0.56	0.06	0.77	0.37
3rd	0.41	1.07	1.83	0.61	0.37	0.06	2.73	0.79	0.06	1.54	0.85
Dec. 1st	2.06	2.11	1.76	0.78	1.13	0.06	4.08	0.83	0.06	1.19	0.99
2nd	2.55	1.14	0.32	0.66	1.29	0.06	2.55	0.50	0.58	0.41	1.00
3rd	1.64	0.37	0.32	2.51	4.81	0.06	2.98	0.96	1.93	2.06	1.48
Mean 1st	0.72	0.96	0.58	0.49	0.76	0.88	0.78	0.59	0.59	1.11	0.83

Table 2 LEAST COST ANALYSIS FOR PUMPING UP (1)

PIPE LINE NAME K.WARAK RIVER TO CANAL
DISCHARGE 4.2 CMS
PIPE LEGNTH 50 M
STATIC HEAD 9.5 M

PIPE DIA M	LINE NO	FLOW VELO. M/SEC	GROSS HEAD M	REQU'D POWER KW	ANNUAL ENERGY KWH	ENERGY COST RP.MIL	PUMP COST RP.MIL	PIPE COST RP.MIL	INSTALL COST RP.MIL	CIVIL COST RP.MIL	TOTAL COST RP.BIL	ANNUAL COST RP.MIL	TOTAL ANNUAL RP.MIL	UNIT COST RP/CUM
1.50	1	2.37	10.99	532	1927	139	783	22	13	26	1	159	298	5.45
1.50	2	1.18	10.58	513	1859	134	755	44	26	37	1	162	296	5.45
1.50	3	0.79	10.51	509	1844	132	749	66	39	48	1	170	303	5.56
1.60	1	2.08	10.86	526	1906	137	774	25	15	27	1	159	296	5.45
1.60	2	1.04	10.55	511	1851	133	752	51	30	39	1	164	298	5.45
1.60	3	0.69	10.49	508	1840	132	748	77	46	51	1	174	306	5.56
1.70	1	1.85	10.76	521	1888	136	767	29	17	29	1	159	295	5.35
1.70	2	0.92	10.52	510	1848	133	751	59	35	41	1	167	300	5.45
1.70	3	0.61	10.48	508	1840	132	748	88	53	54	1	177	310	5.66
1.80	1	1.65	10.69	518	1977	135	762	33	19	30	1	159	294	5.35
1.80	2	0.82	10.51	509	1844	132	749	66	39	43	1	169	302	5.56
1.80	3	0.55	10.47	507	1837	132	746	99	59	56	1	181	313	5.76
1.90	1	1.48	10.64	515	1866	134	758	37	22	32	1	160	294	5.35
1.90	2	0.74	10.49	508	1840	132	748	74	44	45	1	172	304	5.56
1.90	3	0.49	10.47	507	1837	132	746	111	66	59	1	185	318	5.76
2.00	1	1.33	10.60	514	1862	134	757	40	24	33	1	161	295	5.35
2.00	2	0.66	10.48	508	1840	132	748	81	49	48	1	174	307	5.56
2.00	3	0.44	10.46	507	1837	132	746	122	73	62	1	189	321	5.87
2.10	1	1.21	10.57	512	1855	133	754	44	26	35	1	162	296	5.35
2.10	2	0.60	10.48	508	1840	132	748	89	53	50	1	177	310	5.66
2.10	3	0.40	10.46	507	1837	132	746	134	80	65	1	193	326	5.97
2.20	1	1.10	10.55	511	1851	133	752	48	29	36	1	163	296	5.45
2.20	2	0.55	10.47	507	1837	132	746	97	58	52	1	180	312	5.66
2.30	1	1.01	10.53	510	1848	133	751	52	31	38	1	164	297	5.45
2.30	2	0.50	10.47	507	1837	132	746	105	63	54	1	182	315	5.76
2.40	1	0.92	10.52	510	1848	133	751	56	33	39	1	166	299	5.45
2.40	2	0.46	10.46	507	1837	132	746	113	67	57	1	185	318	5.76
2.50	1	0.85	10.51	509	1844	132	749	60	36	41	1	167	300	5.45
2.50	2	0.42	10.46	507	1837	132	746	121	72	59	1	188	320	5.87

Table - 3 **LEAST COST ANALYSIS FOR PUMPING UP (2)**

PROJECT NAME N.WARÂ OPEN CANAL
STARTING GL 44 M
TERMINAL GL 65 M
DISTANCE 7600 M
WATER DEPTH 2 M
BASE WIDTH 2 M
WATER SUF. SLOPE: TO 5000

WATER LEV. M	EXEC. SND M	EMB. SEC M	EXEC.VOL CUM	EMBANK VOL CUM	WET MASON. CUM SQ	TTL COST 1000
46	7600	843	4025495	242561	275022	228688
47	7262	1181	3515639	516761	275022	209249
48	6925	1518	3053033	922571	275022	186269
49	6537	1856	2630652	1400026	275022	164359
50	6250	2193	2259472	2210065	275022	149268
51	5912	2531	1918457	3132211	275022	137459
52	5575	2868	1613613	4266931	275022	128344
53	5237	3206	1342684	5634611	275022	122739
54	4900	3543	1104253	7255351	275022	121922
55	4562	3880	895705	9149441	275022	123479
56	4225	4218	715205	11337141	275022	128431
57	3887	4555	560730	1383869	275022	136831
58	3550	4893	430258	16674351	275022	149691
59	3212	5230	321762	1936436	275022	164059
60	2875	5568	233217	23428971	275022	182921
61	2537	5905	162599	27368431	275022	205341
62	2200	6243	107884	31762931	275022	231341
63	1862	6580	67045	36572391	275022	260941
64	1525	6918	38059	41838561	275022	294161
65	1187	7255	16900	47579721	275022	331041
66	850	7593	4243	53817161	275022	371601

Table 4 LEAST COST ANALYSIS FOR PUMPING UP (3)

PIPE LINE NAME K.WAPAK CANAL TO RESERVOIR
DISCHARGE 4.2 CMS
PIPE LENGTH 5000 M
STATIC HEAD 118.02 M

PIPE DIA M	LINE NO	FLOW VELO. M/SEC	GROSS HEAD M	REQU'D POWER KW	ANNUAL ENERGY KWH	ENERGY COST RP.MIL	PUMP COST RP.MIL	PIPE COST RP.MIL	INSTALL COST RP.MIL	CIVIL COST RP.MIL	TOTAL COST RP.BIL	ANNUAL COST RP.MIL	TOTAL ANNUAL RP.MIL	UNIT COST RP/CUM
1.50	1	2.37	146.74	7106	25752	1856	10466	2210	1326	2642	22	3137	4993	91.15
1.50	2	1.18	134.05	6491	23523	1696	9560	4421	2654	3765	26	3844	5540	101.14
1.50	3	0.79	131.70	6377	23110	1666	9392	6632	3979	4888	32	4691	6357	115.97
1.60	1	2.08	141.84	6868	24889	1794	10115	2576	1546	2780	22	3207	5001	91.25
1.60	2	1.04	132.82	6432	23309	1680	9473	5153	3092	3965	29	4086	5767	105.26
1.60	3	0.69	131.15	6351	23016	1659	9354	7730	4638	5151	35	5064	6724	122.67
1.70	1	1.85	138.53	6709	24313	1752	9881	2950	1770	2921	23	3302	5055	92.28
1.70	2	0.92	132.00	6392	23164	1670	9414	5901	3540	4169	30	4339	6009	109.69
1.70	3	0.61	130.79	6333	22950	1654	9327	8851	5310	5417	38	5447	7102	129.57
1.80	1	1.65	136.26	5498	23911	1723	9718	3300	1980	3065	23	3404	5128	93.62
1.80	2	0.82	131.43	6364	23063	1662	9373	6601	3960	4377	32	4581	6244	113.91
1.80	3	0.55	130.53	6321	22907	1651	9310	9901	5941	5688	40	5812	7464	136.26
1.90	1	1.48	134.65	6521	23632	1703	9604	3717	2230	3212	24	3536	5240	95.68
1.90	2	0.74	131.03	6345	22994	1657	9345	7435	4461	4598	34	4667	6525	119.06
1.90	3	0.49	130.35	6312	22874	1649	9296	11152	6691	5964	43	6239	7888	143.99
2.00	1	1.33	133.50	6465	23429	1689	9522	4091	2454	3362	25	3661	5351	97.64
2.00	2	0.66	130.74	6331	22943	1654	9324	8182	4909	4803	35	5129	6784	123.80
2.00	3	0.44	130.23	6306	22852	1647	9288	12274	7364	6244	46	6628	8275	150.99
2.10	1	1.21	132.67	6424	23280	1678	9461	4484	2690	3515	26	3798	5476	99.91
2.10	2	0.60	130.53	6321	22907	1651	9310	8969	5381	5022	37	5405	7057	128.75
2.10	3	0.40	130.13	6302	22838	1646	9282	13454	8072	6528	49	7036	8683	158.51
2.20	1	1.10	132.05	5394	23171	1670	9417	4878	2926	3671	27	3937	5608	102.38
2.20	2	0.55	130.37	6313	22878	1649	9298	9756	5853	5244	39	5682	7332	133.79
2.30	1	1.01	131.58	6372	23092	1664	9385	5271	3162	3830	28	4080	5745	104.85
2.30	2	0.50	130.26	6308	22860	1648	9291	10543	6325	5470	41	5961	7609	138.84
2.40	1	0.92	131.22	6355	23030	1660	9360	5665	3399	3992	29	4224	5885	107.42
2.40	1	0.46	130.17	6303	22842	1646	9283	11330	6798	5700	43	6240	7887	143.89
2.50	1	0.85	130.95	6341	22979	1656	9339	6058	3635	4156	30	4370	6027	110.00
2.50	2	0.42	130.10	6300	22831	1646	9279	12116	7270	5933	45	6520	8166	149.04

Table - 5(1) CONSTRUCTION COST ESTIMATE FOR KEDUNGWARAK SCHEME

Iten No.	Work	Unit	Quantity	Unit Price (10^3Rp)	Amount (10^6 Rp)
1.	Civil Works				4,232
1-1	Preparatory Works	L.S			313
1-2	Diversion Works				
	Excavation (earth)	m^3	23,000	3.5	81
	(rock)	m^3	23,000	7.5	173
	(tunnel)	m^3	7,800	43.4	339
	Steel support	ton	90	653.3	59
	Concrete	m^3	3,600	124.4	448
	Reinforcement bar	ton	140	609.8	85
	Sub-total				1,184
1-3	Dam				
	Excavation (earth)	m^3	35,000	3.5	123
	Embankment (earth)	m^3	188,000	4.4	827
	(filter)	m^3	16,000	4.8	77
	(riprap)	m^3	12,000	9.1	109
	Curtain & blanket grout	m	8,700	72	626
	Sub-total				1,762
1-4	Spillway				
	Excavation (earth)	m^3	26,000	3.5	91
	(rock)	m^3	26,000	7.5	195
	Concrete	m^3	5,700	94.6	539
	Reinforcement bar	ton	114	609.8	70
	Slope protection	m^2	2,800	27.9	78
	Sub-total				973
2.	Metal Works				225
2-1	Steel pipe	ton	13	2,884	38
2-2	Hollow Jet Valve	ton	15		187
	Total				4,457

-- to be continued --

Table - 5(2) CONSTRUCTION COST ESTIMATE FOR KEDUNGWARAK SCHEME

Item No.	Work	Unit	Quantity	Unit Price (10^3Rp)	Amount (10^6Rp)
3.	Engineerring Service				446
4.	Administration				223
5.	Base Cost				5,126
6.	Physical Contingency				769
	Grand Total				5,894

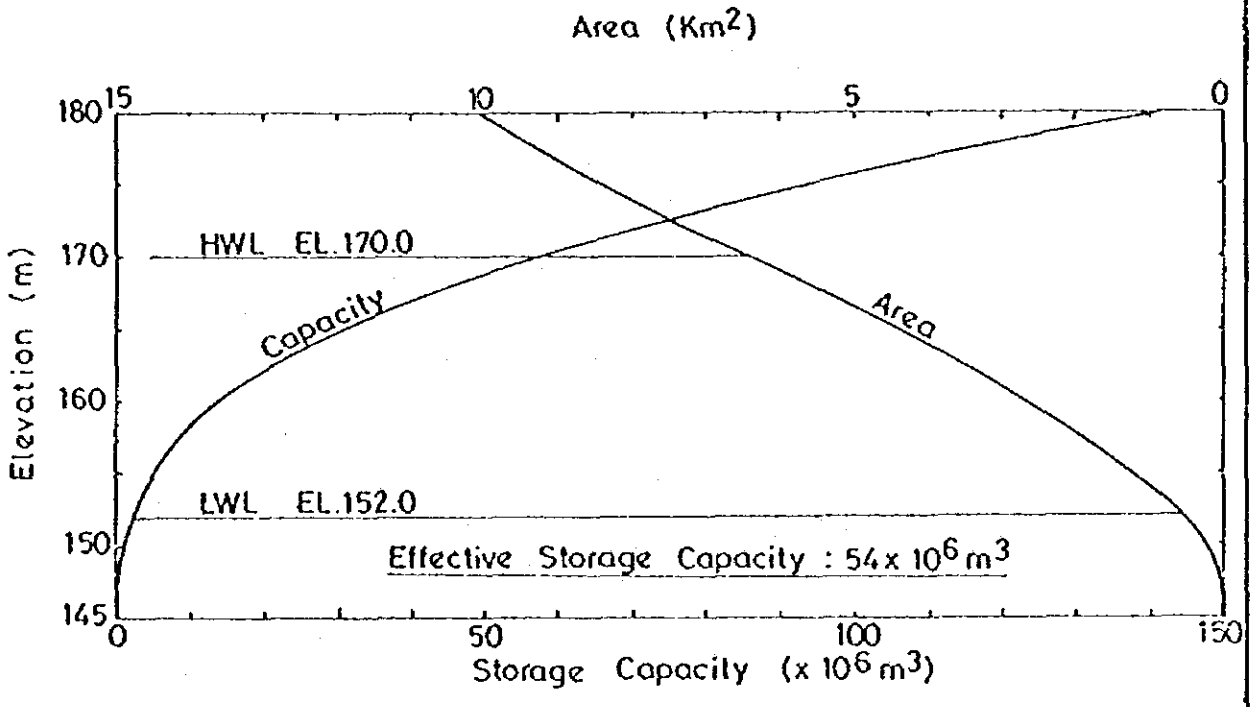


Fig. 1 STORAGE CAPACITY OF KEDUNGWARAK RESERVOIR

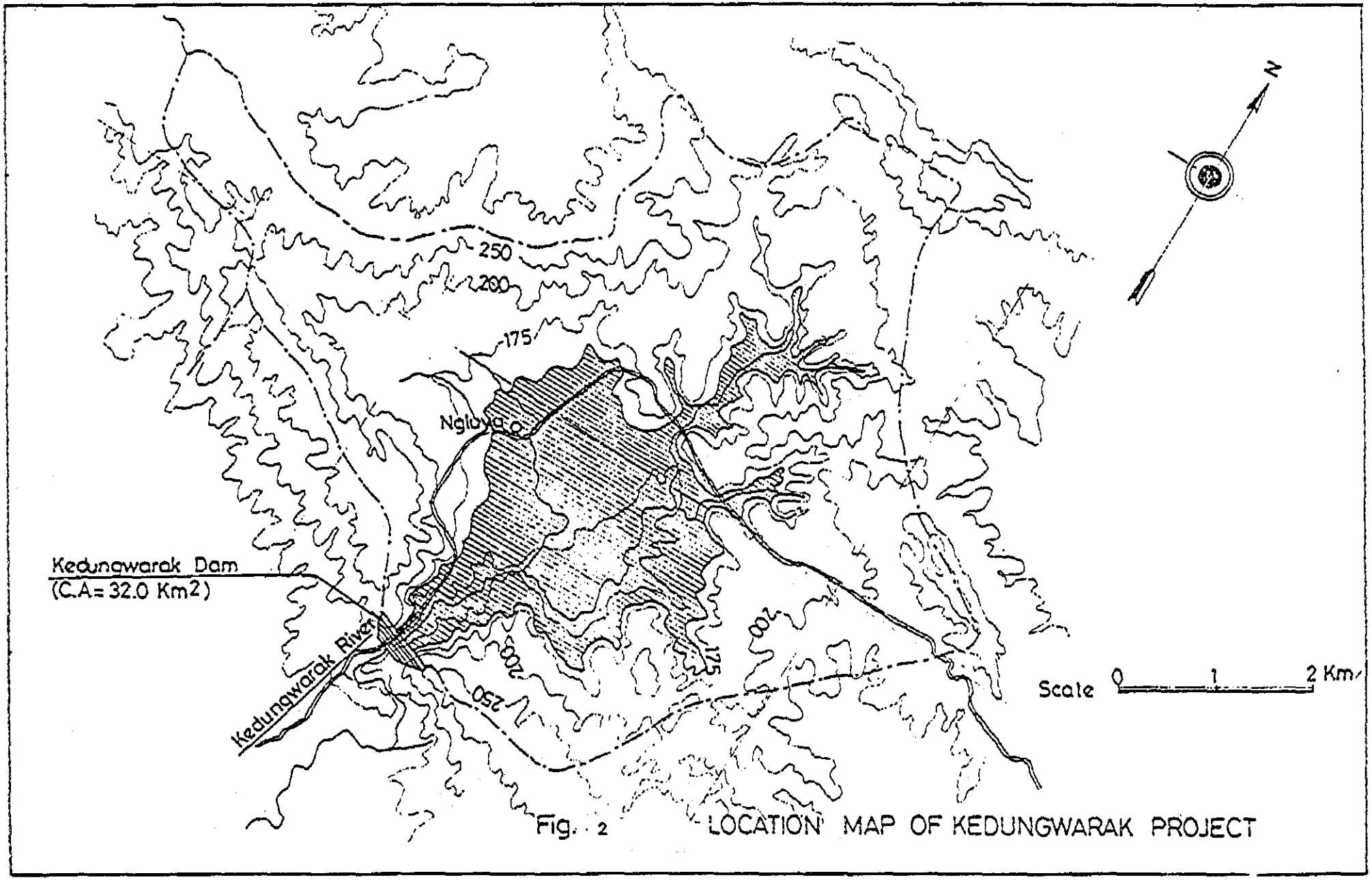


Fig. 2 LOCATION MAP OF KEDUNGWARAK PROJECT

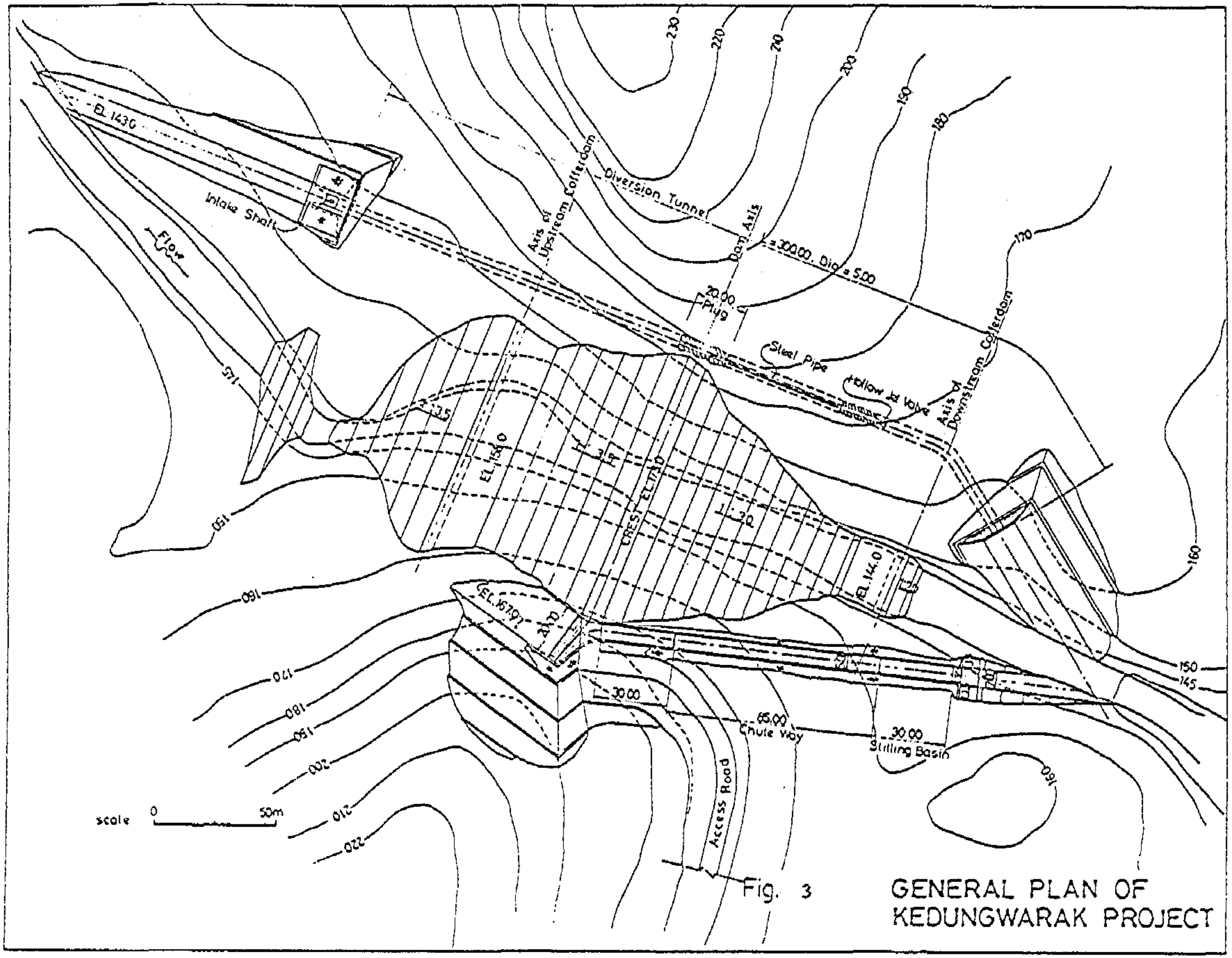


Fig. 3 GENERAL PLAN OF KEDUNGWARAK PROJECT

NOTE MP-10

BENG SCHEME

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOTE MP - 10 Beng Scheme

1. Objectives of Scheme

The objectives are envisaged as follows;

- Water supply to the Beng irrigation area of 3,200 ha
- Water supply to the domestic and industrial use

2. Natural Conditions

Location and Topography

The damsite is selected on Beng river, 5 km from the confluence Brantas river. In the damsite area, the low hills in the left and right banks get near and form a narrow but shallow valley of about 2 km long. In the upstream from the narrow valley, low and flat lands are extending along Beng river and its tribuatries.

