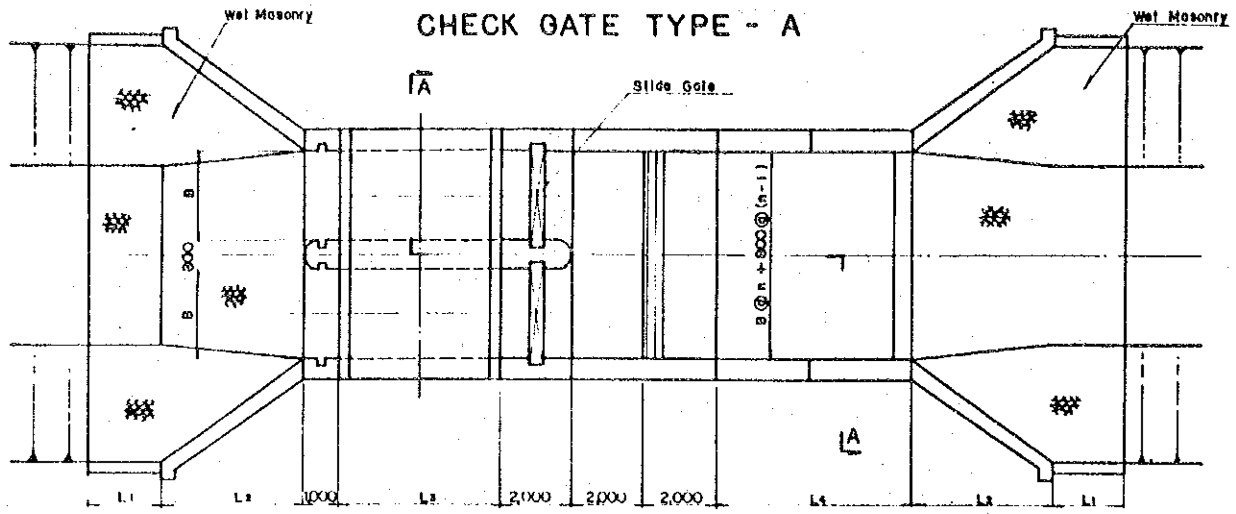
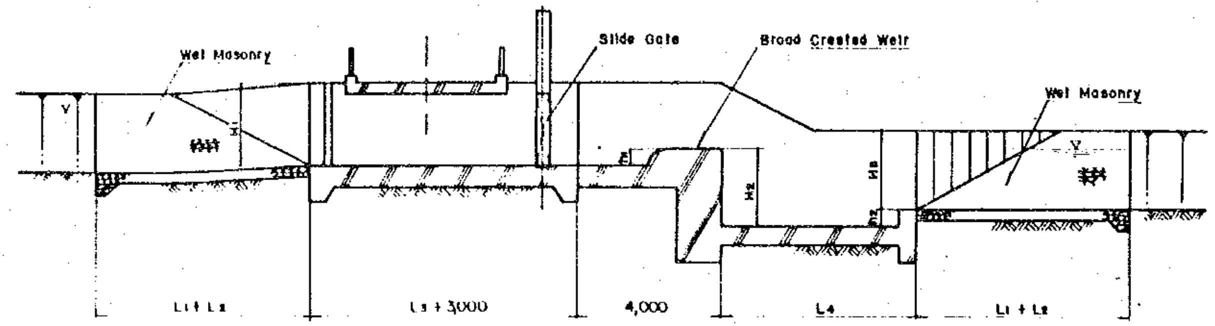
Fig.G-17

CHECK GATE TYPE - A

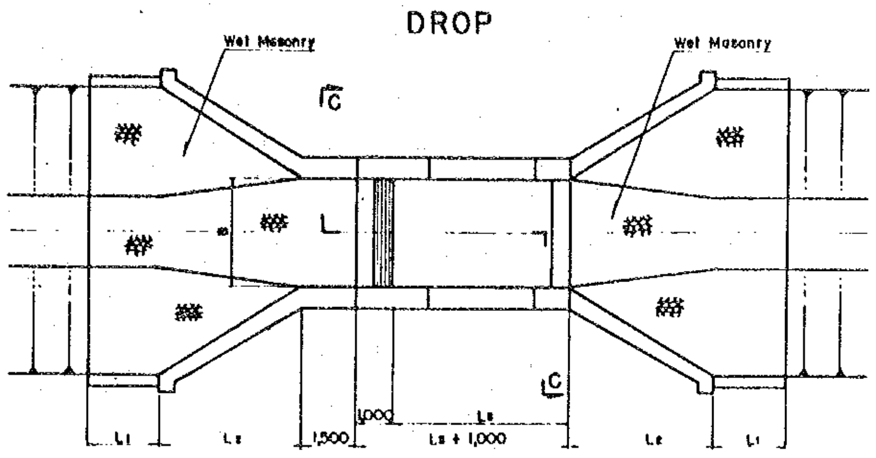


PLAN

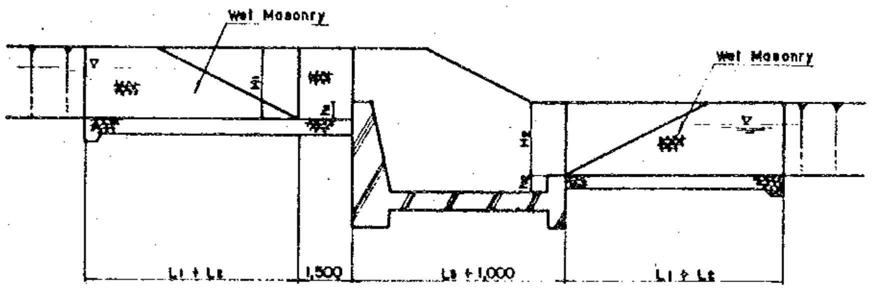


PROFILE

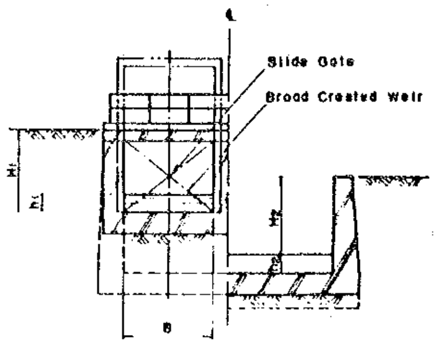
DROP



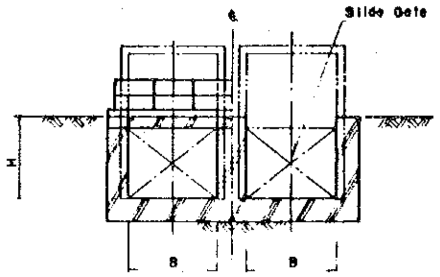
PLAN



PROFILE



SECTION A-A

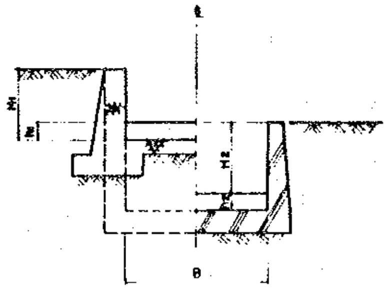


SECTION B-B

DIMENSIONS OF CHECK GATES

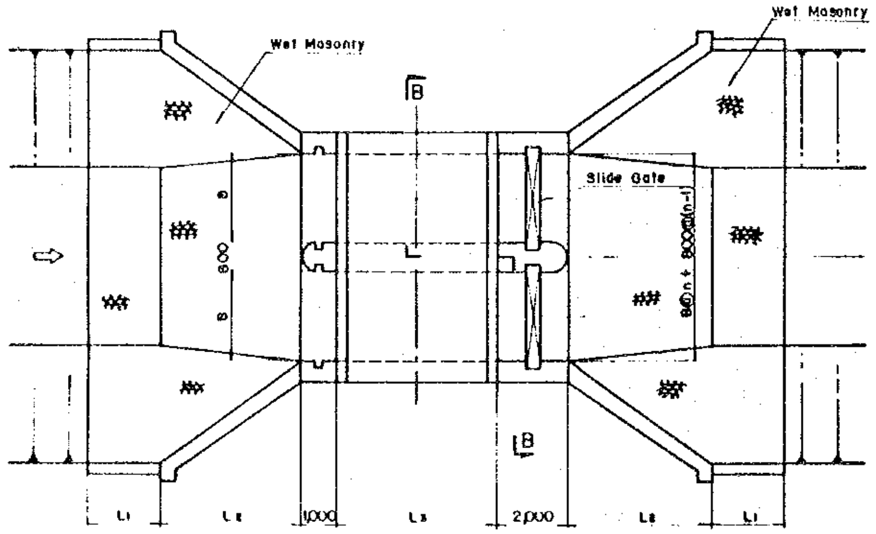
TYPE - A

Discharge (m^3/s)	L_1	L_2	L_3	L_4	B	n	H_1	H_2 Drop=2.0m	Drop=1.5m	Drop=1.0m	Drop=0.3m	H_3	h_1	h_2	Gate
20.0 ~ 15.0	3,000	4,000	4,500	7,000	2,500	4	2,500	3,200	2,700	2,200	1,700	2,500	750	500	2.5 x 2.0^{m}
15.0 ~ 10.0	•	•	•	•	•	3	•	•	•	•	•	•	•	•	•
10.0 ~ 5.0	•	•	•	•	•	2	•	•	•	•	•	•	•	•	•
5.0 ~ 2.0	•	•	•	•	•	1	•	•	•	•	•	•	650	•	•
2.0 ~ 1.0	-	3,000	•	6,000	1,500	1	1,800	•	•	•	•	1,800	450	•	1.5 x 1.5

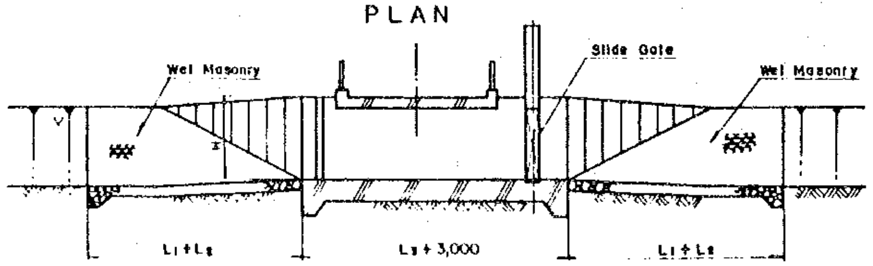


SECTION C-C

CHECK GATE TYPE - B



PLAN



PROFILE

TYPE - B

Discharge (m^3/s)	L_1	L_2	L_3	B	n	H	Gate
20.0 ~ 15.0	3,000	4,000	4,500	2,500	4	2,500	2.5 x 2.0^{m}
15.0 ~ 10.0	•	•	•	•	3	•	•
10.0 ~ 5.0	•	•	•	•	2	•	•
5.0 ~ 2.0	•	•	•	•	1	•	•
2.0 ~ 1.0	•	3,000	•	1,500	1	1,800	1.5 x 1.5
1.0 ~ 0.5	•	•	•	1,000	1	1,500	1.0 x 1.0
0.5 ~	1,500	2,000	3,000	600	1	800	—