The catchment area at the damsite is 134 km^2.

Hydrological Conditions

Low flow is estimated by the Tank Model method. Monthly mean run-off is as follows;

Unit : m^3/s

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
7.1	10.0	9.0	5.8	2.5	1.2	0.7	0.5	0.4	1.0	2.2	5.7

Ten-day mean runoff is as shown in Table 1.

Probable floods are estimated by the Nakayasu's Unit Hydrograph as shown below;

Probability	Probable Flood Peak Discharge
Once in 25 years	384 m^3/s
100	537
200	610
1,000	780
10,000	1,022

Geological Conditions

As this moment, there is no geological investigation data. Additional test boring is proposed.

According to the reconnaissance survey, the geology of the dam

abutments is composed of the volcanic sandstone with low degree of consolidation. Careful examination strength of this rock is needed.

3. Possible Development

The Beng dam has natures similar to those of the Kedungwarak dam as;

- Compact dam embankment
- Large potential storage capacity
- Limited natural runoff

Since the main stream of Brantas river flows at the location 4 km from the Beng damsite, pumping up of the excess water in the rainy season are contemplated from the viewpoint of water supply in the entire Brantas basin.

4. Development Scale

According to the 1 to 50,000 scale map, the potential storage capacity is estimated at 150 x 10^6 m^3 at the elevation of EL. 75 m as shown in Fig.1. This volume is taken as the development scale of the scheme.

The pump-up requirement is calculated taking account the inflow into the reservoir, water requirement of the Beng irrigation area, and water supply to Surabaya. In use of the natural inflow, priority is given to the irrigation water requirement. Assuming that the reservoir must be full at the end of April in every year, the pumping up requirement is calculated as shown in Table 2.

The distance between the Beng dam site and Brantas river is about 4,600 m and difference between the high water level in the reservoir and the water level in Brantas river is about 42 m (EL. 73 m - EL. 31 m). In order to keep the cost minimum, combination of open canal and pipeline is conceived. The open canal covers the first section of 2,600 m and the pipeline covers the remaining 2,000 m. Least cost analysis of pump from river to open canal, open canal and pump and pipe line from canal to reservoir is as shown in Table 3 to 5.

Results are as follows;

1.	Intake discharge	9.67 m^3/s
2.	River to canal	(ℓ = 50 m)
.	EL. 31 m	EL. 37.5 m
	Pipe dia.	2,500 mm
	Pump capacity	833 kW
	Annual energy	3,018 Mwh
3.	Open canal	(ℓ = 2,600 m)
	Base width	3 m
	Slope	1 / 5,000

4. Canal to Reservoir	(ℓ = 2,000 m)
EL. 36.98	EL. 73 m
Pipe dia	2,300 mm
Pump	5,104 kW
Annual energy	18,496 MW

5. Preliminary Layout

Preliminary layout is worked out on the 1 to 5,000 scale map which was tentatively prepared from the 1 to 10,000 aero photos. However, the elevations shown on the 1 to 5,000 scale map are different from those on the 1 to 50,000 scale map. Judging from the elevation of the riverbed of Brantas river at the confluence with Beng river, it is considered that the 1 to 5,000 scale map is mistaken. Although preliminary layout is worked out on 1 to 5,000 scale maps, the elevations shown on the layout shall be interpreted as only reference.

Preliminary layouts are as shown on Fig. 2 and 4. The dam is designed as homogeneous earth-fill type owing to constraint of rock materials.

Principal features are as follows;

PRINCIPAL FEATURES OF BENG SCHEME

Location	10 km west of Ploso city
River Basin	Beng river basin
Stream	Beng river
Hydrology	
Catchment area	134 km^2
Average runoff	3.68 m^3/s
10,000 year probable flood	1,022 m^3/sec
Reservoir	
High water level	EL. 73.0 m (EL. 55.0 m)*
Low water level	EL. 52.0 m (EL. 34.0 m) *
Gross storage capacity	160 x 10^6 m^3
Effective storage capacity	147 x 10^6 m^3
Reservoir surface area at HWL	13 km^2

Dam

	Maindam	Subdam No.1	Subdam No.2
Type	Earthfill	"	"
Crest elevation	EL. 59.0 m	"	"
Crest length	170 m	125 m	300 m
Height above river bed	44 m	24 m	2 m
Dam height	48 m	26 m	4 m
Upstream slope	1 : 3.5	"	"
Downstream slope	1 : 2.8	"	"
Embankment volume	(366,100)	(117,900)	(17,700)

Spillway	
Type	Side channel - Flip bucket type
Crest elevation	EL. 55.0
Crest width	95 m
Chuteway	200 m long, 15 - 10 m wide
Diversion Tunnel	
Type	Circular section
Design discharge	400 m^3/sec
Diameter	5.5 m x 2 nos
Length	500 m + 450 m
Intake	
Dimension	10 m wide, 7 m high
Sill elevation	EL. 27.0 m
Headrace tunnel (Using No.2 diversion tunnel)	
Type	Circular section
Diameter	5.0 m - 4.0 m
Length	255 m (5.0 Dm, including intake tunnel) + 140m (4.0 Dm, steel lining)
Surge Tank	
Type	Port type
Riser shaft	10.0 m Dia
Port diameter	2.5 m Dia
Up-surging water level	EL. 60.2 m
Down-surging water level	EL. 33.3 m
Penstock	
Diameter	4.0 m Dia
Length	45 m
Powerhouse	
Type	Open-air type
Building dimension	25 m long x 26 m wide x 37 m high
Power and energy	
Average firm discharge	10 m^3/sec
Max. plant discharge	48 m^3/sec
Head gross	38 m
rated (effective)	30 m
Installed capacity	12 MW
Dependable capacity	12 MW
Annual energy	10.4 Gwh

6. Cost Estimate

The construction cost the the dam is estimated at Rp.34,909 x 10^6. Breakdown is as shown in Table 6. Including costs of pipeline and pump station, the total cost is estimated at Rp.61,303 x 10^6.

7. Anticipated Benefit

Positive Benefit

Water Supply

The Beng scheme will supply water to the Beng irrigation area and to the Surabaya Metropolitan area as the raw water for domestic and industrial water supply. However, water value of Rp. 100/m^3 is tentatively taken for evaluation of water supply benefit. Separate evaluation will be made later.

150×10^6 m^3 x Rp. 100 /m^3 = Rp. $15,000 \times 10^6$ / year

Power Benefit

Since the hydropower generation is limited mainly in the dry season when large amount of water will be released, the capacity of the power plant is neglected and the only energy production is taken into account.

Energy Benefit

10.4×10^6 kWh x Rp. 90/kWh = Rp.$1,258 \times 10^6$ / year

Negative Benefit

Land

The reservoir area of 1,300 ha is assumed to consists of 50% of paddy field equivalent and 50% of other use. Then the land cost is;

1,300 ha x 0.5 x Rp. 1.0 x 10^6/ha = Rp. 650×10^6 / year
1,300 ha x 0.5 x Rp. 0.5 x 10^6/ha = Rp. 325×10^6 / year

Power Cost

The pumps will be operated continuously throughout the rainy season. Then, the electric power to be consumed by the pumping stations will come from the base thermal station.

Capacity Cost of base thermal

5,900 kW x Rp.205.4/kW = Rp.$1,211.9 \times 10^6$/year

Energy cost

21.5×10^6 kWh x Rp.24 / kWh = Rp.516×10^6 / year

Net Benefit

The net benefit is estimated at Rp.$13,555.1 \times 10^6$ / year

Table - 1(1)

****
* ESTIMATED RUNOFF *
****

PENG

Month		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Jan.	1st	5.53	2.17	13.86	3.52	10.89	0.85	6.50	8.71	9.36	8.47
	2nd	5.93	0.99	12.61	9.37	7.59	0.89	6.14	15.16	10.56	8.31
	3rd	8.95	4.37	13.63	9.47	5.86	4.39	13.98	16.80	5.71	6.34
Feb.	1st	12.45	8.63	10.53	6.88	10.55	6.34	17.20	16.51	6.79	7.71
	2nd	9.62	9.93	17.42	9.33	11.86	15.11	14.20	15.30	5.37	10.55
	3rd	5.17	10.46	21.23	9.13	15.67	12.36	9.59	16.01	2.22	11.95
Mar.	1st	11.79	6.76	15.53	2.60	16.91	10.46	10.63	6.19	1.87	13.68
	2nd	12.37	8.51	14.43	3.19	10.49	10.12	20.02	4.58	1.76	8.56
	3rd	13.55	5.52	9.78	6.32	17.00	12.96	10.26	7.03	3.93	7.43
Apr.	1st	10.21	10.64	5.57	3.72	20.93	8.59	8.76	5.65	1.57	9.02
	2nd	5.81	4.95	2.50	1.40	11.64	3.61	3.12	5.50	0.82	12.09
	3rd	2.17	1.78	2.12	0.76	5.43	1.37	3.01	1.93	0.51	11.93
May	1st	4.44	0.82	0.93	0.49	5.84	0.74	2.00	4.09	0.51	15.97
	2nd	2.24	0.51	0.55	0.40	7.35	0.49	0.88	4.75	0.40	11.03
	3rd	0.88	0.38	0.39	0.33	5.37	0.63	0.48	10.56	0.33	9.99
June	1st	2.86	0.38	0.44	0.36	8.95	0.47	0.41	11.71	0.35	5.17
	2nd	3.32	0.37	0.39	0.35	7.25	0.39	0.37	5.11	0.35	1.85
	3rd	1.28	0.37	0.37	0.35	5.13	0.36	0.36	3.02	0.35	0.82
July	1st	1.87	0.36	0.36	0.35	1.94	0.35	0.35	1.20	0.35	0.51
	2nd	0.86	0.36	0.36	0.35	7.33	0.35	0.35	0.63	0.34	0.40
	3rd	0.48	0.33	0.32	0.32	5.70	0.32	0.31	0.40	0.31	0.33
Aug.	1st	0.42	0.36	0.36	0.35	2.45	0.35	0.34	0.38	0.34	0.35
	2nd	0.38	0.36	0.35	0.35	1.01	0.35	0.34	0.36	0.34	0.35
	3rd	0.33	0.33	0.32	0.31	0.52	0.32	0.31	0.32	0.31	0.31
Sep.	1st	0.36	0.36	0.35	0.34	0.42	0.35	0.34	0.35	0.34	0.34
	2nd	0.36	0.36	0.35	0.34	0.38	0.35	0.34	0.34	0.34	0.34
	3rd	0.36	0.36	0.35	0.34	0.36	0.35	0.34	0.34	0.34	0.34
Oct.	1st	3.20	0.36	0.47	0.34	0.35	0.34	0.34	0.34	0.34	0.34
	2nd	5.37	0.36	3.35	0.34	0.35	0.34	0.34	0.34	0.34	0.34
	3rd	2.92	0.32	1.15	0.31	0.32	0.31	0.31	4.77	0.31	0.31
Nov.	1st	6.32	0.35	0.83	0.34	3.70	0.34	0.34	4.60	0.34	0.34
	2nd	4.77	0.35	0.43	0.34	2.47	0.34	0.46	6.19	0.34	3.49
	3rd	3.33	0.35	1.66	0.34	2.69	0.34	4.91	4.72	3.39	1.42
Dec.	1st	1.55	3.16	1.50	3.76	3.22	1.90	1.84	5.99	7.83	4.08
	2nd	1.29	9.85	0.71	5.73	3.91	8.70	0.82	18.65	9.68	4.45
	3rd	1.34	10.78	0.42	9.34	1.71	6.10	5.08	11.17	9.54	4.35
Mean	1st	4.27	2.97	4.32	2.56	6.19	3.14	4.03	6.25	2.44	5.09

Table - 1(2)

****
* ESTIMATED RUNOFF *
****

BENG

Month		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Mean
Jan.	1st	2.63	6.79	7.03	2.86	12.62	9.47	0.35	4.51	10.06	12.25	6.92
	2nd	1.92	10.57	5.57	4.22	12.57	8.77	2.57	1.64	4.28	7.89	7.07
	3rd	0.79	13.06	2.33	4.42	9.37	7.30	5.59	2.96	1.35	5.53	7.19
Feb.	1st	11.46	20.24	2.55	11.75	16.56	7.25	3.29	3.96	8.49	4.70	9.69
	2nd	10.09	15.50	2.72	8.23	13.90	4.08	3.91	5.83	7.44	2.39	9.59
	3rd	16.92	13.82	3.58	5.39	14.52	9.04	10.39	8.94	7.33	10.65	10.74
Mar.	1st	14.50	13.42	8.50	3.11	9.93	6.94	5.28	14.13	4.39	15.81	9.63
	2nd	10.12	12.35	11.46	11.46	7.65	2.91	4.78	7.40	6.81	12.41	9.05
	3rd	6.83	13.27	10.71	13.74	4.06	3.56	2.30	2.33	4.35	10.07	8.24
Apr.	1st	7.02	12.78	6.95	16.47	1.71	3.21	1.04	2.31	4.58	7.58	7.47
	2nd	12.71	16.73	6.26	10.49	2.34	8.42	5.03	1.07	2.31	2.73	6.01
	3rd	6.89	13.77	3.62	4.04	0.98	4.31	6.05	0.59	1.15	5.23	3.57
May	1st	2.46	10.27	1.38	1.86	0.56	4.96	2.16	0.72	0.61	3.72	3.22
	2nd	1.01	3.24	0.69	2.01	0.43	1.84	0.92	1.24	0.48	1.49	2.34
	3rd	0.51	2.65	0.43	1.57	0.35	1.57	0.48	0.58	0.35	2.44	2.03
June	1st	0.42	1.16	0.40	0.81	0.37	1.20	0.41	0.44	0.36	1.08	1.83
	2nd	0.37	0.62	0.37	0.51	0.36	0.64	0.37	0.39	0.35	0.53	1.21
	3rd	0.36	0.44	0.35	0.42	0.38	0.46	0.36	0.64	0.35	0.42	0.83
July	1st	0.35	0.38	0.36	0.38	0.52	0.40	0.35	0.54	0.35	0.37	0.58
	2nd	0.35	0.36	0.36	0.37	3.55	0.37	0.35	0.41	0.34	0.35	0.90
	3rd	0.31	0.32	0.33	0.33	1.21	0.33	0.32	0.33	0.31	0.31	0.64
Aug.	1st	3.54	0.35	0.36	0.36	0.65	0.36	0.35	0.35	0.34	0.34	0.63
	2nd	1.31	0.35	0.36	0.36	0.45	0.36	0.35	0.35	0.34	0.34	0.43
	3rd	3.19	0.32	0.32	0.32	0.35	0.32	0.31	0.31	0.31	0.31	0.47
Sep.	1st	2.46	0.35	0.35	0.36	0.36	0.36	0.35	0.34	0.34	0.34	0.45
	2nd	1.00	2.51	0.35	0.36	0.36	0.35	0.34	0.34	0.34	0.34	0.49
	3rd	0.55	1.31	0.35	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.39
Oct.	1st	6.14	3.43	0.35	0.35	0.35	0.35	0.34	0.34	0.34	0.34	3.93
	2nd	2.77	4.27	0.35	0.35	0.35	0.35	0.34	0.34	0.34	0.34	1.06
	3rd	0.99	7.51	0.87	0.32	0.32	0.32	0.31	0.31	0.31	0.30	1.12
Nov.	1st	0.57	12.68	0.59	0.35	0.35	0.35	0.34	0.34	0.34	2.94	1.77
	2nd	0.41	7.32	1.44	0.35	0.35	0.35	0.76	2.47	0.34	2.99	1.77
	3rd	6.20	8.82	0.69	5.33	0.35	0.35	6.61	1.50	0.34	10.03	3.16
Dec.	1st	13.46	11.96	6.69	8.48	3.69	0.35	12.90	5.81	0.33	9.11	5.36
	2nd	9.57	9.79	3.80	7.57	8.10	0.35	6.83	10.23	2.98	3.41	6.32
	3rd	6.22	7.09	1.36	6.35	5.28	0.32	4.00	7.64	6.74	1.66	5.45
Mean	1st	4.61	7.33	2.61	3.83	3.74	2.58	2.52	2.55	2.26	3.92	3.36

Table 2

PUMP-UP REQUIREMENT AT BENG
SUPPLY TO SURABAYA 10 CMS

UNIT :CMS

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1964	0	0	0	0	0	0	0	0	0	0	0	7.97
1965	7.97	7.97	7.97	7.97	0	0	0	0	0	0	0	2.92
1966	2.92	2.92	2.92	2.92	0	0	0	0	0	0	0	8.93
1967	8.93	8.93	8.93	8.93	0	0	0	0	0	0	0	2.81
1968	2.81	2.81	2.81	2.81	0	0	0	0	0	0	0	6.71
1969	6.71	6.71	6.71	6.71	0	0	0	0	0	0	0	4.27
1970	4.27	4.27	4.27	4.27	0	0	0	0	0	0	0	4.85
1971	4.85	4.85	4.85	4.85	0	0	0	0	0	0	0	7.81
1972	7.81	7.81	7.81	7.81	0	0	0	0	0	0	0	4.09
1973	4.09	4.09	4.09	4.09	0	0	0	0	0	0	0	6.21
1974	6.21	6.21	6.21	6.21	0	0	0	0	0	0	0	.95
1975	.95	.95	.95	.95	0	0	0	0	0	0	0	6.42
1976	6.42	6.42	6.42	6.42	0	0	0	0	0	0	0	6.42
1977	6.42	6.42	6.42	6.42	0	0	0	0	0	0	0	5.12
1978	5.12	5.12	5.12	5.12	0	0	0	0	0	0	0	7.58
1979	7.58	7.58	7.58	7.58	0	0	0	0	0	0	0	9.67
1980	9.67	9.67	9.67	9.67	0	0	0	0	0	0	0	8.4
1981	8.4	8.4	8.4	8.4	0	0	0	0	0	0	0	7.85
1982	7.85	7.85	7.85	7.85	0	0	0	0	0	0	0	6.41
1983	6.41	6.41	6.41	6.41	0	0	0	0	0	0	0	0

Table-3 LEAST COST ANALYSIS FOR PUMPING UP (1)

PIPE LINE NAME BENG RIVER TO CANAL
DISCHARGE 9.67 CMS
PIPE LENGTH 50 M
STATIC HEAD 6.5 M

PIPE DIA M	LINE NO	FLOW VELO. M/SEC	GROSS HEAD M	REQU'D POWER KW	ANNUAL ENERGY MWH	ENERGY COST RP.MIL	PUMP COST RP.MIL	PIPE COST RP.MIL	INSTALL COST RP.MIL	CIVIL COST RP.MIL	TOTAL COST RP.BIL	ANNUAL COST RP.MIL	TOTAL ANNUAL RP.MIL	UNIT COST RP/CUM
1.50	1	5.47	10.04	1120	4058	292	1649	22	13	26	2	322	615	4.84
1.50	2	2.73	7.87	878	3181	229	1293	44	26	37	1	264	493	3.91
1.50	3	1.82	7.47	833	3018	217	1226	66	39	48	1	260	478	3.81
1.60	1	4.80	9.32	1040	3768	271	1531	25	15	27	2	301	573	4.53
1.60	2	2.40	7.69	858	3109	224	1263	51	30	39	1	261	485	3.81
1.60	3	1.60	7.39	824	2986	215	1213	77	46	51	1	261	477	3.81
1.70	1	4.26	8.82	984	3566	257	1449	29	17	29	2	287	544	4.32
1.70	2	2.13	7.56	844	3058	220	1243	59	35	41	1	259	480	3.81
1.70	3	1.42	7.33	818	2964	213	1204	88	53	54	1	263	477	3.81
1.80	1	3.80	8.45	943	3417	246	1388	33	19	30	1	277	523	4.12
1.80	2	1.90	7.47	833	3018	217	1226	66	39	43	1	259	477	3.81
1.80	3	1.26	7.29	813	2946	212	1197	99	59	56	1	266	478	3.81
1.90	1	3.41	8.18	912	3305	238	1343	37	22	32	1	270	508	4.01
1.90	2	1.70	7.40	826	2993	215	1216	74	44	45	1	260	478	3.81
1.90	3	1.13	7.26	810	2935	211	1193	111	66	59	1	269	481	3.81
2.00	1	3.07	7.97	889	3221	232	1309	40	24	33	1	265	497	3.91
2.00	2	1.53	7.35	820	2971	214	1207	81	49	48	1	261	475	3.81
2.00	3	1.02	7.24	807	2924	210	1188	122	73	62	1	272	483	3.81
2.10	1	2.79	7.82	872	3160	227	1284	44	26	35	1	262	490	3.91
2.10	2	1.39	7.31	816	2957	213	1202	89	53	50	1	263	476	3.81
2.10	3	0.93	7.22	806	2920	210	1187	134	80	65	1	276	487	3.81
2.20	1	2.54	7.70	858	3109	224	1263	48	29	36	1	259	483	3.81
2.20	2	1.27	7.28	812	2942	212	1195	97	58	52	1	264	476	3.81
2.20	3	0.84	7.21	804	2913	210	1184	146	87	68	1	280	493	3.91
2.30	1	2.32	7.60	848	3073	221	1249	52	31	38	1	258	480	3.81
2.30	2	1.16	7.26	810	2935	211	1193	105	63	54	1	266	478	3.81
2.30	3	0.77	7.20	603	2910	209	1182	158	94	71	1	283	493	3.91
2.40	1	2.13	7.52	839	3040	219	1235	56	33	39	1	257	476	3.81
2.40	2	1.06	7.24	808	2928	211	1190	113	67	57	1	269	492	3.91
2.40	3	0.71	7.19	802	2906	209	1181	169	101	74	2	287	497	3.91
2.50	1	1.96	7.46	833	3018	217	1226	60	36	41	1	257	474	3.81
2.50	2	0.98	7.23	806	2920	210	1187	121	72	59	1	271	482	3.81
2.50	3	0.65	7.18	801	2902	209	1179	181	109	77	2	291	500	4.01

Table - 4

LEAST COST ANALYSIS FOR PUMPING UP (2)

PROJECT NAME REND OPEN CANAL
STARTING GL 31 M
TERMINAL GL 45 M
DISTANCE 2600 M
WATER DEPTH 2 M
BASE WIDTH 3 M
WATER SUF. SLOPE: TO 5000

WATER LEV.	REQ. END	REQ. SEC	EXEC. VOL	TEMPBNK VOL	NET MASON.	TTL COST
M	M	M	CUM	CUM	CUM RP	1000
33	2630	418	686771	12784	13188	4283
34	2432	536	565848	26678	10189	3741
35	2264	753	459943	47497	10188	3223
36	2097	921	368161	76014	10189	3039
37	1925	1088	287466	113247	10188	2862
38	1762	1256	220852	160196	10188	2822
39	1574	1423	167315	217867	10188	2911
40	1427	1591	121850	287264	10168	3131
41	1259	1759	85452	369394	10138	3461
42	1092	1926	57115	465260	10188	3965
43	924	2094	35834	575269	10188	4534
44	757	2261	20604	702226	10188	5337
45	589	2429	10420	845835	10188	6223
46	422	2596	4276	1006201	10188	7256

Table-5 LEAST COST ANALYSIS FOR PUMPING UP (3)

PIPE LINE NAME 8ENG CANAL TO RESERVOIR
DISCHARGE 9.67 CMS
PIPE LENGTH 2000 M
STATIC HEAD 38.02 M

PIPE DIA M	LINE NO	FLOW VELO. M/SEC	GROSS HEAD M	REQU'D POWER KW	ANNUAL ENERGY MWH	ENERGY COST RP.MIL	PUMP COST RP.MIL	PIPE COST RP.MIL	INSTALL COST RP.MIL	CIVIL COST RP.MIL	TOTAL COST RP.BIL	ANNUAL COST RP.MIL	TOTAL ANNUAL RP.MIL	UNIT COST RP/CUM
1.50	1	5.47	78.91	8799	31887	2293	12960	884	530	1056	20	2908	5207	41.30
1.50	2	2.73	51.09	5697	20645	1488	8391	1768	1061	1506	16	2398	3887	30.79
1.50	3	1.82	45.94	5122	18562	1338	7544	2653	1591	1955	18	2590	3928	31.10
1.60	1	4.80	68.24	7608	27571	1987	11205	1030	618	1112	18	2632	4620	36.66
1.60	2	2.40	48.42	5399	19565	1410	7952	2061	1236	1586	16	2419	3829	30.38
1.60	3	1.60	44.75	4990	18083	1303	7349	3092	1855	2060	18	2705	4009	31.82
1.70	1	4.26	61.03	6805	24661	1778	10023	1180	708	1168	17	2465	4243	33.68
1.70	2	2.13	46.62	5198	18837	1358	7656	2360	1416	1667	17	2468	3827	30.38
1.70	3	1.42	43.95	4901	17761	1280	7218	3540	2124	2167	19	2836	4117	32.65
1.80	1	3.80	56.06	6250	22650	1633	9205	1320	792	1226	16	2364	3997	31.72
1.80	1	1.90	45.38	5060	18337	1322	7452	2640	1584	1750	17	2530	3852	30.59
1.80	3	1.26	43.40	4839	17536	1264	7127	3960	2376	2275	20	2966	4230	33.57
1.90	1	3.41	52.54	5859	21233	1530	8629	1487	892	1285	16	2316	3847	30.48
1.90	2	1.70	44.50	4962	17982	1296	7308	2974	1784	1835	18	2620	3916	31.00
1.90	3	1.13	43.01	4796	17380	1253	7064	4461	2676	2385	21	3126	4379	34.71
2.00	1	3.07	50.02	5577	20211	1457	8214	1636	981	1345	16	2295	3752	29.76
2.00	2	1.53	43.87	4891	17724	1277	7203	3273	1963	1921	18	2706	3984	31.62
2.00	3	1.02	42.73	4764	17264	1244	7016	4909	2945	2497	22	3273	4518	35.84
2.10	1	2.79	48.17	5371	19464	1403	7910	1793	1076	1406	16	2296	3700	29.35
2.10	2	1.39	43.41	4840	17540	1264	7128	3587	2152	2008	19	2803	4068	32.23
2.10	3	0.93	42.52	4741	17181	1238	6983	5381	3229	2611	24	3430	4669	36.97
2.20	1	2.54	46.90	5228	18910	1363	7685	1951	1170	1468	16	2313	3676	29.14
2.20	2	1.27	43.06	4802	17402	1254	7072	3902	2341	2097	20	2905	4159	32.96
2.20	3	0.84	42.37	4724	17119	1234	6957	5853	3512	2727	25	3590	4824	38.21
2.30	1	2.32	45.77	5104	18496	1333	7517	2108	1265	1532	16	2341	3674	29.14
2.30	2	1.16	42.81	4773	17297	1247	7030	4217	2530	2188	21	3008	4256	33.78
2.30	3	0.77	42.26	4712	17076	1231	6940	6325	3795	2844	26	3751	4982	39.44
2.40	1	2.13	44.99	5016	18177	1310	7388	2266	1359	1596	16	2376	3687	29.25
2.40	2	1.06	42.61	4751	17217	1241	6997	4532	2719	2280	21	3115	4356	34.50
2.40	3	0.71	42.17	4702	17040	1228	6925	6798	4078	2963	27	3913	5142	40.78
2.50	1	1.96	44.38	4948	17931	1292	7287	2423	1454	1662	16	2417	3710	29.45
2.50	2	0.98	42.46	4734	17156	1236	6972	4846	2908	2373	22	3222	4459	35.32
2.50	3	0.65	42.10	4694	17011	1226	6913	7270	4362	3084	28	4076	5302	42.02

Table - 6(1) CONSTRUCTION COST ESTIMATE FOR BENG SCHEME

Item No.	W o r k	Unit	Quantity	Unit Price (10^3 Rp)	Amount (10^6 Rp)
I.	Civil Works				18,208
1-1	Preparatory Works	L.S			1,349
1-2	Diversion Works				
	Excavation (earth)	m^3	8,600	3.5	30
	(rock)	m^3	12,900	7.5	97
	(tunnel)	m^3	33,600	43.4	1,458
	Steel Support	ton	350	653.3	229
	Concrete	m^3	13,740	124.4	1,709
	Reinforcement bar	ton	687	609.8	419
	Consolidation grout	m	3,170	72	228
	Sub-total				4,170
1-3	Dam				
	Excavation (earth)	m^3	52,000	3.5	182
	(rock)	m^3	52,000	7.5	390
	Embankment				
	(earth & filter)	m^3	484,700	4.4	2,133
	(rock)	m^3	17,000	9.1	155
	Curtain & blanket grout	m	10,600	72	763
	Sub-total				3,623
1-4	Spillway				
	Excavation (earth)	m^3	108,600	3.5	380
	(rock)	m^3	162,900	7.5	1,222
	Concrete	m^3	28,100	94.6	2,658
	Reinforcement bar	ton	562	604.8	343
	Backfill	m^3	18,500	3.5	65
	Sub-total				4,668
1-5	Waterway				
	Excavation (earth)	m^3	3,000	3.5	11
	(rock)	m^3	2,000	7.5	23
	(tunnel)	m^3	8,200	43.4	356

-- to be continued --

Table - 6(2) CONSTRUCTION COST ESTIMATE FOR BENG SCHEME

Item No.	W o r k	Unit	Quantity	Unit Price (10^3 Rp)	Amount (10^6 Rp)
	Steel Support	ton	82	653.3	54
	Concrete	m^3	6,700	124.4	833
	Reinforcement bar	ton	337	609.8	206
	Consolidation grout	m	1,500	72	108
	Sub-total				1,589
1-6	Powerhouse				
	Excavation (earth)	m^3	14,800	3.5	52
	(rock)	m^3	22,200	7.5	167
	Concrete	m^3	8,000	94.6	757
	Reinforcement bar	ton	400	609.8	244
	Architectural works	L.S			772
	Utility Works	L.S			818
	Sub-total				2,809
2.	Metal works				1,315
2-1	Gate, Screen	ton	94	5,150	484
2-2	Penstock	ton	236	2,884	681
2-3	Hollow Jet Valve	ton	12		150
3.	Generating Equipment Including T/L	L.S			6,874
	Total				26,396
4.	Engineering Service				2,640
5.	Administration				1,320
6.	Base Cost				30,356
7.	Physical Contingency				4,553
	Grand Total				34,909

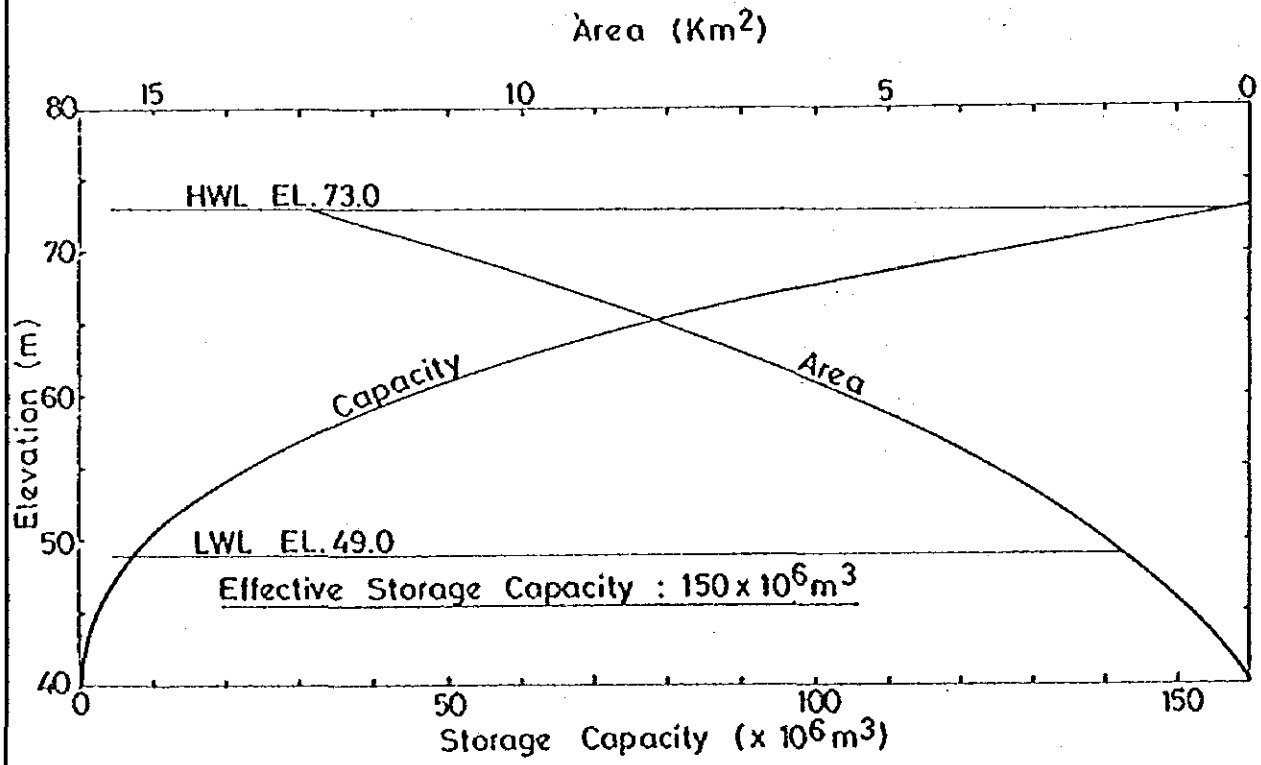


Fig. - 1 STORAGE CAPACITY OF BENG RESERVOIR

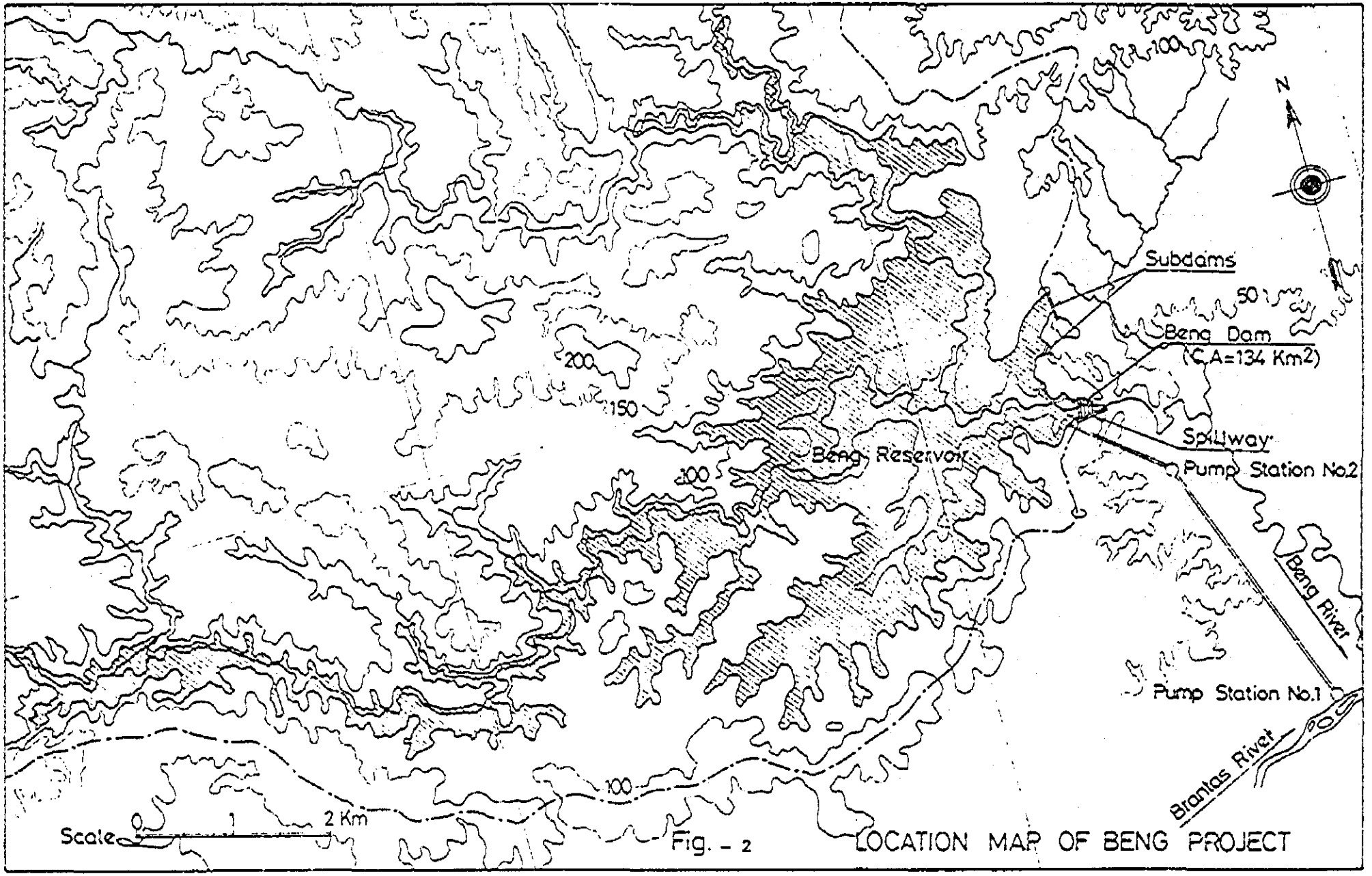
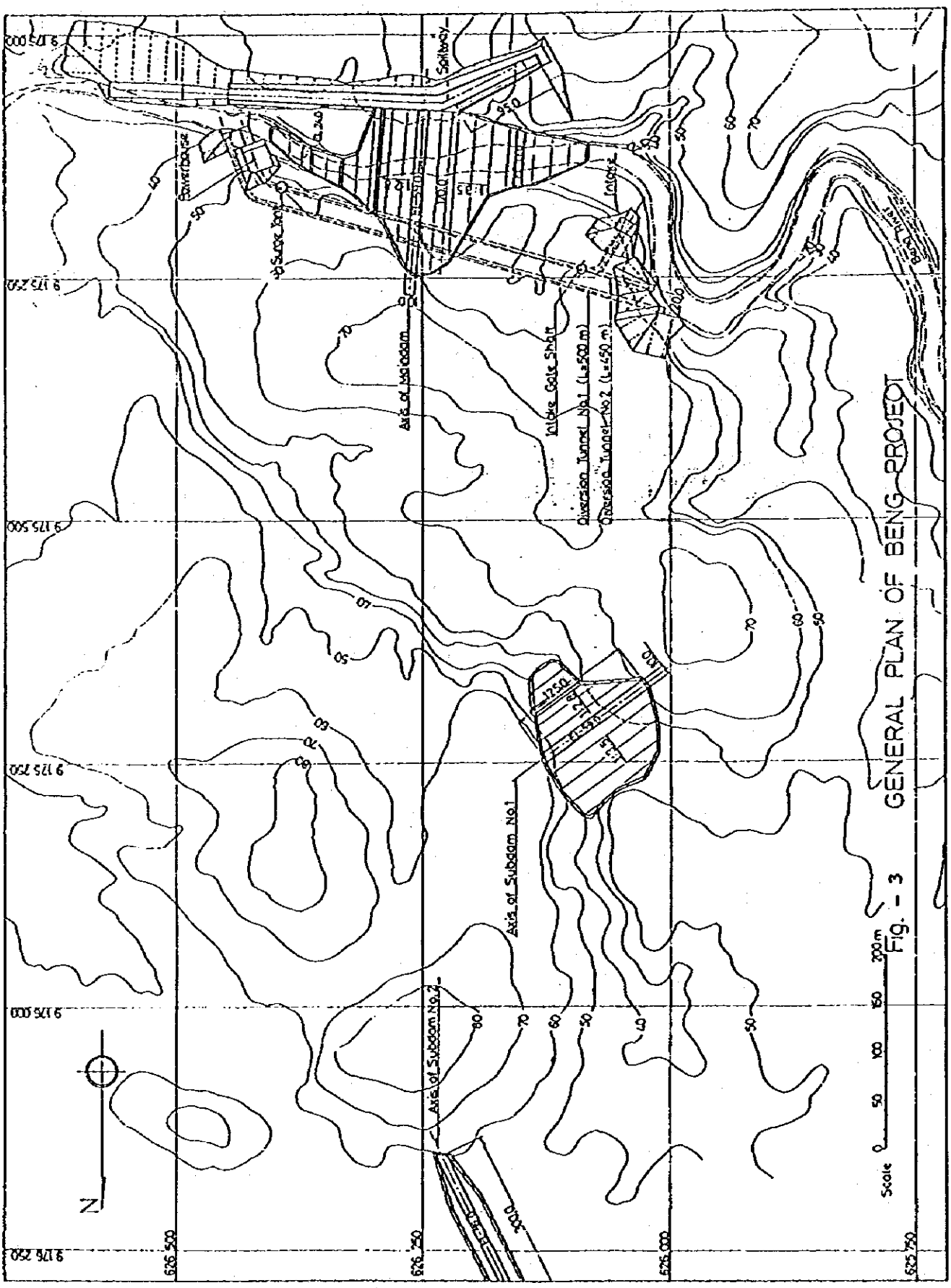


Fig. - 2 LOCATION MAP OF BENG PROJECT



GENERAL PLAN OF BENG PROJECT

Fig. - 3

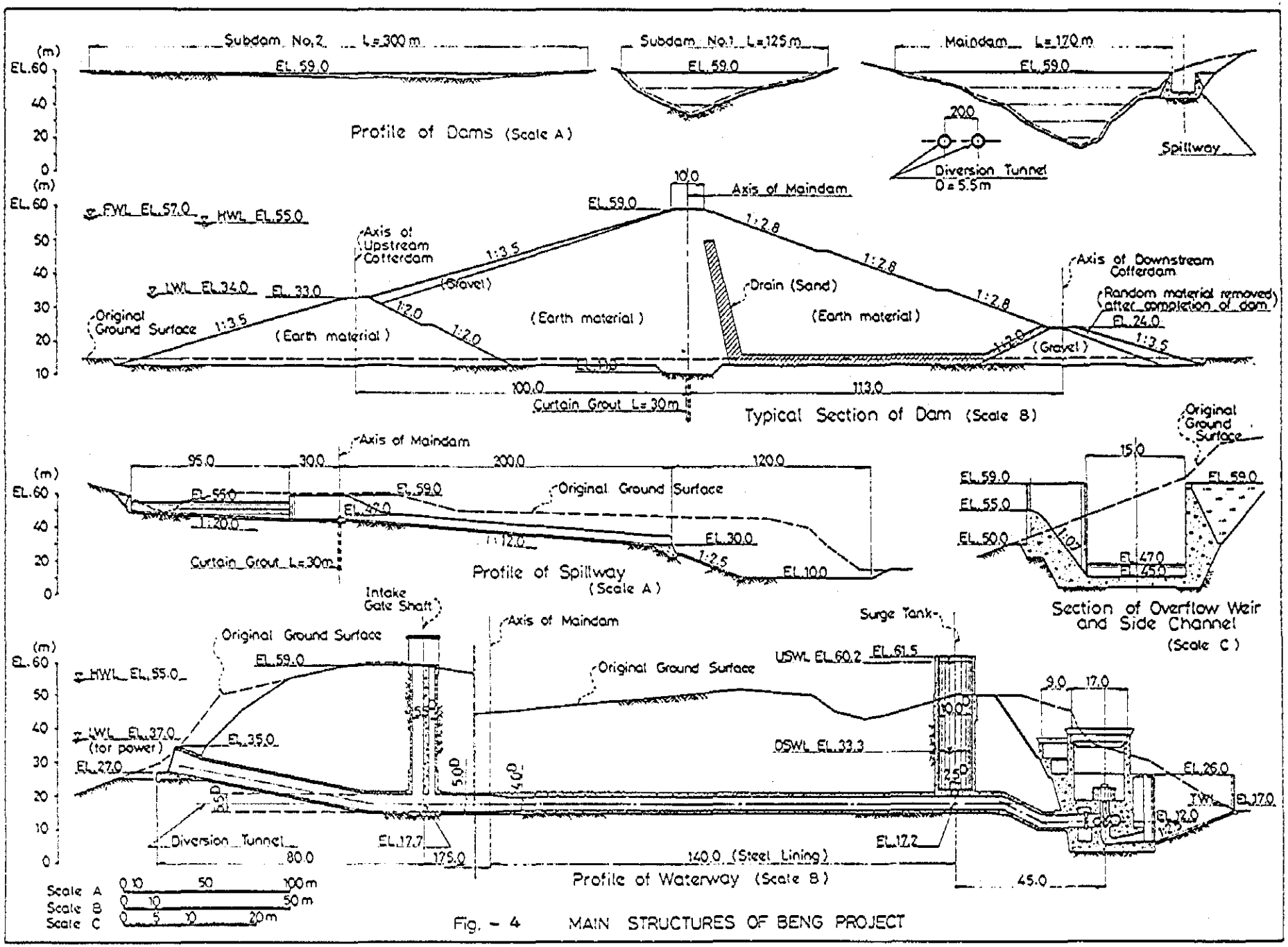


Fig. – 4 MAIN STRUCTURES OF BENG PROJECT

NOTE MP-11

LUMBANGSARI SCHEME

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOTE MP - 11 Lumbangsari Scheme

1. Objective of Scheme

This scheme is envisaged as run-of-river type hydropower station with a daily regulation pond. There is a little effect of storing sediment.

2. Natural Conditions

Location and Topography

The site is selected on Brantas river, 12 km south of the Malang city and 9 km upstream of the Kepanjen damsite . Brantas river has formed a narrow and rather deep valley by eroding the flat plain composed of alluvial deposits and volcanic products upto the surface of hard bed rock. The valley is about 30 m in the bottom of EL. 355 m, and about 25 m in depth.