DIMENSIONS OF DROPS

Discharge (m^3/s)	L_1	L_2	L_3	B	H_1	H_2	h_1	h_2
5.0 ~ 1.0	3,000	5,000	10,000	5,000	3,000	2,500	1,000	800
3.0 ~ 2.0	3,000	4,000	6,000	2,000	2,000	2,000	800	500
2.0 ~ 1.2	•	3,000	•	1,500	1,800	1,800	600	•
1.2 ~ 0.8	•	•	4,000	1,200	1,500	1,500	400	•
0.8 ~ 0.6	2,000	2,000	•	1,000	1,200	1,200	300	300
0.6 ~ 0.4	•	•	3,000	•	1,000	1,000	200	•
0.4 ~ 0.2	•	•	•	•	800	800	—	•
0.2 ~ 0.1	•	•	•	•	500	500	—	•

SCALE

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Check Gate & Drop

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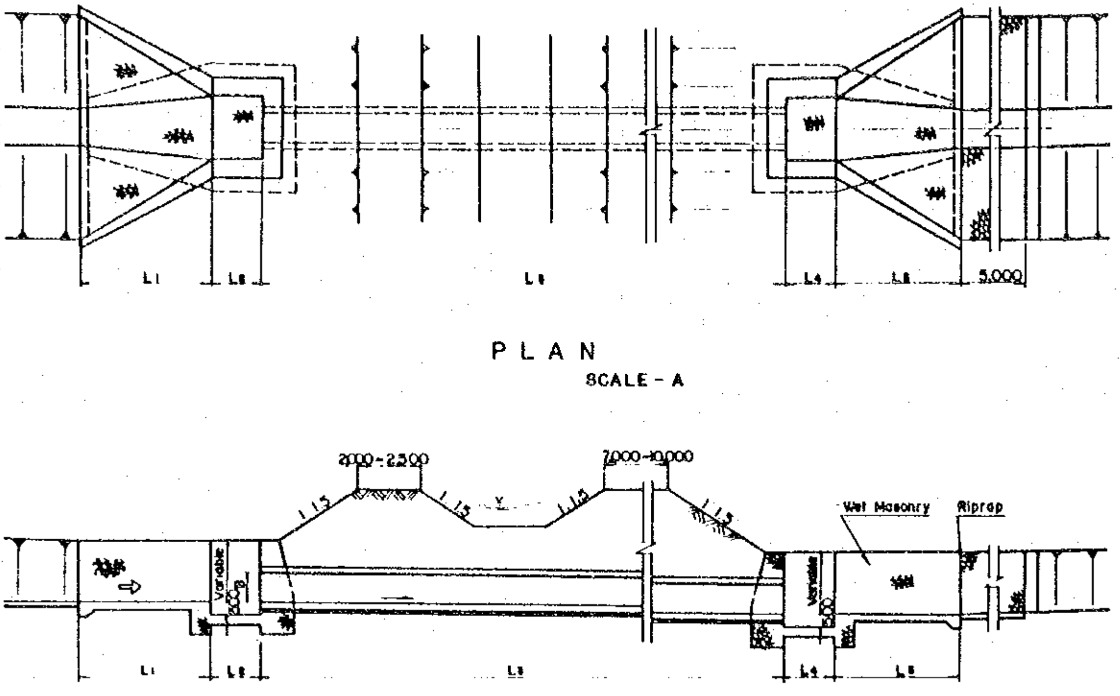
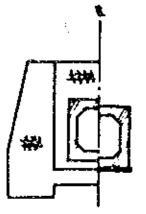
CROSS DRAIN TYPE - A