Hydrology

Runoff at the damsite is estimated from the discharge records at the Blobo site, 5 km downstream of the damsite. The monthly mean runoff is as follows;

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec
42.6	42.2	41.9	37.1	32.4	24.6	20.6	16.4	16.5	21.7	25.9	34.8

The average runoff is estimated at 29.4 m^3/s and the firm discharge at 12.6 m^3/s. Ten-day mean runoff is as shown in Table 1.

Design flood is estimated at 3,500 m^3/s.

Geology

There is no geological data. However, it is considered that the geological conditions of the Lumbangsari site are similar to those of the Kepanjen site. Both abutment is composed of the alluvial deposits and tuffaceous materials. The zone below the riverbed is assumed to be composed of the bassalt and volcanic breccia.

3. Possible Development

The firm discharge at the damsite is 12.6 m^3/s and the possible effective head is 21.75 m to be created by a dam of 28 m high. By this head, the potential energy production is calculated as shown in Table 2. Assuming peaking operation for 5 hours a day the peak discharge of 60 m^3/s is taken. Then the possible capacity to be installed is 10,800 kW. The average annual energy production is estimated at 46.9 GWh as shown in Table 3.

4. Preliminary Layout

Preliminary layout of the scheme is drawn based on 1 to 2,500 scale map as shown on Fig. 1 to 3. The dam is designed to consist of an overflow section with gates and two non-overflow sections. Since the dam height is low and there seems to be no rock materials in the vicinity of the damsite, homogeneous earth-fill type is tentatively selected. To cope with the probable maximum flood, an emergency spillway is designed in the left bank of the river. Principal features of the scheme is as shown below;

PRINCIPAL FEATURES OF LUMBANGSARI SCHEME

Location	12 km south of Malang city 9 km upstream from Kepanjen damsite
River basin	Brantas
Stream	Brantas
Hydrology	
Catchment area	842 km^2
Average runoff	29.4 m^3/sec
Dependable runoff for power	12.6 m^3/sec
PMF	3,500 m^3/sec
Reservoir	
High water level	EL. 374.5 m
Low water level	EL. 373.0 m
Gross storage capacity	5.65 x 10^6 m^3
Effective storage capacity	0.9 x 10^6 m^3
Reservoir surface area at HWL	0.66 km^2
D a m	
Type	Earthfill type
Crest elevation	EL. 378.0 m
Crest length	200 m
Height above river bed	28 m
Dam height	28 m
Upstream slope	1 : 3.5
Downstream slope	1 : 2.5
Embankment volume	126 x 10^6 m^3
Spillway	
Type	Center overflow type
Crest elevation	EL. 365.0 m
Crest width	27.0 m
Chuteway	31.0 m wide
Stilling basin	31.0 wide x 61.5 m long
Diversion	
Type	Open channel type
Design discharge	560 m^3/sec
Dimension	12 m in bottom width and 270 m in length
Intake	
Dimension	13.0 m wide x 11.5 m high
Sill elevation	EL. 366.5 m
Penstock	
Diameter	5.0 m dia
Length	75 m

Powerhouse	
Type	Open air type
Building dimension	34 m long x 28 m wide x 39 m high
Power and Energy	
Average firm discharge	12.6 m^3/sec
Max. plant discharge	60.0 m^3/sec (= 12.6 x 24/5)
Head gross	23.5 m
rated (effective)	21.75 m
Installed capacity	10,800 kW
Dependable capacity	10,800 kW
Annual energy	46.9 GWh

Storage capacity is shown on Fig. 4.

5. Cost Estimate

The total construction cost is estimated at Rp. 34,909 million. Breakdown of the estimated cost is as shown in Table 4.

6. Anticipated Benefit

Positive benefit

The scheme will contribute peak capacity and energy to the power system.

Capacity Benefit

10,800 kW x Rp. 58.2 x 10^3/kW = Rp. 628.6 x 10^6 / year

Energy Benefit

46,876 x 10^3 kWh x Rp. 121 = Rp. 5,670 x 10^6 /year

Negative Benefit

The reservoir area of 66 ha will occupy the present river course where a few production is made. Therefore, the economic loss due to submergence is regarded as nil.

Net Benefit

The net benefit is estimated at Rp. 6,299 x 10^6 /year.

Table -1 (1)

****
* ESTIMAED RUNOFF *
****

LUMBANSARI

Month		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Jan.	1st	27.45	53.65	55.30	46.60	34.90	25.80	38.25	46.70	41.55	26.30
	2nd	38.30	41.35	60.40	49.05	22.30	25.15	33.90	33.85	28.50	38.65
	3rd	36.05	31.55	74.15	58.75	31.95	32.60	37.40	45.90	48.15	53.35
Feb.	1st	38.60	29.80	53.15	55.00	27.65	38.05	26.85	23.15	43.75	45.55
	2nd	41.95	44.20	58.65	44.70	28.35	32.85	64.90	32.60	46.00	45.30
	3rd	34.99	29.30	43.20	56.85	27.10	24.95	76.75	46.35	49.90	47.65
Mar.	1st	52.20	28.10	53.60	53.55	36.60	28.05	42.80	26.40	50.45	36.40
	2nd	35.30	24.15	35.95	50.85	35.75	34.55	54.55	24.05	50.45	57.40
	3rd	58.45	22.70	47.35	49.50	37.05	24.65	57.50	28.00	42.35	76.75
Apr.	1st	57.55	27.30	45.05	43.80	30.70	40.80	40.95	37.90	55.00	52.10
	2nd	39.40	24.80	49.10	32.85	30.00	21.40	35.70	24.60	32.40	45.05
	3rd	39.75	27.70	50.80	36.20	23.20	17.35	31.85	26.85	32.15	37.60
May	1st	42.55	22.60	45.95	25.70	32.75	16.90	35.40	18.75	35.90	32.85
	2nd	46.20	29.05	29.05	23.15	31.65	15.75	34.35	19.40	46.90	29.30
	3rd	38.60	22.95	27.55	20.85	25.05	19.80	37.60	17.45	43.45	30.85
June	1st	28.05	19.90	19.80	21.65	39.55	16.50	20.40	16.20	42.15	30.10
	2nd	25.50	17.50	20.45	19.15	23.55	15.80	17.35	15.90	45.40	25.75
	3rd	28.35	17.65	21.50	17.65	20.85	15.65	16.00	15.95	38.25	23.55
July	1st	29.90	17.90	21.25	16.85	14.60	15.45	15.65	15.10	33.60	24.65
	2nd	22.25	17.65	18.55	16.80	14.50	14.80	15.30	14.55	49.25	24.15
	3rd	20.30	16.25	16.75	16.60	14.10	14.40	14.70	14.20	38.30	23.45
Aug.	1st	18.40	15.60	16.15	16.20	13.65	14.35	14.40	13.85	28.25	21.80
	2nd	18.50	15.15	23.90	15.55	14.75	14.10	14.15	13.65	22.30	23.20
	3rd	19.05	14.70	16.85	14.80	15.00	14.10	14.00	13.60	19.45	22.55
Sep.	1st	18.55	14.30	14.80	14.45	14.15	13.45	13.60	13.65	15.20	18.30
	2nd	17.85	14.20	15.15	14.50	15.40	13.40	13.30	13.65	23.45	15.25
	3rd	17.30	14.35	14.80	15.60	14.15	13.30	13.25	13.55	18.85	16.15
Oct.	1st	15.25	14.35	13.65	14.90	44.45	13.00	23.00	13.10	25.50	14.35
	2nd	14.75	13.80	14.25	14.45	54.10	13.00	24.90	12.80	26.05	13.75
	3rd	22.65	13.55	17.05	15.00	30.85	13.00	21.40	12.65	27.05	18.80
Nov.	1st	19.20	27.75	29.65	16.40	23.50	21.45	15.80	19.00	25.10	23.70
	2nd	30.20	25.60	20.95	14.85	34.35	20.35	17.90	18.55	31.35	20.95
	3rd	29.30	26.30	24.00	15.25	19.95	22.15	24.40	22.40	32.20	23.60
Dec.	1st	23.25	30.05	49.10	26.85	19.75	24.90	31.05	34.30	33.15	29.95
	2nd	23.20	32.35	40.65	47.05	17.90	50.65	28.00	30.55	40.75	34.05
	3rd	29.50	59.40	50.15	29.45	23.60	36.25	25.50	45.50	37.15	26.25
Mean	1st	31.07	24.93	35.57	28.92	26.04	21.90	28.96	23.18	36.10	31.37

Table - 1(2)

ESTIMATED RUNOFF

LUMBANSARI

Month	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Jan. 1st	18.40	30.85	51.45	36.40	34.90	36.00	46.30	25.85	61.00	33.40
2nd	29.75	52.80	56.85	42.40	30.45	56.25	52.05	36.05	44.25	49.00
3rd	40.90	46.75	40.90	30.15	27.00	51.85	43.80	34.15	43.30	58.55
Feb. 1st	33.80	43.25	35.75	26.40	36.85	52.45	41.60	35.25	38.45	45.95
2nd	33.85	43.25	30.00	30.70	38.15	54.20	38.80	34.70	43.40	43.50
3rd	32.20	44.45	29.85	41.80	45.35	43.45	46.30	37.00	38.00	36.35
Mar. 1st	40.25	37.10	38.60	32.60	39.90	51.25	56.05	48.20	37.55	42.80
2nd	43.00	38.20	40.05	40.55	33.75	45.75	47.30	45.55	41.30	39.35
3rd	33.55	47.20	28.75	50.10	27.30	60.70	39.40	42.30	39.75	42.70
Apr. 1st	35.90	38.20	27.70	44.10	35.85	50.05	44.85	36.55	32.30	35.10
2nd	28.85	28.30	27.20	51.80	32.45	61.35	36.85	29.95	31.60	43.85
3rd	35.45	24.45	27.05	45.65	22.70	57.90	32.70	28.60	27.50	36.85
May 1st	31.05	40.95	35.60	55.65	33.80	57.25	31.70	24.90	33.50	45.35
2nd	32.05	30.10	31.85	48.10	27.65	57.75	29.20	21.80	47.05	35.05
3rd	27.40	30.10	24.40	51.75	22.55	45.90	25.80	19.70	42.35	43.80
June 1st	28.10	29.35	22.05	41.75	29.00	32.40	21.20	22.20	48.45	48.30
2nd	24.00	25.40	20.00	37.35	17.95	29.60	21.15	23.55	41.90	29.00
3rd	19.65	24.60	19.60	40.20	19.85	28.45	20.10	19.35	42.35	25.75
July 1st	17.30	24.70	18.80	25.85	17.55	27.15	19.45	14.30	46.40	20.80
2nd	19.30	20.40	17.35	25.25	18.05	27.15	19.35	13.65	31.90	20.55
3rd	19.70	18.40	16.10	20.45	19.95	26.25	18.65	13.70	27.90	16.20
Aug. 1st	15.85	17.45	14.45	16.95	21.75	24.80	18.50	13.50	16.50	16.85
2nd	14.75	15.80	16.40	17.15	18.65	27.45	17.90	13.15	16.75	15.05
3rd	15.00	15.55	13.70	13.95	21.70	22.25	17.75	13.10	14.70	14.50
Sep. 1st	15.75	16.70	13.65	19.30	21.20	22.90	16.25	13.00	16.45	14.10
2nd	19.05	16.05	13.30	25.60	23.45	32.85	15.30	12.70	16.00	14.15
3rd	17.95	15.70	13.20	35.25	18.45	24.70	15.00	12.25	15.60	15.40
Oct. 1st	19.65	16.70	12.80	24.55	28.20	32.45	17.40	12.20	30.90	13.45
2nd	15.30	72.00	12.90	21.65	32.10	29.25	23.80	12.15	23.15	13.15
3rd	16.45	28.50	12.75	33.50	28.65	52.50	22.65	14.30	27.55	15.15
Nov. 1st	19.25	26.50	12.55	23.05	26.60	52.30	21.45	23.40	25.70	24.60
2nd	27.70	35.95	15.55	29.10	32.95	47.80	26.20	22.85	33.55	22.00
3rd	25.00	25.40	20.10	29.00	28.85	53.15	27.60	30.55	29.85	28.75
Dec. 1st	26.60	44.90	28.30	37.05	30.05	56.15	21.15	44.60	38.60	35.00
2nd	22.05	64.45	34.60	40.70	37.20	57.10	22.95	36.25	33.35	28.10
3rd	31.95	30.95	26.60	24.00	30.80	43.75	21.55	37.40	34.40	36.90
Mean 1st	25.74	32.26	25.02	33.60	27.85	42.48	28.83	25.51	33.70	30.53

Table - 1(3)

ESTIMAED RUNOFF

LUMBANSARI

Month		1980	1981	1982	1983	Mean
Jan.	1st	34.95	73.75	62.45	61.65	41.82
	2nd	39.60	50.85	51.30	71.50	43.10
	3rd	42.15	37.75	36.65	45.60	42.88
Feb.	1st	33.15	42.80	56.80	72.05	40.67
	2nd	30.20	41.70	69.55	52.60	42.54
	3rd	37.40	48.40	43.70	56.80	43.25
Mar.	1st	33.05	37.10	53.85	46.40	41.77
	2nd	33.10	36.10	53.15	50.10	41.26
	3rd	33.40	39.75	33.00	61.20	42.64
Apr.	1st	26.25	37.95	42.30	59.00	40.71
	2nd	32.55	29.75	37.90	48.30	35.66
	3rd	35.55	35.05	41.10	61.00	34.79
May	1st	18.80	35.60	19.35	55.85	34.52
	2nd	14.25	36.60	17.30	47.75	32.55
	3rd	16.55	26.40	16.50	47.95	30.22
June	1st	13.60	24.40	15.80	19.40	26.72
	2nd	13.40	30.30	14.95	19.45	23.93
	3rd	13.25	39.50	14.45	15.90	23.26
July	1st	13.20	31.40	14.60	17.90	21.43
	2nd	13.20	42.60	14.70	18.15	21.22
	3rd	13.20	27.45	15.90	15.15	19.08
Aug.	1st	13.30	14.20	14.25	12.90	16.82
	2nd	12.90	12.35	13.40	12.90	16.66
	3rd	12.50	13.20	12.90	12.55	15.72
Sep.	1st	12.10	22.60	12.45	12.10	15.79
	2nd	11.65	23.10	13.00	11.80	16.83
	3rd	11.65	36.15	12.75	12.45	16.99
Oct.	1st	11.90	31.80	12.35	21.35	19.88
	2nd	13.75	29.05	12.10	30.80	22.62
	3rd	13.70	25.90	12.05	47.20	22.61
Nov.	1st	26.00	22.15	12.40	27.65	23.54
	2nd	32.60	29.55	13.75	24.60	26.21
	3rd	44.25	46.15	12.50	31.15	27.99
Dec.	1st	52.25	45.55	31.40	18.70	33.86
	2nd	35.80	42.90	39.75	17.35	35.75
	3rd	46.95	35.05	38.35	30.80	34.67
Mean	1st	24.78	34.30	27.46	35.23	29.72

Table - 2

ENERGY POTENTIAL AT LUMBANSARI

UNIT :MWH

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1960	4583	5650	6600	5944	5705	3561	3238	2515	2335	2387	3422	3430	49375
1961	5639	4236	3357	3469	3343	2393	2323	2040	1863	1872	3463	5554	39558
1962	8577	6364	6158	6302	4578	2685	2531	2547	1945	2028	3243	6301	53265
1963	6969	6312	6907	4907	3121	2541	2257	2088	1937	1993	2021	4621	45679
1964	4015	3495	4918	3618	3998	3650	1939	1952	1900	5760	3382	2765	41428
1965	3774	3950	3901	3459	2366	2084	2004	1911	1745	1752	2780	5018	34750
1966	4926	6659	6983	4717	4331	2337	2048	1911	1745	3106	2526	3787	45581
1967	5697	4036	3532	3885	2493	2069	1968	1846	1778	1731	2606	4996	38660
1968	5349	5855	6413	5198	5678	5470	5434	3128	2500	3535	3854	4990	57407
1969	5375	5607	7749	5859	4178	3452	3243	3035	2161	2121	2967	4038	49790
1970	4049	4061	5224	4356	4054	3119	2533	2048	2293	2306	3128	3643	40821
1971	5873	5307	5531	3954	4529	3450	2841	2187	2106	5220	3819	6235	51059
1972	6665	4027	4795	3563	4099	2680	2341	1996	1745	1727	2095	4007	39746
1973	4868	3936	5577	6154	6986	5187	3200	2149	3485	3611	3528	4528	53215
1974	4133	4838	4508	3956	3750	2513	2502	2794	2743	3992	3843	4397	43975
1975	6491	6918	7121	7361	7195	3933	3616	3336	3498	5193	6863	7017	67447
1976	6371	5307	6378	4974	3882	2715	2579	2431	2024	2874	3272	2948	45760
1977	4324	4328	6099	4135	2972	2830	1870	1785	1650	1742	3339	5304	40385
1978	6647	4880	5329	3974	5528	5770	4739	2148	2089	3667	3874	4773	53424
1979	6383	5153	5605	5035	5590	4489	2572	2060	1898	1881	3276	4508	48468
1980	5257	4218	4473	4102	2228	1750	1779	1737	1539	1770	4472	6074	39404
1981	7223	5357	5084	4467	4402	4096	4530	1785	3559	3884	4254	5522	54169
1982	6699	7014	6231	5274	2382	1965	2034	1819	1661	1639	1680	4928	43330
1983	7970	7395	7123	7318	6798	2380	2292	1722	1580	4525	3626	3062	55796
MEAN	5744	5167	5650	4834	4362	3214	2767	2208	2157	2930	3381	4685	47104

Table - 3

ENERGY PRODUCTION AT LUMBANSARI

UNIT :MWH

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1960	4583	5659	6600	5944	5705	3561	3238	2515	2335	2387	3422	3430	49375
1961	5639	4236	3357	3469	3343	2393	2323	2040	1863	1872	3463	5554	39559
1962	7883	6364	6158	6302	4578	2685	2531	2547	1945	2028	3243	6301	52571
1963	6969	6312	6907	4907	3121	2541	2257	2088	1937	1993	2021	4621	45679
1964	4015	3495	4918	3648	3998	3650	1939	1952	1900	5760	3382	2765	41428
1965	3774	3950	3901	3459	2366	2084	2004	1911	1745	1752	2780	5018	34750
1966	4926	5863	6983	4717	4836	2337	2048	1911	1745	3106	2526	3787	44785
1967	5697	4036	3532	3885	2493	2089	1968	1846	1776	1731	2606	4996	36660
1968	5349	5855	6413	5198	5678	5470	5434	3128	2500	3535	3854	4990	57407
1969	5375	5607	6948	5659	4178	3452	3243	3035	2161	2121	2967	4038	48989
1970	4049	4061	5224	4356	4054	3119	2533	2048	2293	2306	3128	3643	40021
1971	5873	5307	5531	3954	4529	3450	2841	2169	2106	4698	3819	6041	50344
1972	6665	4027	4795	3563	4099	2680	2341	1996	1745	1727	2095	4007	39746
1973	4868	3936	5577	6154	6986	5187	3200	2149	3485	3611	3528	4528	53215
1974	4133	4838	4508	3956	3750	2513	2592	2794	2743	3992	3843	4397	43975
1975	6491	6018	7087	7302	7195	3933	3616	3336	3498	5193	6663	7017	67354
1976	6371	5307	6378	4974	3882	2715	2579	2431	2024	2874	3272	2948	45760
1977	4324	4328	6099	4135	2972	2830	1870	1785	1650	1742	3339	5304	40385
1978	6594	4880	5329	3974	5528	5770	4739	2148	2089	3667	3874	4773	53381
1979	6383	5153	5605	5035	5590	4480	2572	2080	1898	1881	3276	4508	48468
1980	5257	4218	4473	4102	2228	1750	1779	1737	1539	1770	4472	6074	39404
1981	6625	5357	5084	4467	4402	4096	4530	1785	3559	3884	4254	5522	53571
1982	6592	6598	6231	5274	2382	1965	2034	1819	1661	1639	1680	4928	42808
1983	7398	6871	7065	7274	6798	2380	2292	1722	1580	4525	3626	3062	54599
MEAN	5660	5095	5613	4830	4362	3214	2767	2208	2157	2908	3381	4677	46976

Table - 4(1) CONSTRUCTION COST ESTIMATE FOR LUMBANGSARI SCHEME

Item No.	Work	Unit	Quantity	Unit Price (10^3 Rp)	Amount (10^6 Rp)
1.	Civil Works				14,985
1-1	Preparatory works	L.S			1,110
1-2	Access road (new)	km	1	275,000	275
1-3	Diversion works				
	Excavation (earth)	m^3	135,400	3.5	474
	Embankment (coffer dam)	m^3	9,600	4.4	42
	Sub-total				
1-4	Dam				
	Excavation (earth)	m^3	38,400	3.5	134
	Embankment (earth)	m^3	125,700	4.4	553
	Concrete	m^3	26,400	94.6	2,497
	Reinforcement bar	ton	525	609.8	320
	Curtain & blanket grout	m	22,500	72	1,620
	Sub-total				
1-5	Spillway				
	Excavation (rock)	m^3	10,400	7.5	78
	Concrete	m^3	18,630	94.6	1,762
	Reinforcement bar	ton	373	609.8	227
	Backfill	m^3	10,800	3.5	38
	Sub-total				2,106
1-6	Emergency spillway				
	Excavation (earth)	m^3	241,000	3.5	844
	Embankment (fuse dike)	m^3	7,900	4.4	35
	Sub-total				879
1-7	Waterway				
	Excavation (rock)	m^3	3,900	7.5	29
	Concrete	m^3	14,200	124.4	1,766
	Reinforcement bar	ton	641	609.8	391
	Sub-total				2,187

-- to be continued --

Table - 4(2) CONSTRUCTION COST ESTIMATE FOR LUMBANGSARI SCHEME

Item No.	Work	Unit	Quantity	Unit Price (10^3 Rp)	Amount (10^6 Rp)
1-8	Powerhouse				
	Excavation	m^3	13,500	7.5	101
	Concrete	m^3	6,610	94.6	625
	Reinforcement bar	ton	331	609.8	202
	Backfill	m^3	1,600	3.5	6
	Architectural works	L.S			578
	Utility works	L.S			616
	Sub-total				2,127
1-9	Miscellaneous				14,985
2.	Metal Works				3,336
2-1	Gates, valves, etc.	ton	447	5,150	2,457
2-2	Penstock	ton	305	2,884	880
3.	Generating Equipment including T/L	L.S			7,332
	Total				25,653
4.	Engineering Service				2,563
5.	Administration				1,283
6.	Base Cost				29,501
7.	Physical Contingency				4,425
	Grand Total				33,926