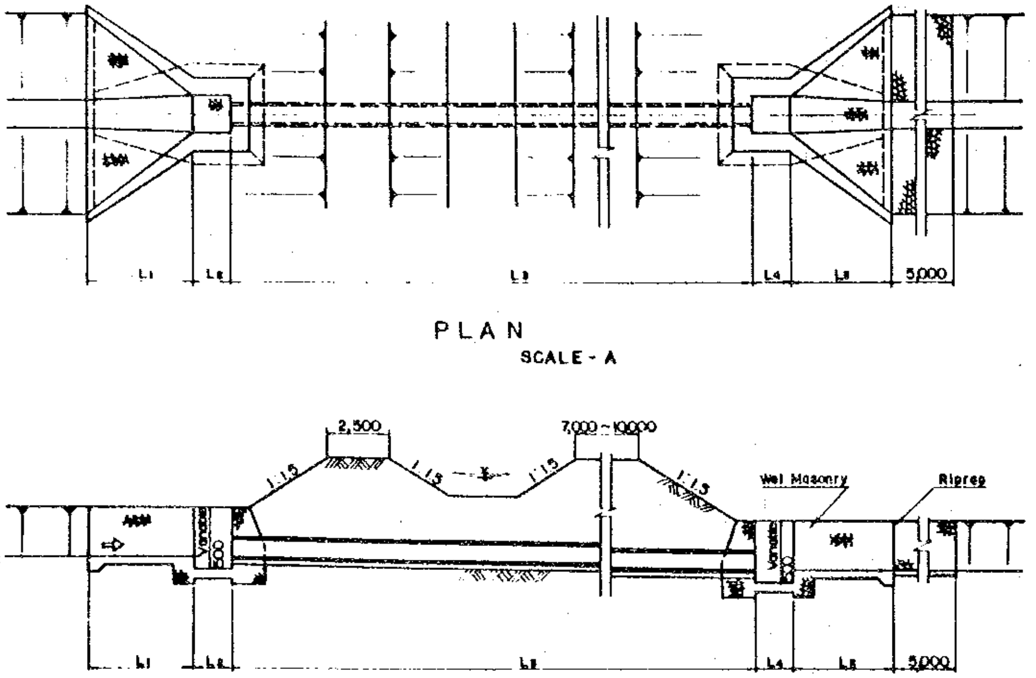
PLAN
SCALE - A

PROFILE
SCALE - A



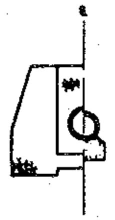
SECTION A - A
SCALE - C

CROSS DRAIN TYPE - B



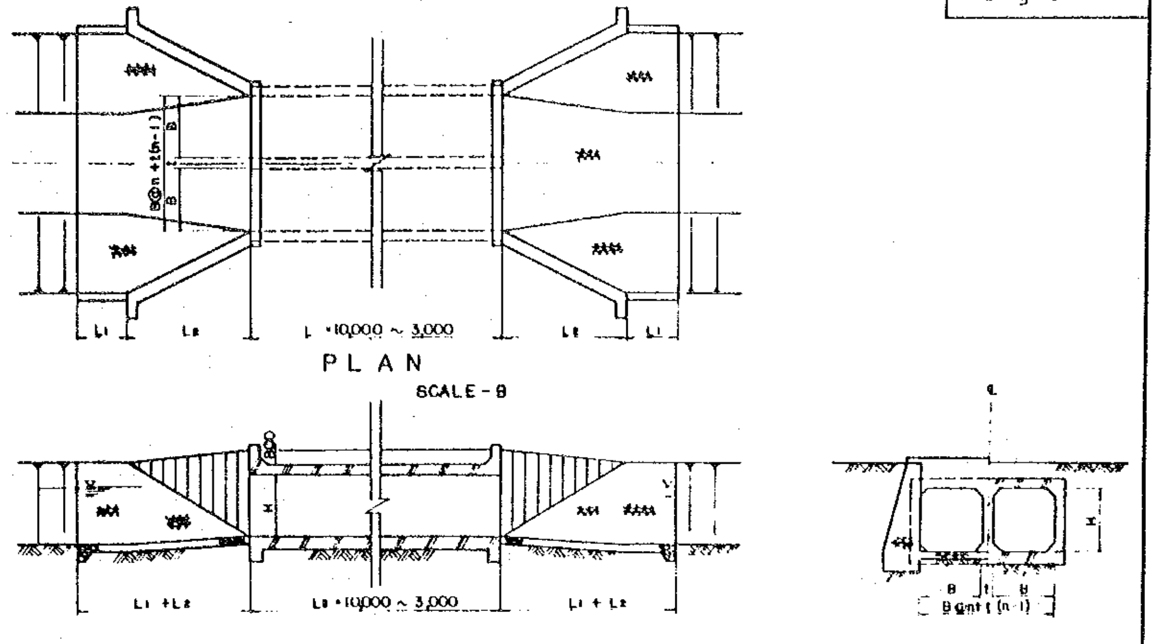
PLAN
SCALE - A

PROFILE
SCALE - A



SECTION B - B
SCALE - C

CULVERT TYPE - A

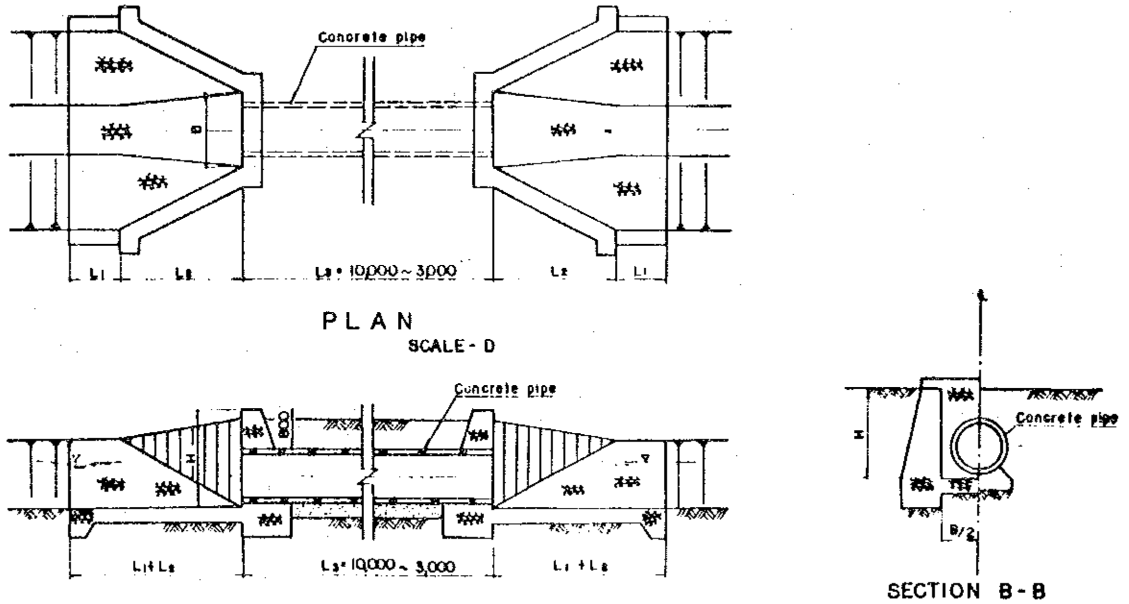


PLAN
SCALE - B

PROFILE
SCALE - B

SECTION A - A
SCALE - A

CULVERT TYPE - B



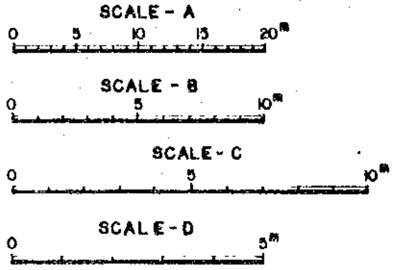
PLAN
SCALE - D

PROFILE
SCALE - D

SECTION B - B
SCALE - B

DIMENSION OF CROSS DRAINS

TYPE	Culvert Discharge (m³/sec)	L1	L2	L3	L4	L5	B	n
TYPE - A	6.0 ~ 3.0	7,000	3,000	40,000 ~30,000	3,000	7,000	2,500	1
	3.0 ~ 2.0	6,000	2,500	40,000 ~30,000	2,500	6,000	2,000	1
	2.0 ~ 1.2	5,000	2,000	40,000 ~30,000	2,000	5,000	1,500	1
	1.2 ~ 0.8	5,000	2,000	40,000 ~30,000	2,000	5,000	1,200	1