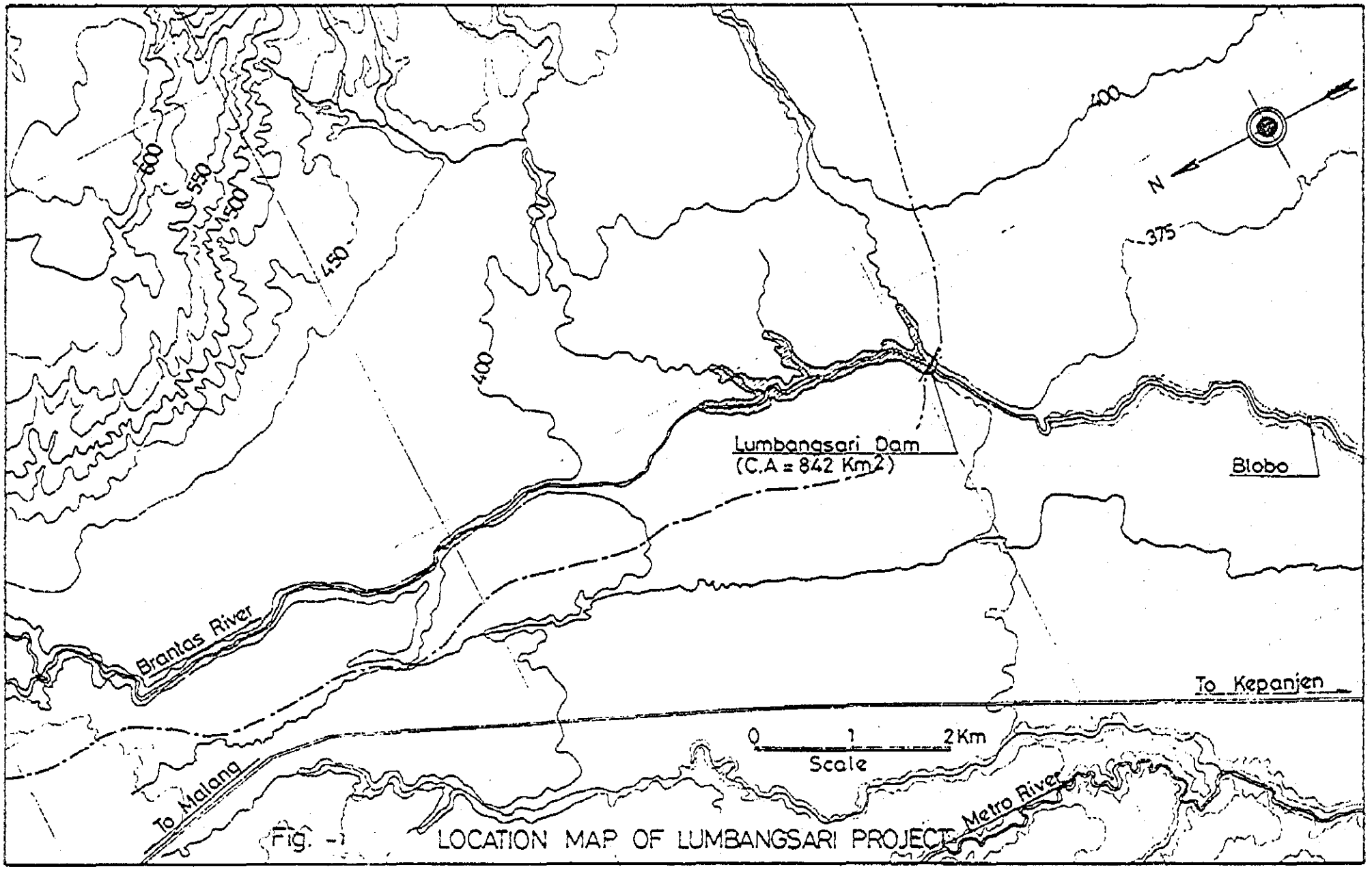


Fig. -1 LOCATION MAP OF LUMBANGSARI PROJECT

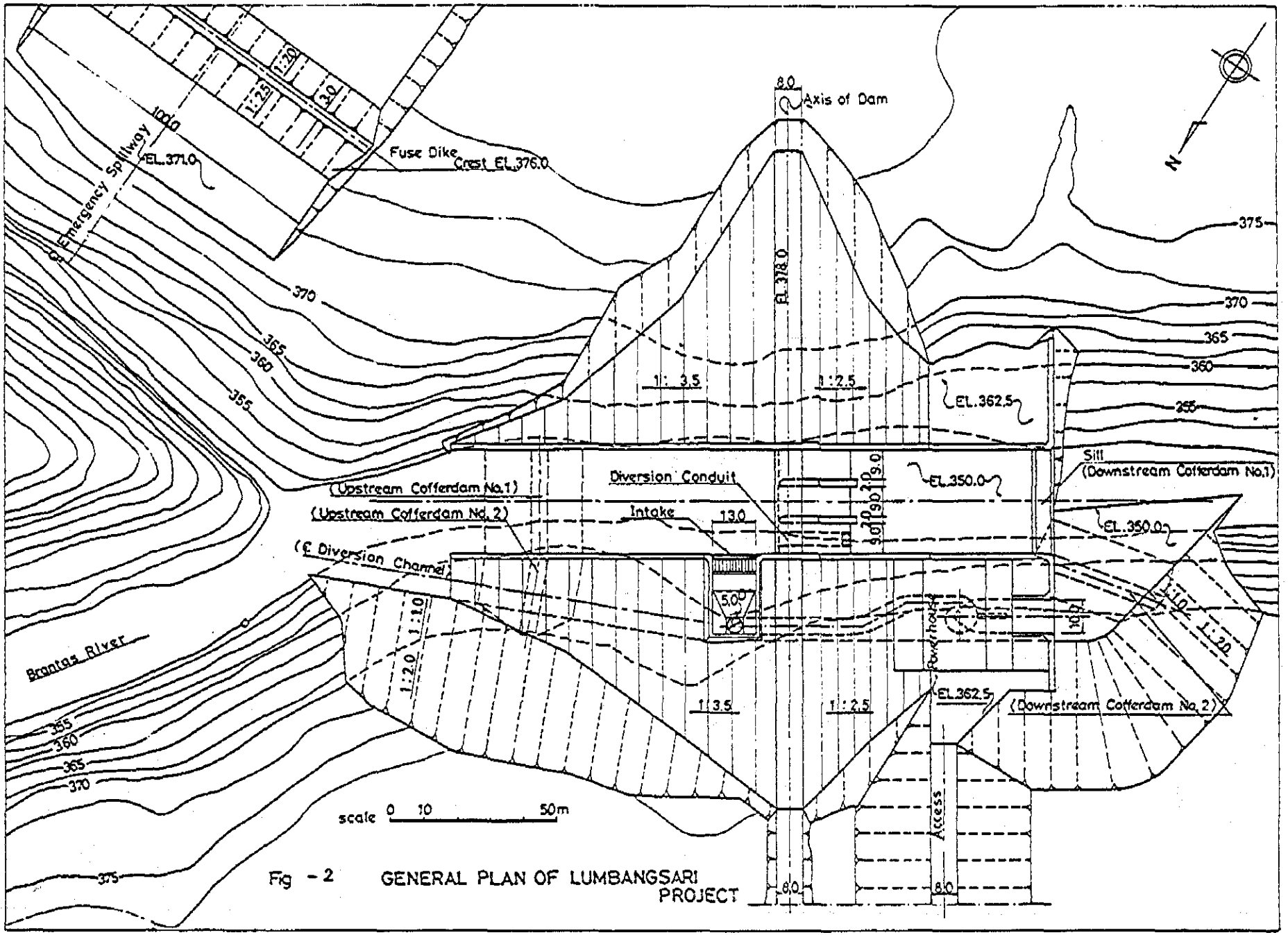


Fig - 2 GENERAL PLAN OF LUMBANGSARI PROJECT

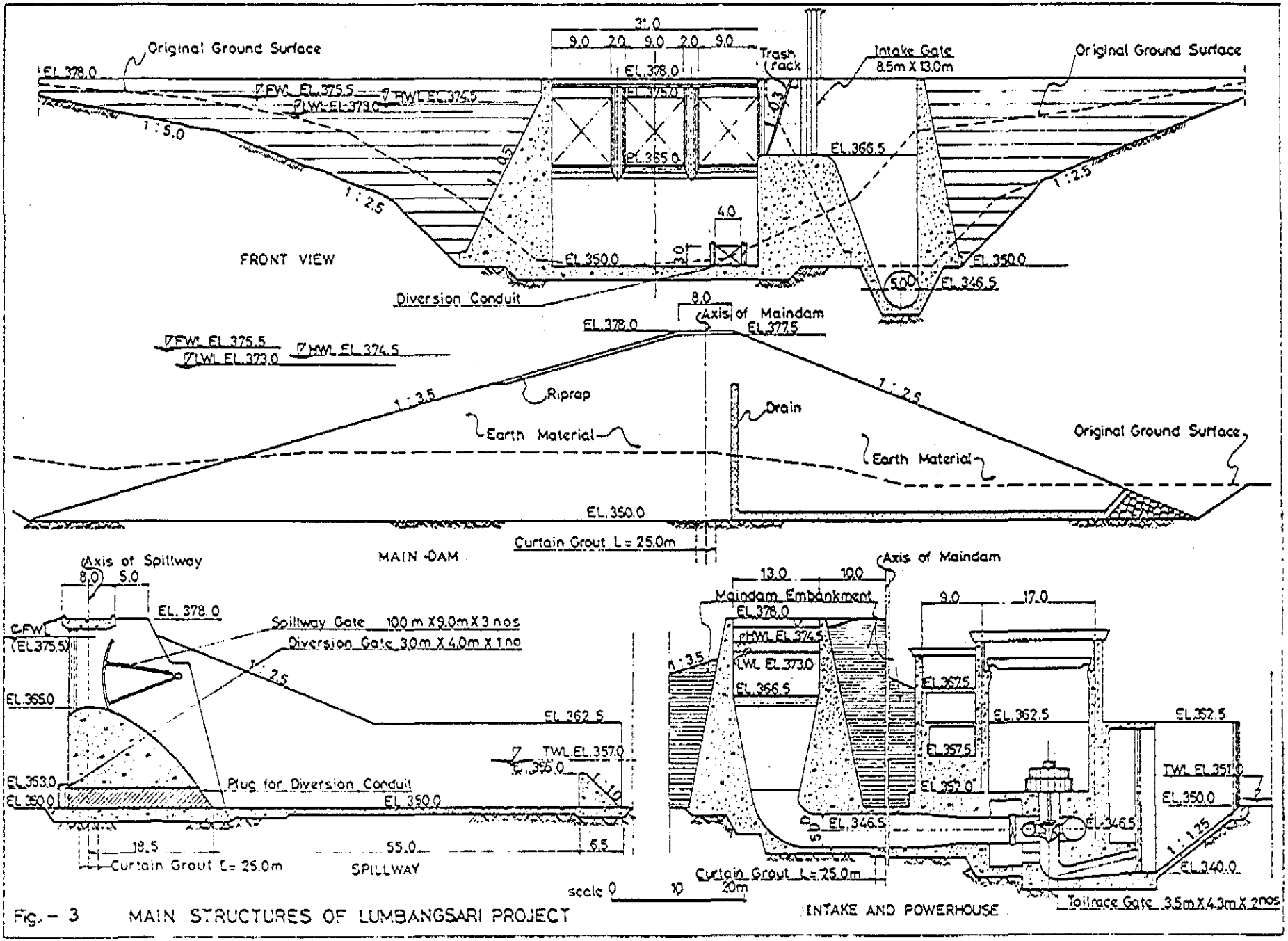


Fig. – 3 MAIN STRUCTURES OF LUMBANGSARI PROJECT

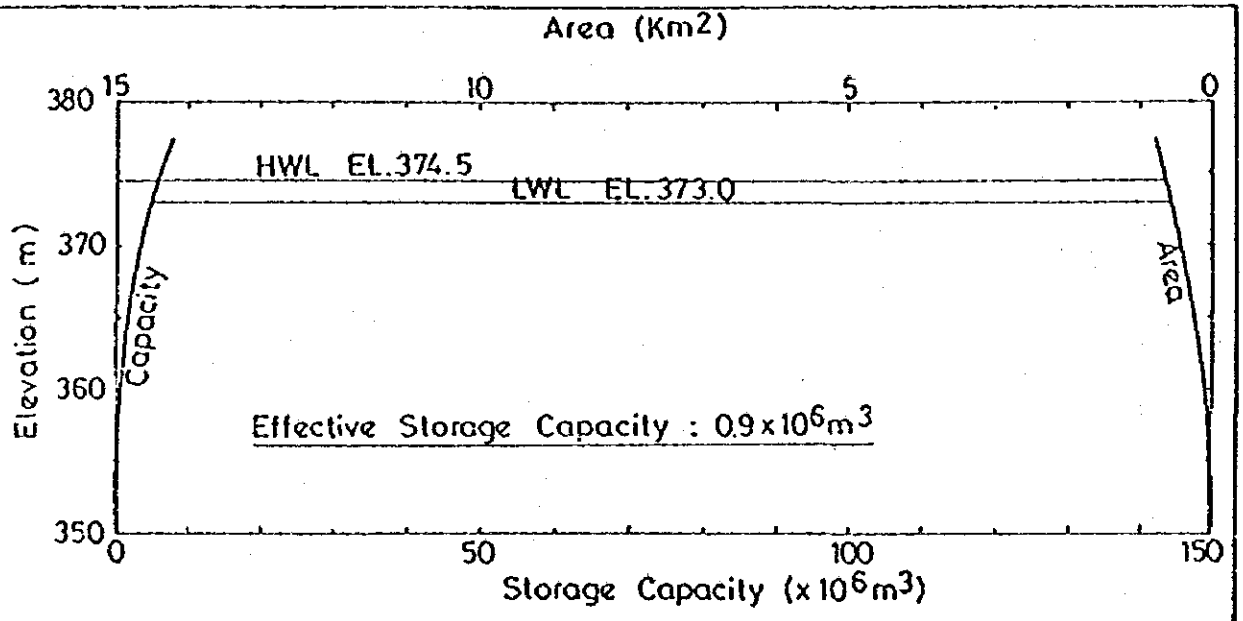


Fig. - 4 STORAGE CAPACITY OF LUMBANGSARI RESERVOIR

NOTE MP-12

KEPANJEN SCHEME

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOTE MP - 12 Kepanjen Scheme

1. Objective of Scheme

The objective of this scheme of is hydropower generation by run-off river type power plant with a daily regulation pond. There is a little effect of storing sediment.

2. Natural Condition

Location and opography

The site is selected on Brantas river, 20km south from the Malang city and 5 km upstream from the Sengguruh damsite. The catchment area at the damsite is 912 km^2. Brantas river has formed a narrow and rather deep valley by eroding the flat plain composed of alluvial deposits and volcanic products upto the surface of hard bed rock. The river bed is about EL. 300 m and the plain is EL. 320 m. There is a small fall of 10 m high just downstream of the selected damsite. Storage capacity is shown on Fig. 1.

Hydrology

Runoff at the damsite is estimated from the discharge records at Blobo minus irrigation water intake to the Molek irrigation system. Monthly mean runoff is as follows.

Unit : m^3/s

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
35.3	34.6	34.6	30.4	26.1	18.9	15.0	11.5	11.9	17.1	20.2	27.6

Ten-day mean runoff is as shown in Table 1.

Design flood is estimated at 3,720 m^3/s.

Geology

According to the geological investigation made by BRBDEO, the abutments are composed of the alluvial deposit and tuffaceous materials. The riverbed and the zones beneath it are composed of the basalt and volcanic breccia.

3. Possible Development

The firm discharge at the damsite is estimated at 7.5 m^3/s and the possible effective head is 20.25 m to be created by a dam of 20 m high. By this head, the potential energy production is calculated as shown in Table 2. Assuming peaking operation for 5 hours a day, the peak discharge of 36 m^3/s is taken. The possible installed capacity is 6,000 kW. The average annual energy production is estimated at 32.5 GWh as shown in Table 3.

4. Preliminary Layout

Preliminary layout of the scheme is drawn based on 1 to 1,000 scale map as shown on Fig. 2 to 4. The dam is designed to consist of an overflow section with gates and two non-overflow sections. Since the dam height is low and there seems to be no rock materials in the vicinity of the damsite, homogenous earth-fill type is tentatively selected. To cope with the probable maximum flood, an emergency spillway is designed in the right bank. Principal features of the scheme is shown below.

PRINCIPIAL FEATURES OF KEPANJEN SCHEME

Location	20 km south of Malang city 5 km upstream from Sengguruh damsite
River basin	Brantas
Stream	Brantas
Hydrology	
Catchment area	912 km^2
Average annual rainfall	2,100 mm
Average runoff	23.6 m^3/sec
Dependable runoff for power	7.5 m^3/sec
PMF	3,720 m^3/sec
Reservoir	
High water level	EL. 316.5 m
Low water level	EL. 314.0 m
Gross storage capacity	1.25 x 10^6 m^3
Effective storage capacity	0.5 x 10^6 m^3
Reservoir surface area at HWL	0.24 km^2
D a m	
Type	Earth-fill type
Crest elevation	EL. 320.0 m
Crest length	150 m
Height above river bed	20 m
Dam height	20 m
Upstream slope	1 : 3.0
Downstream slope	1 : 2.5
Embankment volume	70 x 10^6 m^3
Spillway	
Type	Center overflow type
Crest elevation	EL. 306.5 m
Crest width	27.0 m
Chuteway	31.0 m wide x 60 m long
Diversion	
Type	Open channel type
Design discharge	600 m^3/sec
Dimension	10 m in bottom width x 250 m long
Intake	
Dimension	10 m wide x 11.5 m high
Sill elevation	EL. 308.5 m
Penstock	
Diameter	4.0 m dia
Length	90 m

Powerhouse	
Type	Open air type
Building dimension	27 m long x 26 m wide x 35 m high
Power and energy	
Average firm discharge	7.5 m^3/sec
Max. plant discharge	36.0 m^3/sec (=7.5 x 24/5)
Head gross	22.5
rated (effective)	20.25
Installed capacity	6,000 kW
Dependable capacity	6,000 kW
Annual energy	32.5 GWh

5. Cost Estimate

The total construction cost is estimated at Rp. 20,719 million. Breakdown is as shown in Table 4.

6. Anticipated Benefit

Positive Benefit

The scheme will contribute peak capacity and energy to the power system.

Capacity Benefit

6,000 kW x Rp. 58.2 x 10^3/kW = Rp. 349.2 x 10^6 /year

Energy Benefit

32.5 x 10^6 kWh x Rp. 121/kWh = Rp. 3,931 x 10^6 / year

Negative Benefit

The reservoir area will consist mainly of the present river course where cultivation is very limited. Then, the economic loss due to submergence is regarded as nil.

Net Benefit

The net benefit is estimated at Rp. 4,280 x 10^6 per year.

Table - 1(1)

****
* ESTIMATED RUNOFF *
****

KEPANJEN

Month	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Jan. 1st	29.15	46.35	48.00	39.30	27.60	18.50	30.95	39.40	34.25	19.00
2nd	31.00	34.05	53.10	41.75	15.00	17.85	26.60	26.55	21.20	31.35
3rd	28.75	24.25	66.85	51.45	24.65	25.30	30.10	38.60	40.85	46.05
Feb. 1st	31.10	22.30	45.65	47.50	20.15	30.55	19.35	15.65	36.25	38.05
2nd	34.45	36.70	51.15	37.60	20.85	25.35	57.40	25.10	38.50	37.80
3rd	47.40	16.80	35.70	49.35	19.60	17.45	69.25	38.85	42.40	40.15
Mar. 1st	44.80	20.70	46.20	46.15	29.20	20.65	35.40	19.00	43.05	29.00
2nd	27.90	16.75	28.55	43.45	28.35	27.15	47.15	16.65	43.05	50.00
3rd	51.05	15.30	39.95	42.10	29.65	17.25	50.10	20.60	34.95	69.35
Apr. 1st	55.85	20.60	38.35	37.10	24.00	34.10	34.25	31.20	48.30	45.40
2nd	32.70	18.10	42.40	26.15	23.30	14.70	29.00	17.90	25.70	38.35
3rd	33.05	21.00	44.10	29.50	16.50	10.65	25.15	20.15	25.45	30.90
May 1st	36.45	16.50	39.85	19.60	26.65	10.80	29.30	12.65	29.80	26.75
2nd	40.10	22.95	22.95	17.05	25.55	9.65	23.25	13.30	40.80	23.20
3rd	32.50	16.85	21.45	14.75	18.95	13.70	21.50	11.35	37.35	24.75
June 1st	22.15	14.00	13.90	15.75	33.65	10.60	14.50	10.30	36.25	24.20
2nd	19.60	11.60	14.55	13.25	17.65	9.90	11.45	10.00	39.50	19.85
3rd	22.45	11.75	15.60	11.75	14.95	9.75	10.10	10.05	32.35	17.65
July 1st	24.30	12.30	15.65	11.25	9.00	9.85	10.05	9.50	28.00	19.05
2nd	16.65	12.05	12.95	11.20	8.90	9.20	9.70	8.95	43.65	18.55
3rd	14.70	10.65	11.15	11.00	8.50	8.80	9.10	8.60	32.70	17.85
Aug. 1st	13.50	10.70	11.25	11.30	8.75	9.45	9.50	8.95	23.35	16.90
2nd	13.60	10.25	19.00	10.65	9.85	9.20	9.25	8.75	17.40	18.30
3rd	14.15	9.80	11.95	9.90	10.10	9.20	9.10	8.70	14.55	17.65
Sep. 1st	13.95	9.70	10.20	9.85	9.55	8.85	9.00	9.05	10.60	13.70
2nd	13.25	9.60	10.55	9.90	10.80	8.80	8.70	9.05	18.85	10.65
3rd	12.70	9.75	10.20	11.00	9.55	8.70	8.65	8.95	14.25	11.35
Oct. 1st	10.65	9.75	9.05	10.30	39.85	8.40	18.40	8.50	20.90	9.75
2nd	10.15	9.20	9.65	9.85	49.50	8.40	20.30	8.20	21.45	8.65
3rd	18.05	8.95	12.45	10.40	26.25	8.40	16.80	8.05	22.45	14.20
Nov. 1st	13.50	22.05	23.95	10.70	17.80	15.75	10.10	13.30	19.40	18.00
2nd	24.50	19.90	15.25	9.15	28.65	14.65	12.20	12.85	25.65	15.25
3rd	23.60	20.60	18.30	9.55	14.25	16.45	18.70	16.70	26.50	17.90
Dec. 1st	16.65	12.65	42.50	20.25	13.15	18.30	24.45	27.70	26.55	23.35
2nd	16.60	25.75	34.05	40.45	11.30	44.05	21.40	23.95	34.15	27.45
3rd	22.90	20.85	43.55	22.85	17.00	29.65	18.90	38.90	30.55	19.65
Mean 1st	25.13	17.52	27.49	22.86	19.97	15.83	22.47	17.10	30.02	25.28