	0.8 ~ 0.6	4,500	1,500	40,000 ~30,000	1,500	4,500	1,000	1
TYPE - B	0.6 ~ 0.4	4,000	1,500	40,000 ~25,000	1,500	4,000	ϕ 900	1
	0.4 ~ 0.2	4,000	1,500	40,000 ~25,000	1,500	4,000	ϕ 700	1



DEMENSIONS OF CULVERTS

TYPE	Discharge (m /sec)	L1	L2	B	H	t	Pipeϕ	n
TYPE-A	16.48	3,000	7,000	2,500	2,500	400	—	2
	10.0~6.0	2,000	5,000	2,500	2,500	300	—	2
	6.0~3.0	•	•	•	•	•	—	1
	3.0~2.0	•	•	2,000	2,000	250	—	1
	2.0~1.0	1,500	4,000	1,500	1,500	•	—	1
	1.0~0.6	•	•	1,000	1,000	200	—	1
TYPE - B	0.6~0.4	1,000	3,000	1,300	2,000	—	ϕ900	—
	0.4~0.1	•	•	1,100	1,800	—	ϕ700	—

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Culvert & Cross Drain

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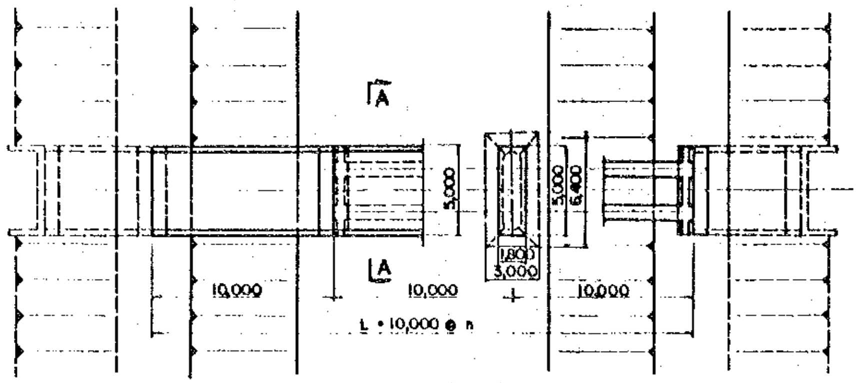
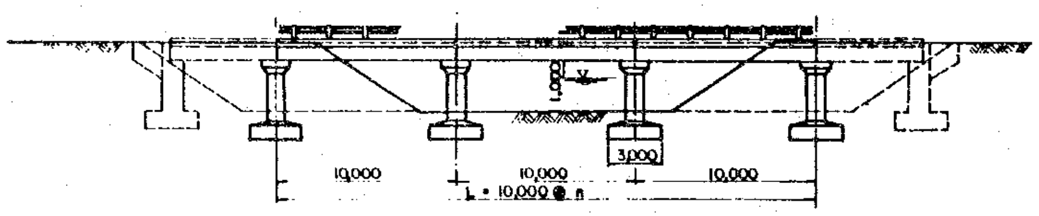
Fig.G-19