Table - 1(2)

ESTIMAED RUNOFF

KEPANJEN

Month	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Jan. 1st	11.10	23.55	44.15	29.10	27.60	28.70	39.00	18.55	53.70	26.10
2nd	22.45	45.50	49.55	35.10	23.15	48.95	44.75	28.75	36.95	41.70
3rd	33.60	39.45	33.60	22.85	19.70	44.55	36.50	26.85	36.00	51.25
Feb. 1st	26.30	35.75	28.25	18.90	29.35	44.95	34.10	27.25	39.95	38.45
2nd	26.35	35.75	22.50	23.20	30.65	43.70	31.30	27.20	35.90	36.00
3rd	24.70	36.95	22.35	34.30	37.85	35.95	38.80	29.50	30.50	28.85
Mar. 1st	32.85	29.70	31.20	25.20	32.50	43.85	48.65	40.80	30.15	35.20
2nd	35.60	30.80	32.65	33.15	26.35	38.35	39.90	38.15	33.90	31.95
3rd	26.15	39.80	31.35	42.70	19.90	53.30	32.00	34.90	32.35	35.30
Apr. 1st	29.20	31.50	21.00	37.40	29.15	43.35	38.15	29.85	25.60	28.40
2nd	22.15	21.60	20.50	45.10	25.75	54.65	30.15	23.25	24.90	37.15
3rd	28.75	17.75	20.35	38.95	16.00	51.20	26.00	21.90	20.80	30.15
May 1st	24.95	34.85	29.50	49.55	27.70	51.15	25.60	18.80	27.40	39.25
2nd	25.95	24.00	25.75	42.00	21.55	51.65	23.10	15.70	40.95	28.95
3rd	21.30	24.00	18.30	45.65	16.45	39.80	19.70	13.60	36.25	37.70
June 1st	22.20	28.45	16.15	35.85	14.10	26.50	15.30	16.30	42.55	42.40
2nd	18.10	19.50	14.10	31.45	12.05	23.70	15.25	17.65	38.00	23.10
3rd	13.75	18.70	13.70	34.30	13.95	22.55	14.20	13.45	36.45	19.85
July 1st	11.70	19.10	13.20	20.25	11.95	21.55	13.85	8.70	40.80	15.20
2nd	13.70	14.80	11.75	19.65	12.45	21.55	13.75	8.05	26.30	14.95
3rd	14.10	12.80	10.50	14.85	14.35	20.65	13.05	8.10	22.30	10.80
Aug. 1st	10.95	12.55	9.55	12.05	16.85	19.90	13.60	8.60	11.60	11.95
2nd	9.85	10.90	11.50	12.25	13.75	22.55	13.00	8.25	11.85	10.15
3rd	10.10	10.65	8.80	9.05	16.80	17.35	12.85	8.20	9.80	9.60
Sep. 1st	11.15	12.10	9.05	14.70	16.60	18.30	11.65	8.40	11.85	9.50
2nd	14.45	11.45	8.70	21.00	18.85	28.25	10.70	8.10	11.40	9.55
3rd	13.35	11.10	8.60	30.65	13.85	20.10	10.40	7.65	11.00	10.80
Oct. 1st	15.05	12.10	8.20	19.95	23.60	27.85	12.80	7.60	26.30	8.85
2nd	10.70	67.40	8.30	17.05	27.50	24.65	19.20	7.55	18.55	8.55
3rd	11.85	23.90	8.15	28.90	24.05	47.90	18.05	9.70	22.95	10.55
Nov. 1st	13.55	20.80	6.85	17.35	20.90	46.60	15.75	17.70	20.00	18.90
2nd	22.00	30.25	9.85	23.40	27.25	42.10	20.45	17.15	27.85	16.30
3rd	19.30	19.70	14.70	23.30	23.15	47.45	21.90	24.85	24.15	23.05
Dec. 1st	20.00	38.30	21.70	30.45	23.45	49.55	14.55	38.00	32.00	28.40
2nd	15.45	57.85	28.00	34.10	30.60	50.50	15.85	29.65	26.75	21.50
3rd	25.35	24.35	20.00	17.40	24.20	37.15	14.95	30.80	27.80	30.30
Mean 1st	19.66	26.32	19.23	27.53	21.77	36.41	22.74	19.44	27.62	24.45

Table - 1(3)

ESTIMATED RUNOFF

KEPANJEN

Month		1980	1981	1982	1983	Mean
Jan.	1st	27.65	66.45	55.15	54.35	34.52
	2nd	32.30	43.55	44.00	64.20	35.80
	3rd	34.85	30.45	29.35	38.30	35.58
Feb.	1st	25.65	35.30	49.30	64.55	33.17
	2nd	22.70	34.20	62.05	45.10	35.06
	3rd	29.90	40.90	36.20	49.30	35.54
Mar.	1st	25.65	29.70	46.45	39.00	34.37
	2nd	25.70	28.70	45.75	42.70	33.86
	3rd	26.00	32.35	25.60	53.80	35.65
Apr.	1st	19.55	31.25	35.60	52.30	34.22
	2nd	25.85	23.05	31.20	41.60	28.96
	3rd	28.85	28.35	34.40	54.30	28.09
May	1st	12.70	29.50	13.25	49.75	28.42
	2nd	8.15	30.50	11.20	41.65	26.24
	3rd	10.45	20.30	10.40	41.85	23.70
June	1st	7.70	18.50	9.90	13.50	21.02
	2nd	7.50	24.40	9.05	13.55	18.03
	3rd	7.35	33.60	8.55	10.00	17.36
July	1st	7.60	25.80	9.00	12.30	15.83
	2nd	7.60	37.00	9.10	12.55	15.62
	3rd	7.60	21.85	10.30	9.55	13.48
Aug.	1st	8.40	9.30	9.35	8.00	11.92
	2nd	8.00	7.45	8.50	8.00	11.76
	3rd	7.60	8.30	8.00	7.65	10.82
Sep.	1st	7.50	18.00	7.85	7.50	11.19
	2nd	7.05	18.50	8.40	7.20	12.23
	3rd	7.05	31.55	8.15	7.85	12.39
Oct.	1st	7.30	27.20	7.75	16.75	15.28
	2nd	9.15	24.45	7.50	26.20	18.00
	3rd	9.10	21.30	7.45	42.60	18.01
Nov.	1st	20.30	16.45	6.70	21.95	17.84
	2nd	26.90	23.85	8.05	18.90	20.51
	3rd	38.55	40.45	6.80	25.45	22.30
Dec.	1st	45.65	38.95	24.80	12.10	26.81
	2nd	29.20	36.30	33.15	11.25	29.13
	3rd	40.35	28.45	31.75	24.20	26.74
Mean	1st	18.70	28.22	21.38	29.16	23.69

Table - 2

ENERGY POTENTIAL AT KEPANJEN

UNIT :KWH

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1960	3351	4380	5216	4922	4546	2599	2312	1727	1615	1645	2493	2365	37177
1961	4334	2932	2197	2416	2347	1512	1480	1284	1176	1165	2532	2483	25843
1962	7069	5075	4805	5054	3497	1783	1654	1756	1252	1311	2327	5038	40627
1963	5572	5043	5502	3754	2140	1649	1398	1329	1244	1278	1190	3474	33580
1964	2822	2373	3650	2582	2957	2682	1103	1202	1210	4786	2457	1746	29575
1965	2598	2828	2703	2406	1437	1224	1163	1164	1066	1054	1896	3844	23389
1966	3670	5349	5572	3578	3084	1459	1204	1164	1066	2314	1659	2697	32824
1967	4388	2907	2360	2803	1555	1228	1129	1103	1095	1034	1734	3823	25167
1968	4063	4571	5042	4026	4521	4376	4356	2297	1769	2714	2896	3817	44453
1969	4089	4371	6286	4648	3124	2497	2317	2211	1453	1377	2070	2931	37371
1970	2854	2931	3935	3242	3009	2188	1656	1291	1576	1570	2220	2564	29041
1971	4552	4091	4221	2868	3451	2698	1942	1423	1492	4282	2864	4976	38775
1972	5239	2868	3980	2503	3051	1779	1477	1244	1066	1030	1271	2902	28467
1973	3616	2815	4263	4916	5739	4113	2276	1386	2686	2784	2592	3389	40580
1974	2931	3654	3268	2870	2726	1623	1626	1986	1995	3139	2886	3265	31977
1975	5127	4753	5701	6040	5934	2945	2664	2491	2698	4258	5511	5704	53830
1976	5015	4061	5099	3817	2848	1811	1698	1645	1325	2099	2352	1896	33586
1977	3110	3180	4750	3036	2002	1918	1038	1047	977	1045	2416	4110	28634
1978	5273	3694	4033	2886	4381	4655	3709	1385	1386	2837	2914	3616	40775
1979	5027	3948	4299	3874	4439	3455	1692	1322	1208	1174	2358	3369	36160
1980	3978	3046	3236	3005	1309	912	953	1002	874	1071	3471	4827	27691
1981	5809	4138	3804	3345	3333	3097	3515	1047	2754	3039	3269	4313	41468
1982	5320	5689	4872	4096	1452	1113	1191	1078	987	949	872	3759	31376
1983	6504	6035	5703	5999	5563	1499	1431	988	912	3635	2684	2022	42983
MEAN	4432	3947	4350	3695	3269	2284	1874	1441	1450	2150	2456	3455	34806

Table - 3

ENERGY PRODUCTION AT KEPANJEN

UNIT :MWH

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1960	3351	3965	4190	4119	4362	2599	2312	1727	1615	1645	2493	2365	34747
1961	3915	2904	2197	2416	2347	1512	1460	1284	1176	1165	2532	2483	25395
1962	4517	4071	4216	4372	3341	1783	1654	1756	1252	1311	2327	4439	35045
1963	4517	4080	4517	3710	2140	1649	1398	1329	1244	1278	1190	3294	30354
1964	2822	2373	3650	2582	2957	2682	1103	1202	1210	4083	2457	1746	28873
1965	2598	2828	2703	2406	1437	1224	1163	1164	1066	1054	1896	3518	23063
1966	3670	3406	4493	3578	3084	1459	1204	1164	1066	2314	1659	2697	29802
1967	4135	2815	2360	2803	1555	1228	1129	1103	1095	1034	1734	3694	24692
1968	3847	4226	4471	3528	4265	4224	4047	2297	1769	2714	2896	3817	42108
1969	3641	4080	4234	4165	3124	2497	2317	2211	1453	1377	2070	2931	34105
1970	2854	2931	3935	3242	3009	2188	1656	1291	1576	1570	2220	2564	29041
1971	4013	4069	4052	2868	3451	2698	1942	1423	1402	3011	2864	3993	35788
1972	4111	2868	3980	2503	3051	1779	1477	1244	1086	1030	1271	2902	27589
1973	3616	2815	3965	4372	4517	4113	2276	1386	2686	2784	2592	3388	38516
1974	2931	3594	3268	2870	2726	1623	1626	1986	1995	3139	2886	3265	31917
1975	4222	4079	4517	4372	4517	2945	2684	2491	2698	3728	4372	4517	45127
1976	4517	3959	4339	3730	2848	1811	1698	1649	1325	2099	2352	1896	32229
1977	3110	3180	4469	3036	2002	1918	1038	1047	977	1045	2416	4029	28272
1978	4517	3694	4033	2886	4169	4372	3515	1385	1386	2837	2914	3616	39330
1979	4117	3849	4290	3827	4232	3196	1692	1322	1209	1174	2358	3569	34638
1980	3978	3946	3236	3005	1309	912	953	1002	874	1071	3368	4242	27003
1981	4270	3979	3804	3345	3333	3097	3474	1047	2754	3039	3088	4181	39419
1982	4221	4080	4054	4096	1452	1113	1191	1078	987	949	872	3759	27860
1983	4517	4080	4517	4372	4517	1499	1431	988	912	3341	2884	2022	34888
MEAN	3846	3540	3896	3425	3073	2255	1851	1441	1450	2033	2396	3281	32492

Table - 4(1) CONSTRUCTION COST ESTIMATE FOR KEPANJEN SCHEME

Item No.	Work	Unit	Quantity	Unit Price (10^3 Rp)	Amount (10^6 Rp)
1.	Civil Works				8,306
1-1	Preparatory works	L.S			615
1-2	Access road				
	(Existing road improvement)	km	2	35,000	70
1-3	Diversion works				
	Excavation (earth)	m^3	114,100	3.5	399
	Backfill	m^3	11,600	3.5	41
	Embankment (coffer dam)	m^3	22,400	4.4	99
	Sub-total				539
1-4	Dam				
	Excavation (earth)	m^3	20,100	3.5	70
	Embankment (earth)	m^3	69,600	4.4	306
	Concrete	m^3	11,250	94.6	1,064
	Reinforcement	ton	218	609.8	133
	Curtain & blanket grout	m	11,250	72	810
	Sub-total				2,384
1-5	Spillway				
	Excavation (rock)	m^3	9,400	7.5	71
	Concrete	m^3	7,890	94.6	746
	Reinforcement bar	ton	158	609.8	96
	Backfill	m^3	1,800	72	6
	Sub-total				920
1-6	Emergency spillway				
	Excavation (earth)	m^3	180,800	3.5	633
	Embankment (fuse dike)	m^3	7,900	4.4	35
	Sub-total				668
1-7	Waterway				
	Excavation (rock)	m^3	12,500	7.5	94
	Concrete	m^3	8,100	94.6	766

- to be continued -

Table -4(2) CONSTRUCTION COST ESTIMATE FOR KEPANJEN SCHEME

Item No.	Work	Unit	Quantity	Unit Price (10^3 Rp)	Amount (10^6 Rp)
	Reinforcement bar	ton	315	609.8	192
	Sub-total				1,052
1-8	Powerhouse				
	Excavation	m^3	36,600	7.5	275
	Concrete	m^3	6,000	94.6	568
	Reinforcement bar	ton	300	609.8	183
	Backfill	m^3	2,500	3.5	9
	Architectural works	L.S			319
	Utility works	L.S			340
	Sub-total				1,693
1-9	Miscellaneous				366
2.	Metal Works				2,314
2-1	Gates, valve, etc.	ton	315	5,150	1,622
2-2	Penstock	ton	240	2,884	692
3.	Generating Equipment including T/L	L.S			5,041
	Total				15,661
4.	Engineering Service				1,566
5.	Administration				783
6.	Base Cost				18,011
7.	Physical Contingency				2,702
	Grand Total				20,712

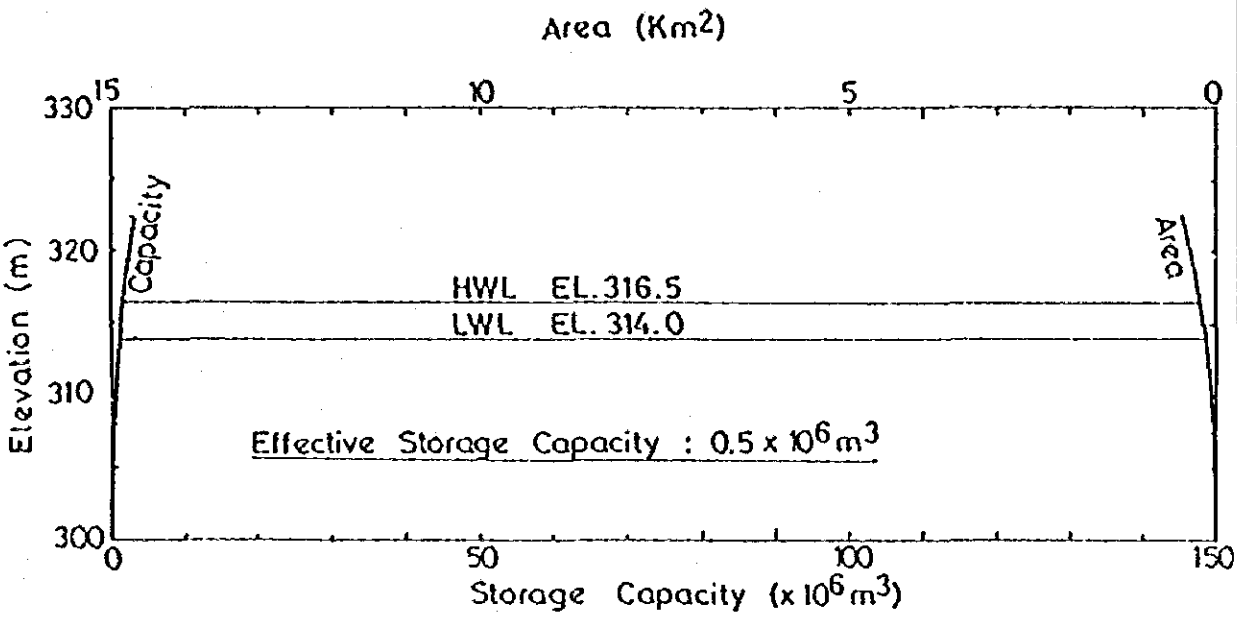


Fig. 1 STORAGE CAPACITY OF KEPANJEN RESERVOIR

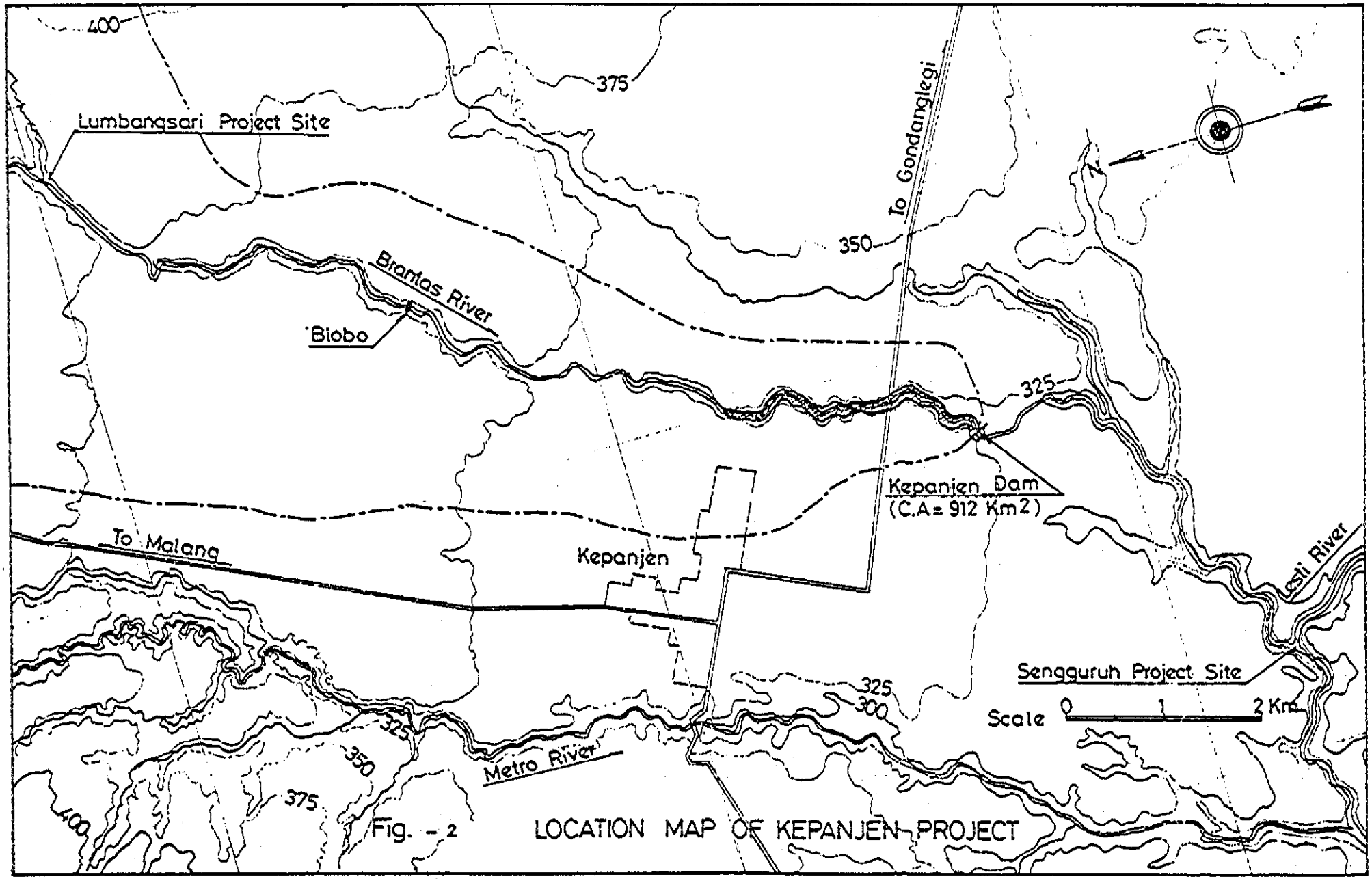


Fig. - 2 LOCATION MAP OF KEPANJEN PROJECT

MP-12.12

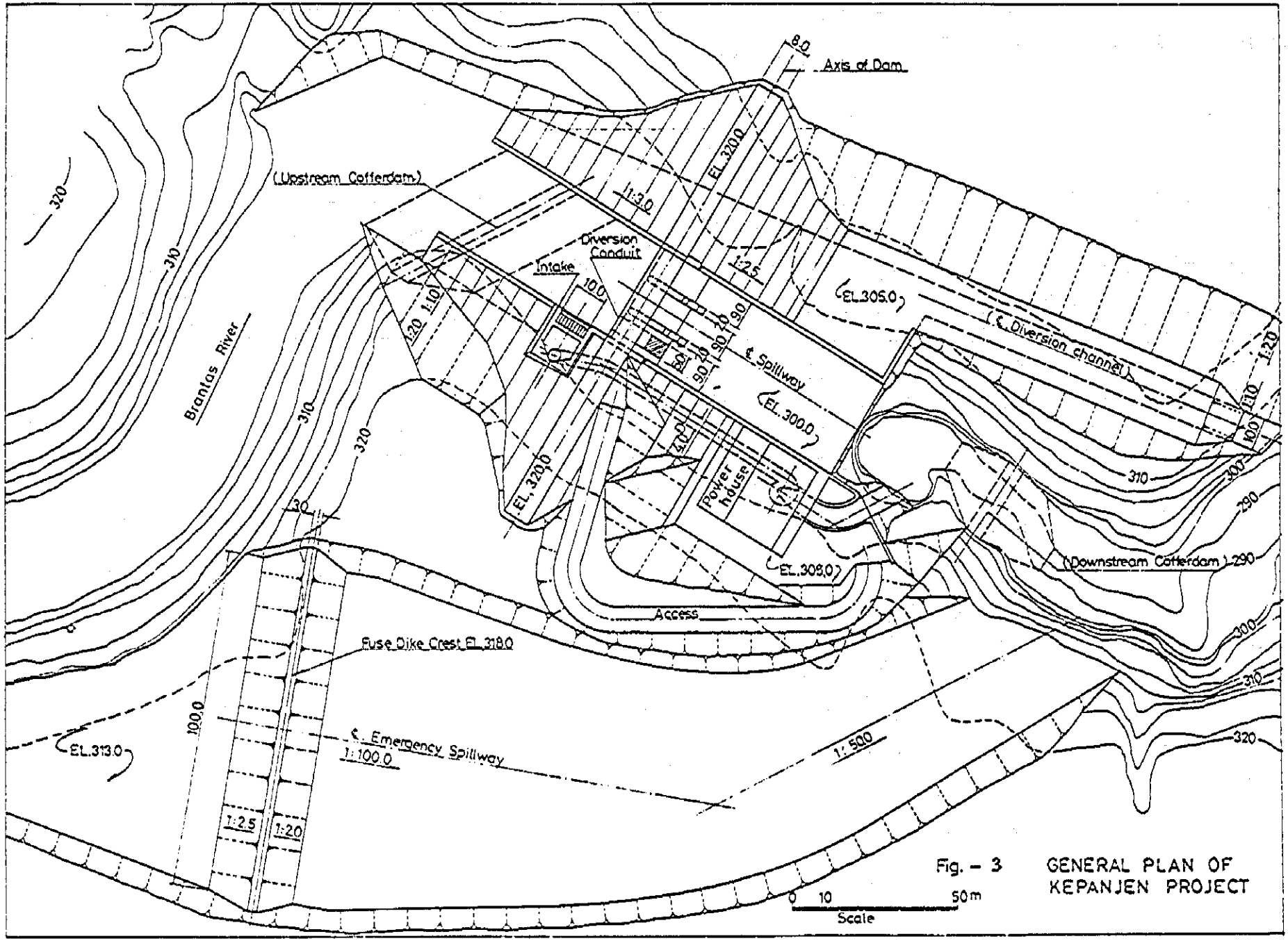


Fig. – 3 GENERAL PLAN OF KEPANJEN PROJECT

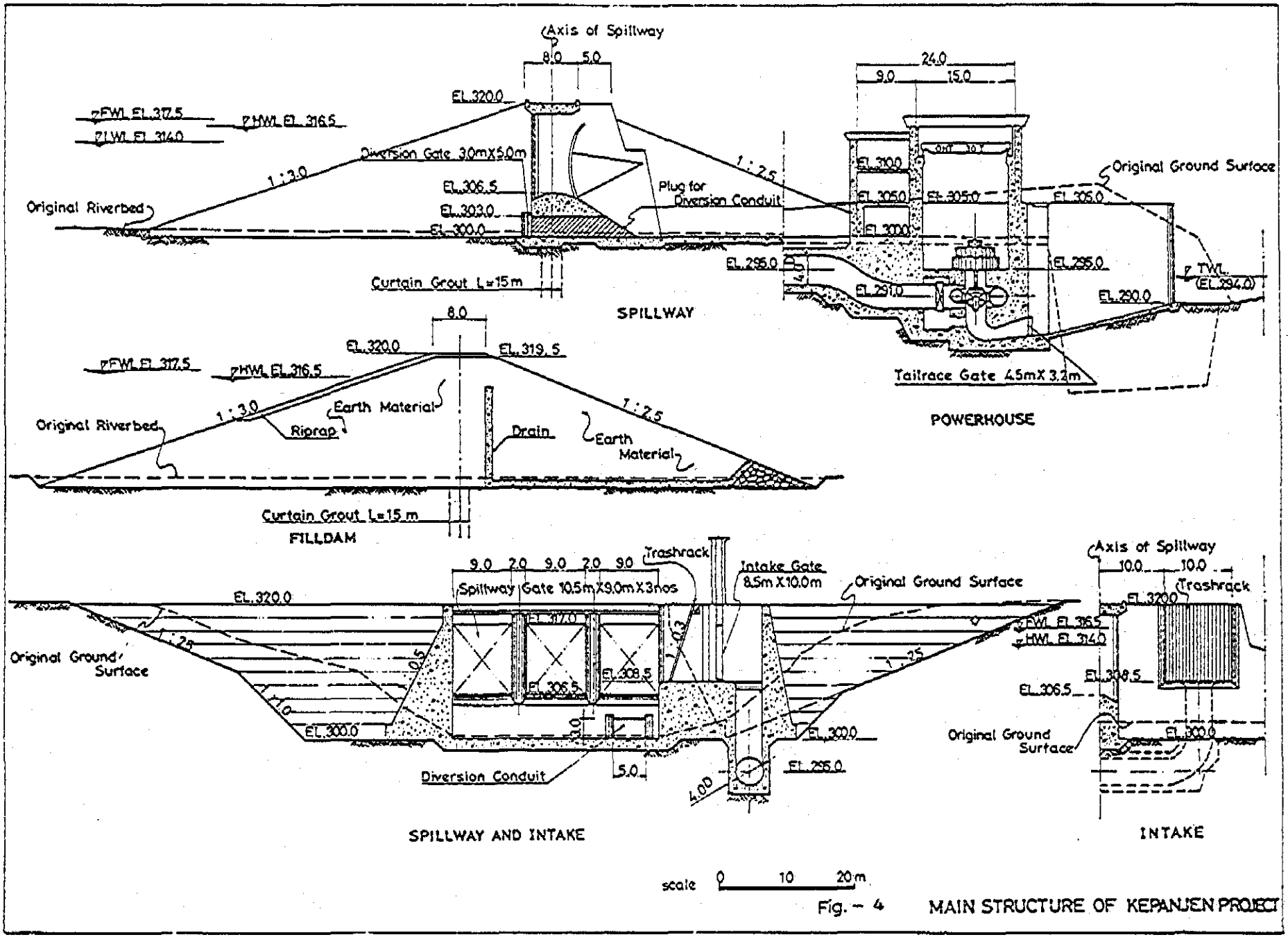


Fig. – 4 MAIN STRUCTURE OF KEPANJEN PROJECT

NOTE MP-13

TRANSBASIN FROM SOLO RIVER

TABLE OF CONTENTS

LIST OF TABLES

NOTE MP-13. Transbasin from Solo River

In the vicinity of the Brantas basin, the Solo river seems to have a potential of excess water. The Solo river has a catchment area of 16,000 km^2. According to the MacDonald's estimates, the minimum discharge with the recurrence period of once in 20 years is 6.8 m^3/s at Bojonegoro, and any intake works or shortage facilities should be located upstream of Babat, about 70 km from Surabaya,owing to the extensive annual flooding in the lower reaches and the problem of saline intrusion.

Although there is an uncertainty whether the amount of 6.8 m^3/sec will be used for development of the Solo basin in future or not, a transbasin plan from the Solo river is preliminary examined hereunder.

Since the topography between Babat and Surabaya is very flat and there are so many crossing with streams, drains and roads, it will be practically impossible to construct a series of open canals and boosting stations. Therefore, it will be necessary to use a pipeline system. As the terminal point of the pipeline, Gedangsari is selected. The pipeline route is selected along the narrow gauge railway shown on 1 to 50,000 scale map. Distance between Babat and Gedangsari is measured as 72 km.

Assuming the intake discharge of 6.5 m^3/s, construction and operation costs are estimated for different size of pipe and number of lines as shown in Table 1.

The results suggested that the unit raw water cost from the Solo river is as high as Rp. 180 / m^3 or so.

Table – 1 CONSTRUCTION AND OPERATION COST OF PIPELINE

PIPE LINE NAME BABAI - SUSARAYA
DISCHARGE 6.5 CMS
PIPE LENGTH 72000 M
STATIC HEAD 0 M

PIPE DIA M	LINE NO	FLOW VELO. M/SEC	GROSS HEAD M	REQU'D POWER KW	ANNUAL ENERGY MWH	ENERGY COST RP.MIL	PUMP COST RP.MIL	PIPE COST RP.MIL	INSTALL COST RP.MIL	CIVIL COST RP.MIL	TOTAL COST RP.MIL	ANNUAL COST RP.MIL	TOTAL ANNUAL RP.MIL	UNIT COST RP/CUM
1.50	1	571.50	3.67	42829	375182	27050	63082	31337	19102	38047	201	28658	55709	271.81
1.50	2	142.87	1.83	10707	93793	6762	15770	53674	38204	54222	227	32350	39152	190.96
1.50	3	63.50	1.22	4759	41688	3005	7009	95511	57307	70378	304	43387	46393	226.29
1.60	1	405.13	3.23	30361	265962	19175	44718	37105	22263	40038	190	27161	46337	226.03
1.60	2	101.28	1.61	7590	66488	4793	11179	74211	44526	57107	247	35245	40039	195.28
1.60	3	45.01	1.07	3373	29547	2130	4966	111317	66790	74175	340	48480	53610	246.89
1.70	1	293.25	2.86	21977	192518	13880	32369	42487	25492	42072	193	26843	40720	198.68
1.70	2	73.31	1.43	5498	48127	3469	8092	84975	50985	60044	269	38463	41933	204.55
1.70	3	32.58	0.95	2442	21391	1542	3596	127462	76477	78016	377	53815	55356	270.06
1.80	1	216.22	2.55	16204	141947	10234	23866	47529	28517	44149	190	27149	37383	182.41
1.80	2	54.05	1.27	4051	35486	2558	5966	95053	57035	63034	292	41886	44225	215.78
1.80	3	24.02	0.95	1800	15768	1136	2651	142583	85552	91920	413	58932	60689	293.33
1.90	1	162.08	2.29	12147	106407	7671	17891	53534	32120	46266	198	28233	35905	175.20
1.90	2	40.52	1.14	3037	26604	1918	4473	107068	64241	69077	319	45580	47498	231.75
1.90	3	18.01	0.76	1350	11826	852	1988	160602	96361	85839	456	64937	65340	321.15
2.00	1	123.31	2.03	9244	80951	5836	13611	58916	35349	49426	206	29454	35292	172.21
2.00	2	30.82	1.03	2310	20235	1458	3402	117832	70699	69173	345	49207	50666	247.20
2.00	3	13.70	0.68	1027	8996	648	1512	176748	106048	85920	494	70526	71174	347.21
2.10	1	95.97	1.97	7125	62415	4500	10494	64581	38748	50628	217	30992	35492	173.14
2.10	2	23.76	0.93	1781	15601	1124	2623	129162	77497	72322	372	53070	54195	264.40
2.10	3	10.56	0.62	792	6937	500	1166	193743	116245	94016	535	78357	78857	374.92
2.20	1	74.19	1.70	5560	48705	3511	8139	70246	42147	52673	229	32688	36200	176.64
2.20	2	18.54	0.85	1390	12176	877	2047	140492	84295	75524	399	56981	57858	282.22
2.20	3	8.24	0.56	618	5413	390	910	210738	126442	98175	575	82217	82607	403.03
2.30	1	58.54	1.56	4387	38430	2770	6461	75911	45546	55159	242	34502	37273	181.79
2.30	2	14.63	0.78	1097	9609	692	1615	151822	91093	78779	427	60929	61622	300.65
2.30	3	6.50	0.52	487	4266	307	717	227733	136639	102398	618	86101	86408	421.26
2.40	1	46.56	1.43	3497	30633	2208	5150	81576	48945	57469	255	36402	38611	188.38
2.40	2	11.64	0.71	874	7656	552	1287	163152	97891	82066	455	64907	65459	319.30
2.40	3	5.18	0.47	389	3407	245	572	244728	146836	106885	659	94006	94252	459.79
2.50	1	37.54	1.32	2813	24641	1776	4143	97241	52244	59859	269	39357	40164	195.80
2.50	2	9.38	0.66	703	6158	444	1035	174492	104689	85447	485	68909	69353	338.35
2.50	3	4.17	0.44	313	2741	197	461	261723	157033	111035	701	99929	100127	488.42

NOTE MP-14

REFERENCE, SUMMARY OF PROJECT

TABLE OF CONTENTS

LIST OF REFERENCE

Number	Name of Data	Author	Date of Issue
MP 01	REVIEW FEASIBILITY REPORT ON KESAMBEN HYDROPOWER DEVELOPMENT PROJECT EXECUTIVE SUMMARY REPORT	P.T. INDRA KARYA	Mar. 1982
MP 02	- do - MAIN REPORT		
MP 03	- do - SUPPORTING REPORT VOLUME I		
MP 04	SUPPORTING REPORT VOLUME II		
MP 05	LAPORAN PENYELIDIKAN GEOLOGI		
MP 06	LAPORAN AKHIR PROYEK KARANGKATES TAHAP-I APPENDIKS DESIGN CALACULATION DAN PERHITUNGAN BIAYA	BRANTAS OFFICE	Jan. 1982
MP 07	KARANGKATES SECOND STAGE DEVELOPMENT PROJECT DESIGN CALCULATION REPORT	NIPPON KOEI	July 1973
MP 08	DESIGN REPORT ON SENGGURUH HYDROPOWER PROJECT VOLUME II CIVIL WORKS	P.T. INDRA KARYA/ NIPPON KOEI	
MP 09	STUDI KELAYAKAN PENGEMBANGAN DAN PENGENDALIAN EROSI PADA DAERAH KARANGKATES BAGIAN HULU PROYEK BENDUNGAN KARANGKATES LAPORAN UTAMA	P.T. INDRA KARYA	Mar. 1982
MP 10	- do - LAPORAN PELENGKAP VOLUME I I. STUDI GEOLOGI DAM MATERIAL CONSTRUKSI II. STUDI HIDROLOGI III. STUDI SOCIAL EKONOMI		
MP 11	LAPORAN PELENGKAP VOLUME II I. STUDI KELISTRIKAN		

Number	Name of Data	Author	Date of Issue
	II. STUDI IRIGASI III. STUDI DAM LESTI		
MP 12	FEASILITY REPORT ON THE LESTI III DAM AND IRRIGATION PROJECT		
MP 13	REVIEW REPORT ON HYDROLOGICAL STUDY FOR LESTI III PROJECT	NIPPON KOEI	Jan. 1984
MP 14	LAPORAN PENYELIDIKAN GEOLOGI, DAERAH ALIRAN K. LESTI DAN K. GENTENG	PROYEK BRANTAS	Mar. 1981
MP 15	SURVAI, INVESTIGASI & DESIGN DETAIL PADA PROYEK BENDUNGAN KARANGKATES. LAPORAN SURVAI DAN INVESTIGASI	P.T. INDRA KARYA	June 1983
MP 16	SURVAI DAN INVESTIGASI UNTUK DAERAH KARANGKATES HULU PADA PROYEK PENGEMBANGAN KARANGKATES HULU LAPORAN GEOLOGI DAN LAPORAN MEKANIKA TANAH	P.T. INDRA KARYA	Mar. 1984
MP 17	LAPORAN PENYELIDIKAN GEOLOGI TAHAP PERTAMA DI RENCANA PROYEK BENDUNGAN METRO MALANG	P.T. INDRA KAYRA	Jan. 1983
MP 18	STUDY REPORT ON KEPANJEN HYDROPOWER PROJECT	NIPPON KOEI	June 1984
MP 19	SURVAI DAN INVESTIGASI UNTUK PENYIAPAN STUDY/DESAIN DAERAH IRRIGASI WIDAS LOWER REACH PADA PROYEK WIDAS. LAPORAN GEOLOGI & MEKANIKA TANAH VOLUME I	P.T. INDRA KARYA	Aug. 1984
MP 20	RESERVOIR SEDIMENTATION STUDY, KARANGKATES, EAST JAVA, INDONESIA	HYDRAULICS RESEARCH	May 1979

Number	Name of Data	Author	Date of Issue
MP 21	REPORT ON SILTATION PROBLEM OF KARANGKATES RESERVOIR	COLOMBO PLAN EXPERT (MR. TAKANASHI)	Jan. 1980
MP 22	SURVEY REPORT ON THE SEDIMENT PROBLEM AT KARANGKATES RESERVOIR, EAST JAVA	COLOMBO PLAN EXPERT (MR. SAKAI)	Feb. 1980
MP 23	INSTRUCTION MANUAL FOR SEDIMENTATION STUDY IN KARANGKATES RESERVOIR	NIPPON KOEI	Oct. 1980
MP 24	STUDY ON SEDIMENTATION IN KARANGKATES RESERVOIR	NIPPON KOEI	Oct. 1980
MP 25	SEDIMENTATION IN KARANGKATES RESERVOIR AND ITS EFFECT ON POWER OUTPUT	NIPPON KOEI	Mar. 1982
MP 26	SEDIMENTATION SURVEY, KARANGKATES RESERVOIR, EAST JAVA, INDONESIA	HYDRAULICS RESEARCH STATION	Dec. 1982
MP 27	RESERVOIR SEDIMENTATION STUDY, EAST, JAVA, INDONESIA	HYDRAULIC RESEARCH STATION	Jun. 1978
MP 28	RESERVOIR SEDIMENTATION STUDY, SELOREJO, EAST JAVA	HYDRAULIC RESEARCH STATION	Jan. 1983
MP 29	RESERVOIR SURVEY METHODS (KARANGKATES, SELOREJO)	HYDRAULIC RESEARCH STATION	Jan. 1983
MP 30	FEASIBILITY REPORT ON THE WLINGI MULTIPURPOSE PROJECT MAIN REPORT	NIPPON KOEI	Nov. 1973
MP 31	RESERVOIR SEDIMENTATION STUDY, WLINGI, EAST JAVA	HYDRAULIC RESEARCH STATION	Dec. 1983
MP 32	SEDIMENT MEASUREMENT DATA BOOK (METRO, BLOBO, SUMBEREJO, LESTI.1, LESTI.2, GADANG BIRU STATION)	BRANTAS OFFICE	

Number	Name of Data	Author	Date of Issue
MP 33	FEASIBILITY REPORT ON THE KARANGKATES SECOND STAGE DEVELOPMENT PROJECT (PART II : SUPPORTING REPORT)	BRANTAS MULTIPURPOSE PROJECT	June 1972
MP 34	REGULATIONS FOR OPERATION KARANGKATES DAM OF KARANGKATES PROJECT	NIPPON KOEI	Sep. 1972
MP 35	KARANGKATES PROJECT STUDY REPORT FOR OPERATION OF KARANGKATES-LAHOR RESERVOIR	NIPPON KOEI	Feb. 1978
MP 36	REGULATIONS FOR OPERATION OF SELOREJO DAM OF SELOREJO PROJECT	NIPPON KOEI	Dec. 1970
MP 37	DESIGN REPORT ON KARANGKATES PROJECT	NIPPON KOEI	Apr. 1962
MP 38	DESIGN REPORT ON KALI KONTO PROJECT	NIPPON KOEI	Sep. 1962
MP 39	REPORT ON THE BRANTAS RIVER BASIN DEVELOPMENT PLAN	OTCA	May 1972
MP 40	STUDY REPORT ON HYDROPOWER DEVELOPMENT OF THE BRANTAS BASIN: SENGGURUH AND KESAMBEN PROJECTS	BRBDEO	Feb. 1977

NOTE MP-14 SUMMARY OF PROJECT

NAME OF PROJECT : KARANG KATES MULTI-PURPOSE PROJECT (first stage)

1. BACKGROUND

In 1961, an overall study on development of the K. Brantas basin was carried out, and this project was identified as one of the most promosing project. Design was prepared in 1961/62. Preparatory works and division tunnel construction were started in 1962 with the war reparation fund from Japan.

Construction works were suspended during the civil disturbance in 1965. Construction was re-started with the financial assistance from Japan through OECF. Dam was completed in 1972, and impounding was started subsequently.

At present, dam and reservoir, and power station are well operated.

2. OBJECTIVES OF THE PROJECT

- flood control
- hydropower generation
- irrigation water supply to the downstream area of K. Brantas

3. PROJECT FEATURES

3.1 Project Area

- Upstream of K. Brantas

3.2 Project Component

- Reservoir	catchment area	2,050 km^2
	HWL	EL. 272.5 m
	LWL	EL. 246.0 m
	gross storage	343 x $10^6 m^3$
	effective storage	253 x $10^6 m^3$
- Dam	rock-fill, zoned with center core	
	crest elevation	EL. 279.0 m
	riverbed elevation	EL. 179.0 m
	dam height	97.5 m

	crest length	823.5 m
	embankment volume	6,150 x 10^3 m^3
	storage efficiency	41.1
- Spillway	design flood	200 years
	design discharge	580 m^3/sec
	spillway discharge	400 m^3/sec
- Connection tunnel	between Labor and Karang Kates reservoirs	
	diameter	2.5 - 3.0 m
	length	822.0 m
	elevation	EL 251.0 m (inlet)
		EL 247.0 m (outlet)
- Power station	addition of one unit to Karang Kates power station	

3.3 Construction Cost

	Foreign Yen 10^6	Local Rp. 10^6
- Dam	2,531.2	11,876.4
- No.3 unit	3,005.7	361.3

3.4 Benefit

- Power generation ; included in the Karang Kates power station
- flood control ; 580 m^3/sec to 400 m^3/sec
- irrigation area ; included in the first stage

4. WATER BALANCE

Increase the dry season flow by 29.4 x m^3, when needed

5. RECOMMENDATION

Same problems as the Karang Kates reservoir

- Spillway	design flood	1,000 years
	design discharge	4,200 m^3/sec
	spillway discharge	1,600 m^3/sec

- Intake	crest elevation	EL. 231.25 m
- Power station	installed capacity	35 MW x 2 units (1st stage)
		35 MW x 1 unit (2nd stage)
	maximum gross head	93.5 m
	design head	78.0 m
	max. discharge/unit	51.39 m^3/sec
	annual energy output	328 GWh (normal)
		217 GWh (dry)

3.3 Construction Cost

- Foreign component (unit: Yen x 10^6)

	War reparation fund	OECF loan
Dam	5,764.5	2,697.5
Power station		5,227.4

- Local component (Unit: Rp. x 10^6)

Dam	3,701.2	3,701.2
Power station		2,331.4

3.4 Benefit

- Power generation ; 328 GWh
- irrigation area ; 34,000 ha
- flood control ; 4,200 m^3/sec to 1,600 m^3/sec

4. WATER BALANCE

Increase the dry season flow by 253 x $10^6 m^3$, when needed

5. RECOMMENDATION

(1) Reservoir sedimentation and effective storage capacity

Sounding survey shall be made in every year.
Aero photo shooting at the time when the reservoir water level is lowered near LWL is recommended for precise estimation of the current reservoir capacity.

(2) Spillway Capacity

The present capacity of the spillway is based on the old standard. Review based on the current standard will be needed.