BRIDGE TYPE - A

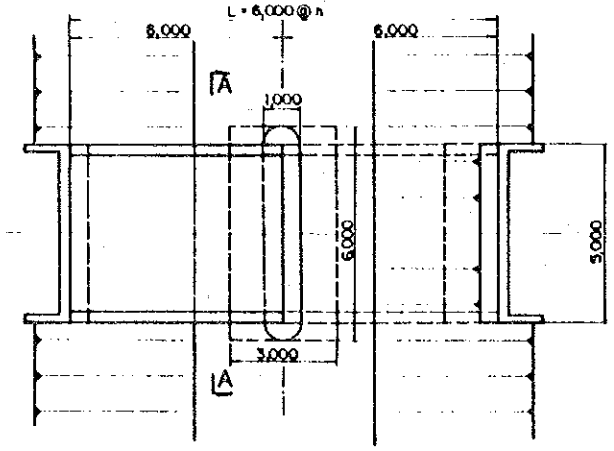


PLAN
SCALE - A

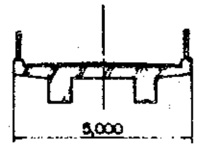


PROFILE
SCALE - A

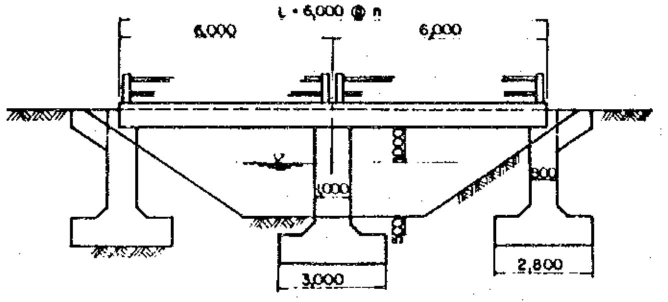
BRIDGE TYPE - B



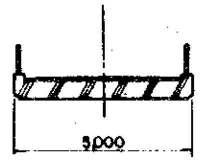
PLAN
SCALE - B



SECTION A-A
SCALE - B

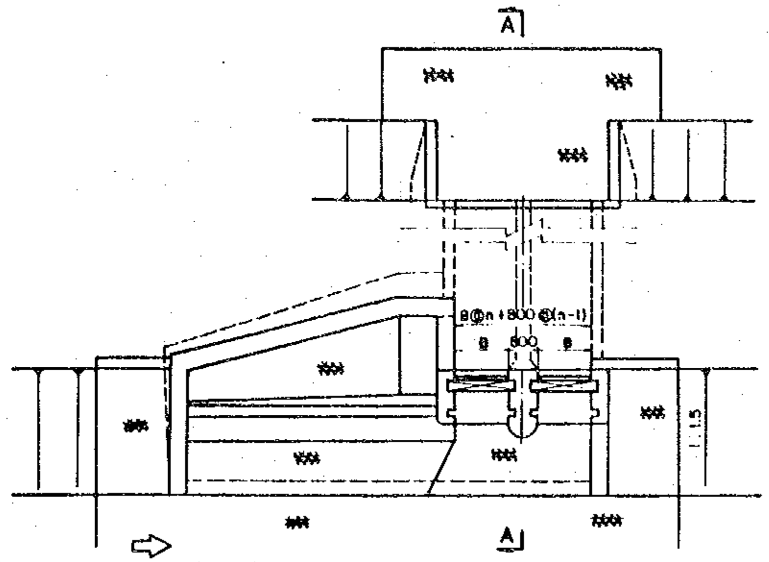


PROFILE
SCALE - B



SECTION A-A
SCALE - B

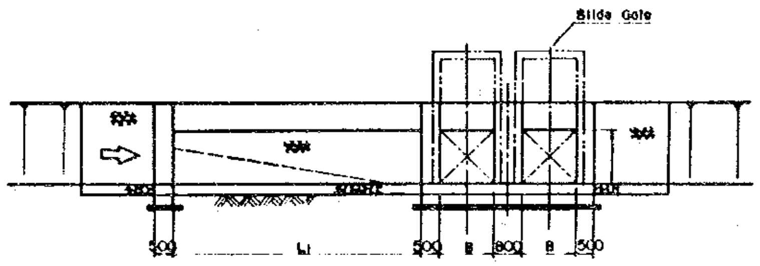
SPILL WAY AND WASTE WAYS



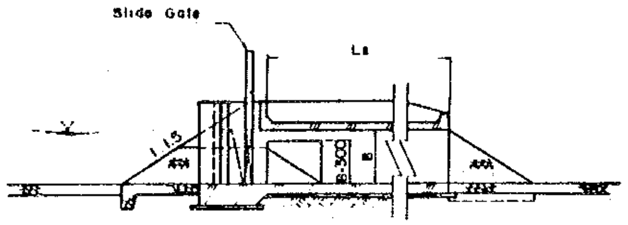
PLAN
SCALE - B

DIMENSIONS OF SPILL WAY & WASTE WAYS

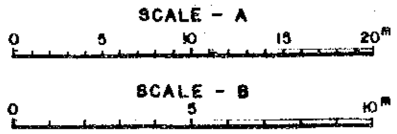
Discharge (m³/s)	B	n	L₁	L₂
16.48 ~ 9.0	2,000	2	15,000 ~ 10,000	15,000 ~ 5,000
9.0 ~ 4.5	1,500	2	15,000 ~ 5,000	15,000 ~ 5,000
4.5 ~ 2.5	1,500	1	10,000 ~ 5,000	15,000 ~ 5,000
2.5 ~ 2.0	1,200	1	10,000 ~ 5,000	15,000 ~ 5,000
2.0 ~ 1.0	1,000	1	10,000 ~ 5,000	15,000 ~ 5,000



PROFILE
SCALE - B



SECTION A-A
SCALE - B



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Bridge, Spillway & Wasteway

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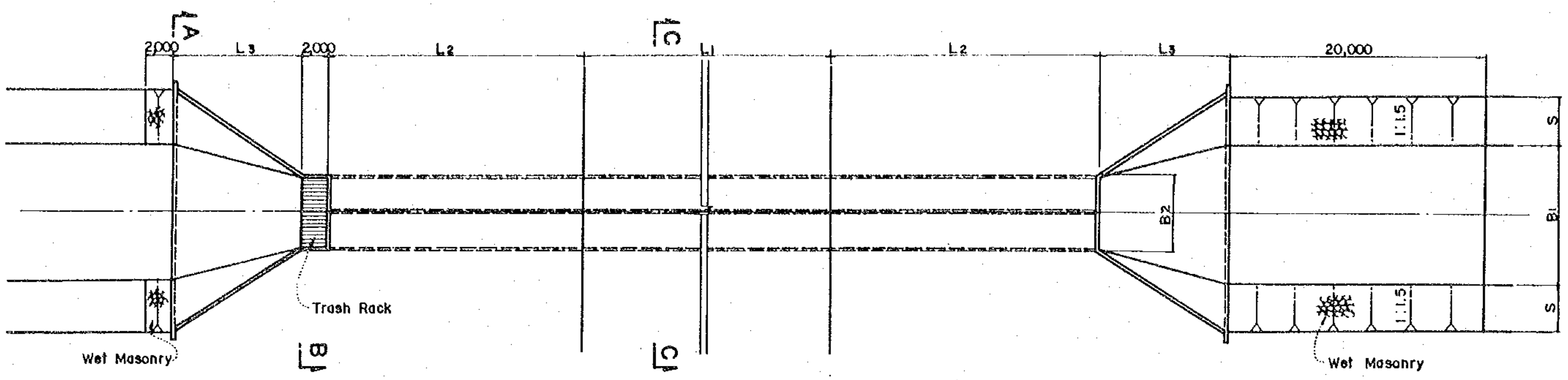
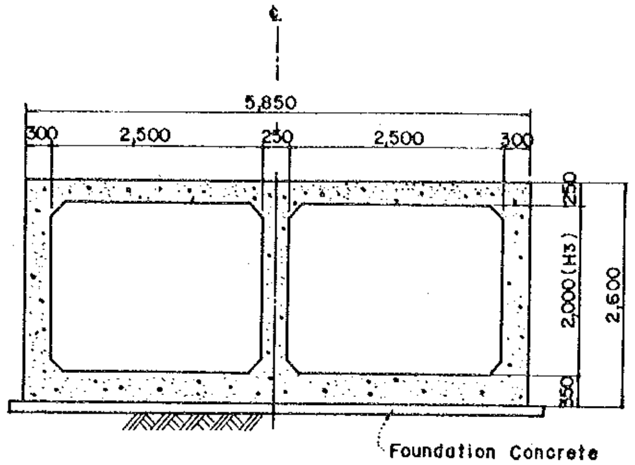
Fig.G-20