(3) Reservoir Operation

Presently, the reservoir is operated by BRBDEO with consent of Coordination Committee organized among the water uses. Basically, reservoir operation in the dry season is made according to irrigation water requirement. Since the water supply condition in the basin become tight, it will be necessary to review the operation rule according to new situations.

SUMMARY OF PROJECT

NAME OF PROJECT : KARNG KATES MULTI-PURPOSE PROJECT (second stage)

1. BACKGROUND

There was an alternative plan to construct one dam at Pogaji, instead of two dams on K. Brantas and K. Lahor. Based on technical and economic comparison, two dam plan was selected.

Design of the Lahor dam was carried out in parallel to the construction works of the Karang Kates dam. Construction was started in 1973 and completed in 1977.

2. OBJECTIVES OF THE PROJECT

- hydropower generation (water supplement to Karang Kates reservoir)
- flood control
- irrigation water supply

3. PROJECT FEATURES

3.1 Project Area

- on K. Lahor, one of the tributaries of K. Brantas, joining near Pogaji

3.2 Project components

- Reservoir	Catchment area	160 km^2
	HWL	EL. 272.7 m
	LWL	EL. 253.0 m
	gross storage	36.1 x $10^6 m^3$
	effective storage	29.4 x $10^6 m^3$
- Dam	rock-fill, zoned with center core	
	crest elevation	278.0 m
	riverbed elevation	206.0 m
	dam height	74.0 m
	crest length	433.0 m
	embankment volume	1,018 x $10^3 m^3$
	storage efficiency	28.9

SUMMARY OF PROJECT

NAME OF PROJECT : WLINGI MULTI-PURPOSE PROJECT (first stage)

1. BACKBROUND

The Wlingi dam was firstly planned as after-bay for the Karang Kates dam. Later, the project was reformulated as dam for peak power station. Dam construction was started in 1975 and completed in 1978.

2. OBJECTIVE OF THE PROJECT

- Power generation
- Sediment control
- Creation of head for irrigation intake

3. PROJECT FEATURES

3.1 Project Area

on K. Brantas near Wlingi

3.2 Project Component

- Reservoir	catchment area	2,890 km^2
	HWL	EL. 163.5 m
	LWL	EL. 162.0 m
	gross storage	24 x $10^6 m^3$
	effective storage	5.2 x $10^6 m^3$
- Dam	crest elevation	EL. 167.0 m
	riverbed elevation	EL. 139.0 m
	dam height	26.0 m
	crest length	735.0 m
	embankment volume	610 x $10^6 m^3$
- Spillway	design flood	200 years
	design flood	3,440 m^3/sec
	spillway discharge	2,820 m^3/sec
	gate	10 m x 10 m x 4 nos.

- Power station	installed capacity	27 MW, 2 units
	maximum gross head	24.5 m
	design head	22.0 m
	max. discharge/unit	149.54 m^3/sec
	annual energy output	152 GWh (normal)
		113 GWh (dry)
- Irrigation intake	Sill elevation	EL. 159.5 m
	gate	2.5 m x 2.5 m x 2 units

3.3 Construction Cost

	Foreign Yen 10^6	Local Rp. 10^6
- Dam	1,345.8	7,347.6
- Power station	9,107.1	8,776.2

3.4 Benefit

- Power generation ; 152 GWh per annum
- Sediment control ; 18.8 x $10^6 m^3$

4. WATER BALANCE

Since the reservoir has only daily regulation capacity for power generation, there is not contribution to the water balance. From the reservoir, irrigation water to the Lodoyo - Tulungagung irrigation project is taken at the maximum capacity of 19.2 m^3/sec. Historical intake amount is as follows:

Year	Yearly intake $10^6 m^3$	
1980	120.2	
1981	184.5	
1982	240.3	(from May to Oct. 114.4)
1983	251.3	

5. RECOMMENDATION

(1) Reservoir Sedimentation

As one of the functions of the reservoir, sediment contorl is planned from the beginning. It is necessary to observe the

progress of the sedimentaiton through sounding survey in every year, whether the effective capaicty is eaten or not. If the effective capacity is reduced by sedimentation, appropriate countermeasures shall be taken.

(2) Spillway Capacity

The present capacity of the spillway is based on the old standard. Review based on the current standard will be necessary. The present spillway is of gated weir type without non-gated over flow section. Since the sub-basin of the Wlingi reservoir is the heavy rainfall area, it is necessary to establish a flood forecasting system in this area.

SUMMARY OF PROJECT

NAME OF PROJECT: WLINGI MULTI-PURPOSE PROJECT (second stage)
LODOYO DAM AND POWER STATION

1. BACKGROUND

The project was planned as after bay for the Wlingi power station which is operated as peak power station. Later, the project was re-formulated to have a power station to be located in the diversion channel.

Construction was started in 1977 and completed in 1983.

2. OBJECTIVES OF THE PROJECT

- Regulate the peak outflow into ordinary flow
- Power generation

3. PROJECT FEATURES

3.1 Project Area

- Downstream of the Wlingi dam

3.2 Project Component

- Reservoir	catchment area	3,017 km^2
	HWL	EL. 136 m
	LWL	EL. 130.5 m
	gross storage	5.8 x $10^6 m^3$
	effective storage	4.2 x $10^6 m^3$
- Dam	gated weir	
	sill elevation	EL. 125.0 m
	gate width	12.0 m x 9
	discharge capacity	3,970 m^3/sec
- Power station	installed capacity	4.5 MW
	annual energy output	14 GWh

3.3 Construction Cost

	Foreign Yen 10^6	Local Rp. 10^6
- Dam	1,872.2	8,671.2
- Power station	910.4	509.8

SUMMARY OF PROJECT

NAME OF PROJECT: KALI KONTO PROJECT

1. BACKGROUND

The project was planned in the overall study in 1961. Construction was started in 1962 and completed in 1973.

2. OBJECTIVE OF THE PROJECT

- Flood control
- Hydropower generation
- Irrigation water supply

3. PROJECT FEATURES

3.1 Project Area

- Upstream of K. Konto

3.2 Project Component

- Reservoir	catchment area	236 km^2
	HWL	EL. 622 m
	LWL	EL. 598 m
	gross storage	62.3 x $10^6 m^3$
	effective storage	50.1 x $10^6 m^3$
- Selorejo dam	zone fill of earth, sand and gravel	
	crest elevation	EL 625.0 m
	riverbed elevation	EL. 578.5 m
	dam height	49.0 m
	dam length	450 m
	embankment volume	2,063 x $10^3 m^3$
	storage efficiency	24.3
- Spillway	gated spillway	
	designed flood	100 years x 1.2
	design discharge	680 m^3/sec

- Power station	installed capacity	4.5 MW
	effective head	37.1 m
	max. discharge	14.8 m^3/sec
	annual energy output	28 GWh (normal) 20 GWh (dry)
- Sabo dams	Mendalan dam	
	Tokol dam	

3.3 Construction Cost

- Foreign component (unit: Yen 10^6)

	War reparation fund	OCEF loan
Dam and power station	1,231.2	1,565.8

- Local component (unit: Rp. 10^6)

Selorejo dam	3,701.1
Power station	296.6
Mendalan Sabo dam	294.4
Tokol Sabo dam	437.8

3.4 Benefit

- Power generation ; 28 GWh per annum
- Irrigation area ; 20,-00 ha

4. WATER BALANCE

Increase the dry season flow by 50.1 x $10^6 m^3$, when needed

5. RECOMMENDATION

(1) Reservoir sedimentation and effective storage capacity

Sounding survey shall be made in every year. Aero photo shooting at the time when the reservoir water level is lowed near LWL is recommended for precise estimation of the current reservoir capacity.

(2) Spillway capacity

The present capacity of the spillway is designed based on the old standard. Review based on the current standard will be needed.

SUMMARY OF PROJECT

NAME OF PROJECT: WIDAS IRRIGATION PROJECT
BENING DAM

1. BACKGROUND

The project was formulated by the feasibility report prepared in 1976. Upon completion of designs, construction was started in 1978 and completed in 1982.

2. OBJECTIVES OF THE PROJECT

- To irrigate paddy fields of 8,600 ha in the rainy season and 5,400 ha in the dry season

3. PROJECT FEATURES

3.1 Project Area

The Bening dam is located on K. Bening, one of the tributaries of K. Widas, Irrigation area extends in the left bank of K. Widas.

3.2 Project Component

- Reservoir	catchment area	89.5 km^2
	HWL	EL. 108.6 m
	LWL	EL. 96.4 m
	gross storage	32.9 x $10^6 m^3$
	effective storage	28.4 x $10^6 m^3$
- Bening dam	homogeneous earth-fill	
	crest elevation	EL. 111.6 m
	riverbed elevation	EL. 76.0 m
	dam height	36.0 m
	crest length	640 m
	embankment volume	917 x $10^3 m^3$
	storage efficiency	31.0
- Spillway	design flood	100 year x 1.2
	design discharge	500 m^3/sec

- Intake	crest elevation of weir	EL. 95.5 m
	outlet capacity	4,6 m^3/sec at LWL
- Power station	installed capacity	0.72 MW
- Irrigation	command area	8,600 ha
	main canal	17.8 km

3.3 Construction Cost

- Foreign component Yen 1,334.3 x 10^6
- Local component Rp. 18,365.8 x 10^6

3.4 Benefit

- Estimated net benefit at D.F. = 12% US$4,542 x 10^3
- Estimated EIIR = 15%

  according to Feasibility Report, June, 1976

4. WATER BALANCE

Increase the dry season flow by 28.4 x $10^6 m^3$, but this amount is to be consumed in the Widas irrigation area.

SUMMARY OF PROJECT

NAME OF PROJECT: SENGGURUH HYDROPOWER DEVELOPMENT PROJECT

1. BACKGROUND

- Need of Project

According to the load demand forecast, power demand in East Java system will be a deficiency in both peak power and energey in 1983. Large scale steam plants are required for meeting the increasing demand and reliable peak power by hydropower plants are also required with an adequate capacity.

Sengguruh project will effectively contribute to the peak power requirement of the East Java system.

- History of Project

Hydropower development in the Brantas basin has been carried out by the Brantas Multipurpose Project Executive Board (BRBDEO) since 1960's. Following Selorejo, Karangkates I&II and Wling I, it is strongly requested to develop new hydropower project for supplying energy to increasing power demand of East Java in 1980's. Sengguruh Project is considered as one of the promising development projects in the Brantas river basin.

The Project was firstly proposed in 1961 Comprehensive Report and also listed up as one of potential development projects by 1973 Master Plan. A study report of the Project was prepared by BRBDEO in 1977. Successively, the feasibility report was prepared by BRBDEO in June 1978.

- Present status of Project

The Project was appraised by ADB in April 1983, excepting the loan for procurement of the generating equipment.

The civil work was commenced in April 1983, while procurement of the generating equipment and metal work is under tender.

2. OBJECTIVES OF PROJECT

Sengguruh Project is a single purpose project for developing a hydropower development system in the Brantas river basin in East Java. The purpose of the Project is to effectively utilize the hydropower potential of the Brantas river by constructing a dam and a power station.

The installed capacity of Sengguruh Project is 29,000 kW which is composed of 2 units with 14,500 kW each generating equipment.

3. Project Features

3.1 Project Area

- Location

The proposed Sengguruh dam site is located at about 25 km south of Malang or at just downstream of the confluence of the Brantas river and Lesti river which is the upstream end of Karangkates reservoir.

- Particular area

The proposed dam site, of which the foundation consists mainly of basalt and sand stone layers, is relatively good in geological condition for dam construction.

3.2 Project Component

(1) Reservoir

Drainage area	1,659 km^2
Flood water level	EL. 292.5 m
High water level	EL. 292.5 m
Low water level	EL. 291.4 m
Storage capacity Gross	24.1 x $10^6 m^3$
Net	2.7 x $10^6 m^3$
Design flood peak	2,500 m^3/s
Average runoff	57.4 m^3/s
90% dependable runoff	32.3 m^3/s

(2) Dam

Type	Rockfill type
Crest EL.	EL. 295.0 m
River bed EL.	EL. 264.0 m
Height	33 m
Crest length	378 m
Embankment volume	477,000 m^3 including coffer dams

(3) Spillway

Type	Center overflow weir with two nos. of roller gate
Design discharge	2,500 m^3/s
Extraordinary discharge	3,000 m^3/s

(4) Diversion System

Type	Open channel common to spillway waterway
Design discharge	1,350 m^3/s (10 year flood)

(5) Power station

Firm peak output	29,000 kW
Peaking operation hour	5 hours a day
Installed capacity	2 x 14,500 kW
Min. head	18.5 m
Max. head	27.7 m
Max. peak discharge	2 x 94.5 m^3/s
Annual energy	98.56 x 10^6 kWh
Turbine	Vertical Kaplan 2 x 15,000 kW
Generator	Vertical shaft 2 x 16,200 kVA

- Annual disbursement:

(a) 1st year (1979/80)	- (D.C.) 4,922	&	(F.C.)	5,427
(b) 2nd year (1980/81)	- (D.C.) 4,983	&	(F.C.)	3,383
(c) 3rd year (1981/82)	- (D.C.) 5,665	&	(F.C.)	23,592
(d) 4th year (1982/83)	- (D.C.) 3,101	&	(F.C.)	6,686

3.4 Benefit (12% interest rate) (Unit: US$1,000)

- Annual benefit	: 8,082
- Capitalized benefit	: 41,960
- Capitalized cost	: 37,443
- Net benefit (B-C)	: 4,517

3.5 Economic Evaluation

(a) B/C (12% interest rate) 1.12

(b) IRR 13.5%

Note: /1 1978/79 price level

/2 Exchange rate: US$ 1.0 = Rp. 415 = ¥.250

/3 Life period: 50 years

3.6 Implementation Schedule

(1) First year (1979/80)

(a) Preparatory works

(b) Diversion canal excavation

(c) Spillway excavation

(d) Spillway concreting

(e) Intake excavation

(2) Second year (1980/81)

(a) Diversion canal excavation

(b) Coffering works

(c) Dam foundation excavation

(d) Dam foundation grouting

(e) Spillway concreting

(f) Intake excavation

(g) Power house excavation

(h) Power house substructure concreting

(3) Third year (1981/82)

(a) Dam embankment

(b) Dam foundation treatment

(c) Concreting of spillway weir

(d) Excavation and concreting of intake structures

(e) Gates and trash installation of intake

(f) Concreting of superstructure of power house

(g) Erection works of generating equipment

(4) Fourth year (1982/83)

(a) Dam embankment

(b) Erection of spillway gates

(c) Erection of penstock lines

(d) Concreting of superstructure of power house

(e) Erection and test of generating equipment

(f) Construction of transmission line

4. WATER BALANCE

4.1 Water requirement : Not applicable

4.2 Water available : Not applicable

4.3 Water balance : Not applicable

5. RECOMMENDATION

5.1 Problem Encountered

- Further study items : Not applicable

- Other conceivable alternative : Not applicable

6. REFERENCES

- List of Reports

(1) The Comprehensive Report on the Kali Brantas Overall Development, 1961, Nippon Koei (1961 Comprehensive Report)

(2) Report on the Brantas River Basin Development Plant, May 1973, OCTA (1973 Master Plan)

(3) Study Report on Hydropower Development of the Brantas River, Sengguruh and Kesamben Project, BRBDEO, Feb., 1977.

(4) Feasibility Report on Kesamben Development Project, June 1978, Brantas River Basin Development Executive Agency (BRBDEO)

(5) Review Report on the Feasibility Study on Sengguruh Hydropower Development Project, Feb., 1980.

SUMMARY OF PROJECT

PROJECT NAME: WONOREJO DAM AND IRRIGATION PROJECT

1. BACKGROUND

1.1 Needs of Project

The project area is now under the Tulungagung Drainage project, which intends to improve mal-drainage condition in the central low land of K.Ngrowo basin. After completion of the drainage project, the area will be dried up. Therefore, it is needed to supply stable water for irrigation for maximum use of the land resources in the area.

1.2 History of Project

The project was formulated as the second stage development in the Tulungagung area during the feasibility study on the Tulungagung Drainage project in 1978/79. Feasibility study on this project was made in 1982, with smaller project only for irrigation water supply to the Tulungagung area. After the drought year, 1982, the project's scope has been expanded to include water supply to the downstream of K. Brantas, taking the topographical advantage at the damsite.

1.3 Present Status

Detailed design of the project has been completed in September, 1984, and project appraisal by ABD is scheduled in October/November, 1984. In parallel with the design works, construction of the diversion tunnel has been carried out by BRBDEO on force account basis.

2. OBJECTIVES OF THE PROJECT

- Irrigation water supply to the Tulungagung area of 7,000 ha. ($53 \times 10^6 m^6$)
- Water supply to the downstream area of K. Brantas ($53 \times 10^6 m^6$)
- Hydropower generation (13 MW)
- Flood control by reservoir

3. PROJECT FEATURES

3.1 Project Area

The Segawe dam is located on K. Song and a connection tunnel connects K. Song with K. Wangi, a tributary of K. Gondang. The Wonorejo dam is located on K. Gondang. An irrigation intake weir is located on K. Gondang near Tiudan village. Irrigation area extends in the area surrounded by the Parit Aung and Parit Raya canals.

3.2 Project Components

- Segawe dam	catchment area		82.8 km^2
- Connection tunnel	length		804 m
	discharge capacity		160 m^3/sec
- Wonorejo reservoir	catchment area		82.8 + 43.5 km^2
	HWL		EL. 183 m
	LWL		EL. 141 m
	gross storage		122 x $10^6 m^3$
	effective storage		106 x $10^6 m^3$
- Wonorejo dam	zoned rock-fill		
	crest elevation		EL. 187 m
	riverbed elevation		EL. 110 m
	dam height		97 m
	crest length		500 m
	embankment volume		6,470 x $10^3 m^3$
	storage efficiency		16.4
- Spillway	design flood		10,000 years
	design discharge		990 m^3/sec
- Power station	Wangi P/S		7 MW
			29 GWh/annum
	Wonorejo P/S		6 MW
			33 GWh/annum
- Tiudan headwork	concrete weir		
	crest elevation		EL. 100.1 m
	intake capacity	Main I	15 m^3/sec
		Main II	8 m^3/sec
- Irrigation	gravity area		6,420 ha
	pump area		1,120 ha

3.3 Construction Cost (unit US$ 1,000)

	Foreign	Local	Total
Financial cost			
Wonorejo dam	35,045	34,060	69,105
Segawe dam	5,193	11,222	16,415
Power equipment	5,910	592	6,502
Irrigation facility	7,069	15,863	22,932
Direct cost total	53,217	61,737	114,954
Land aquisition		6,928	6,928
Administration		5,580	5,580
Engineering services	6,000	520	6,520
Physical contingency	5,922	7,477	13,399
Price contingency	24,957	43,707	68,664
Grand Total	90,096	125,949	216,045
Economic cost	77,855	65,884	143,739
Disbursement schedule			
1985	0	2,082	2,082
1986	8,055	6,172	14,227
1987	10,680	14,451	25,131
1988	20,529	33,234	53,763
1989	25,903	38,681	64,584
1990	24,949	31,329	56,278

3.4 Benefit (unit US$ 1,000)

- Irrigation for Tulungagung	12,540
- Water supply to K. Brantas	4,028
- Power generation	3,628
- Negative benefit	- 43
- Total benefit	20,153

3.5 Elevation

- EIRR 13%

4. WATER BALANCE

Increase the dry season flow in K. Brantas by 53 x $10^6 m^3$, when needed

5. RECOMMENDATION

No

6. REFERENCE

SUPPORTING REPORT FOR DETAILED DESIGN WORK OF WONOREJO DAM AND IRRIGATION PROJECT, TULUNGAGUNG II, September 1984

SUMMARY OF PROJECT

NAME OF PROJECT: LESTI III AND IRRIGATION PROJECT

1. BACKGROUND OF PROJECT

1.1 Needs of Project

The K. Lesti basin is less-developed area in the K. Brantas basin, owing to lack of stable supply of irrigation water. At present, the area is planted mainly with upland crops, yields of which are low.

From the viewpoint of equitable development of the K. Brantas basin, development of the K. Lesti area is desired.

1.2 History of Project

The Lesti III dam site was firstly identified as a power potential site in the Overall Report, 1973. In 1982, a feasibility report was prepared, which proposed a 30 m high fill-dam, irrigation development of 1,200 ha and hydropower development of 12.6 MW. In 1983, the project features were revised to extend the irrigation area up to 4,400 ha. Subsequently, detailed designs have been prepared according to the revised project scope by the Indonesian consultant.

1.3 Present Status of Project

The project is proposed to ADB for financing of construction.

2. OBJECTIVES OF PROJECT

- Irrigation development over an area of 4,400 ha in the southern part of the Lesti basin
- Hydropower development of 12.6 MW

3. PROJECT FEATURES

3.1 Project Area

- Southern part of the Lesti basin and the riparian area along K. Brantas up to the Karang Kates dam

3.2 Project Components

- Reservoir	catchment area	382 km^2
	HWL	EL. 342.5 m
	LWL	EL. 341.5 m
	gross storage	7.4 x $10^6 m^3$
	effective storage	4.0 x $10^6 m^3$
- Dam	rock-fill with center core	
	crest elevation	EL. 346.0 m
	dam height	30.0 m
	crest length	390.0 m
	embankment volume	155 x $10^3 m^3$
- Spillway	gated type	
	gate	10.0 x 6.1 m x 4 nos.
	design discharge	1,150 m^3/sec
- Power station	installed capacity	4.2 MW, 3 units
	design head	23.15 m
	max. discharge	62.6 m^3/sec
	energy output	23 GWh/annum
- Irrigation intake	crest elevation	EL. 340.0 m
- Irrigation facilities	irrigation area	4,462 ha
	main canal	1.7 km, 4.9 m^3/sec
	secondary canal I	4.9 km, 1.59 m^3/sec
	secondary canal II	34.15 km, 3.31 m^3/sec

3.3 Construction Cost (Unit; US$ 1,000)

Wirm items	Local	Foreign	Total
Preparatory works	1,590		1,590
Civil works	7,231	181	7,412
Electrical works	903	1,676	2,579
Metal works	590	1,096	1,686
Irrigation facilities	11,831		11,831
Direct cost	22,145	2,953	25,098
Administration incl. engineering	1,743	4,000	5,743
Physical contingency	2,389	695	3,084
Total	26,277	7,649	33,926

Data source; Revised Feasibility Report, 1983 (English)

3.4 Benefit (Unit; US$ 1,000)

- Irrigation benefit	8,619
- Power benefit	2,267
- Sediment control	960
- Negative benefit	-241
Total annual benefit	11,605

3.5 Evaluation

EIRR ------ 18.7%

4. WATER BALANCE

- Decrease the dry season flow in K. Brantas by certain amount.

5. RECOMMENDATION

(1) Possible leakage from reservoir

The damsite is selected on the limestone and the reservoir is also on the limestone. It will be necessary to confirm possibility of leakage from the reservoir through the limestone layers.