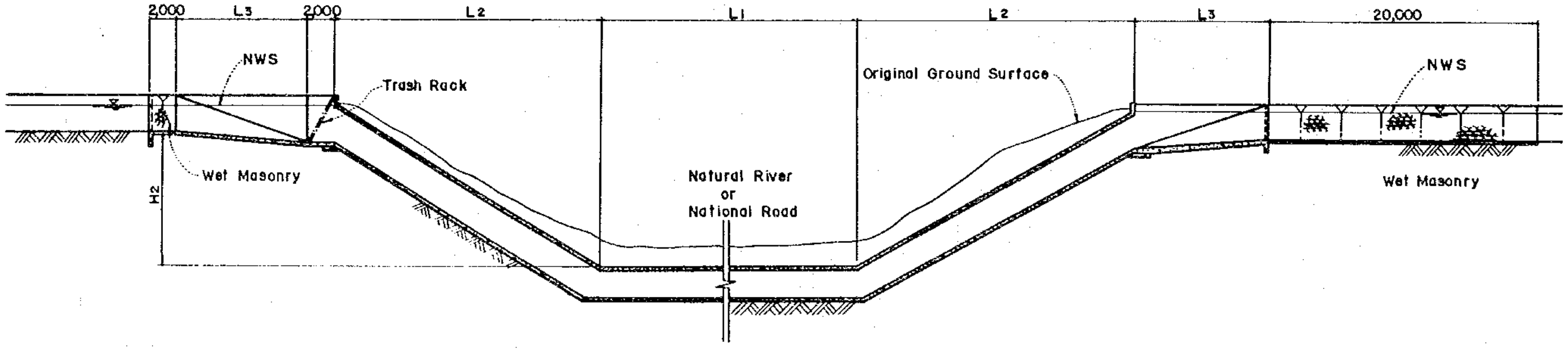


PLAN
SCALE : A

SYPHON No.1 & No.2

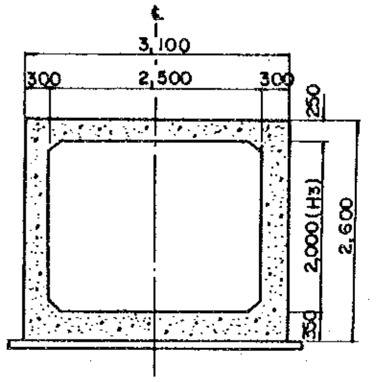


SECTION C-C
SCALE : B



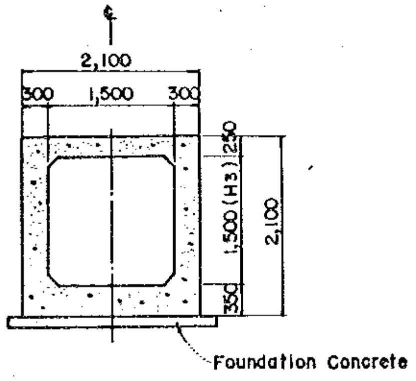
PROFILE
SCALE : A

SYPHON No. 3

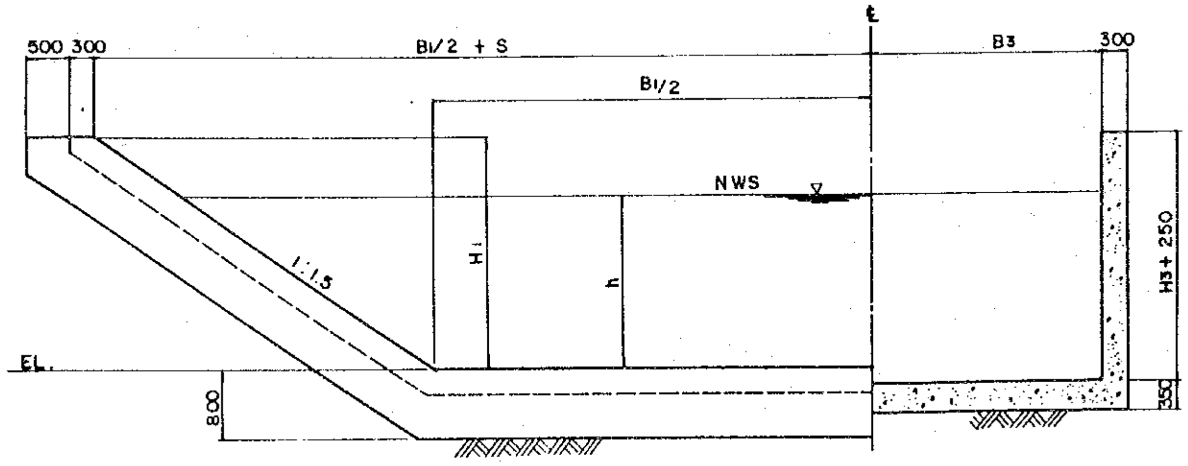


SECTION C-C
SCALE : B

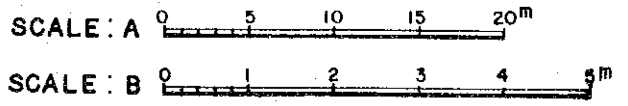
SYPHON No. 4



SECTION C-C
SCALE : B



SECTION A-B
SCALE : B



DEMENSION OF SYPHONS

No.	L1 (m)	L2 (m)	L3 (m)	B1	B2	B3	H1	H2	h	S	EL. (m)
No. 1	478.0	20.0	10.7	10,500	5,850	2,625	2,700	10,000	2,041	4,050	35.084
No. 2	2,048.0	25.0	10.7	9,200	5,850	2,625	2,500	12,000	1,814	3,750	33.719
No. 3	2,598.0	25.0	8.0	6,400	3,100	1,250	2,200	12,000	1,568	3,300	31.257
No. 4	8.0	10.0	5.0	3,000	2,000	750	1,900	1,500	1,373	2,850	13.808

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Syphon

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APPENDIX-H

RIVER IMPROVEMENT

APPENDIX - H

RIVER IMPROVEMENT

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LIST OF TABLES

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APPENDIX-H

RIVER IMPROVEMENT

1. INTRODUCTION

The principal rivers in the Project Area are the Ciujung, the Cibeureum and the Cibanten rivers as shown in Fig. H-1. The Ciujung river occupies the major portion of the Project Area, followed by the Cibeureum and the Cibanten rivers.

The Ciujung river is the largest and the most important river in the Project Area with a total catchment area of 1,850 km^2 at its estuary. In the upstream basin, it splits into three main tributaries at Rangkasbitung where the catchment area comes to 1,383 km^2, or about 75% of the whole Ciujung basin, comprising 594 km^2 for the Upper Ciujung, 331 km^2 for the Ciberang and 458 km^2 for the Cisimeut river basins.

The average annual runoff of the Ciujung river amounts to 3.35 billion m^3 which is remarkably biased to the rainly season. Besides, the flood outflow from splitted three main tributaries join almost coincidentally at Rangkasbitung due to the topographic condition in the basin. Accordingly the flood events have been frequent giving damage on the downstream reaches especially in and around Rangkasbitung.

The lower reaches of the Ciujung river have already been provided with dykes, of which some sections were recently improved by PROSIDA. However, the rest of the Ciujung river has no special provision for flood mitigation except a few groynes at some places.

In the Master Plan study, firstly the whole section of the Ciujung river from the river mouth to Rangkasbitung was subject to the study of river improvement. The study was made, with a design scale of 50-year return period as the overall master plan level, on several alternative plans in combination with flood regulation by proposed upstream dams.

However, the study revealed that every alternative plan would require an excessively heavy investment so far as the present socio-economic level in the basin was concerned.

Accordingly, considering the pressing requirement for flood mitigation in and around Rangkasbitung, the first stage plan was studied with a lesser design scale of 10-year return period and in a shortened river section focussing on Rangkasbitung. The section from the Pamarayan weir to Rangkasbitung was subject to the river improvement study, taking account of its improvement effect of lowering the flood water level at Rangkasbitung by dredging and short cuts.

After the comparative study on several first stage alternative plans, the first stage plan F-2, which consists of the flood regulation by Karian dam and the river improvement of 1/10 design scale in the upstream section from the Pamarayan weir, was found to be the most advantageous from the economic viewpoint.

Thus the flood control for the Ciujung river in the Master Plan was finally concluded as follows:

- Judging from the present socio-economic condition of the Ciujung river basin, the flood control will presently be focussed on the flood mitigation in and around Rangkasbitung,
- The proposed Karian reservoir will be provided with a flood control storage to regulate the flood outflow from the Ciberang river, and
- Besides, considering the unregulated flood outflow from the Upper Ciujung and the Cisimeut river basins, a river improvement plan will be set up for the river section from Pamarayan to Rangkasbitung to protect the flood-prone area in and around Rangkasbitung.

Accordingly the river section from Pamarayan weir to Rangkasbitung will be considered as the objective study section for river improvement in the Feasibility Study, together with the flood regulation by the Karian reservoir.

2. PRESENT CONDITION OF CIUJUNG RIVER

2.1 General Condition

The configuration of the Ciujung river and its major tributaries are shown in Fig. H-2 and Table H-1. The present condition of the objective river section and downstream reaches of the Ciujung river are briefly described in the following.

The river section from the estuary to Kragilan has the riverbed gradient ranging from 1/6,000 to 1/5,000 and the river width ranging from 170 to 100 m. This section has already been provided with dykes on both river banks. Recently the additional river improvement works were completed by PROSIDA with the design flood discharge of 1,100 m^3/sec.

The river section of about 18.8 km from Kragilan to the Pamarayan weir has the mean riverbed gradient of 1/3,200 and the river with ranging from 100 to 150 m. A remarkable river bend exists about 3 km upstream from the Kragilan bridge, which has resulted in some collapse of river bank. The embankments of left and right primary canals for the Ciujung irrigation scheme, located on both banks of the Ciujung river, form the boundary of flooded area stretching along the river.

Small tributaries joining the main stream, especially the Cikambuy river with a catchment of 48 km^2, have troubles of interior inundation.

The river section of about 17 km from the Pamarayan weir to Rangkasbitung, has the mean riverbed gradient of about 1/3,000 and the river width ranging from 100 to 150 m. The sedimentation is remarkable on the riverbed upstream from the Pamarayan weir, which may aggravate the flood water stage. Many meanders exist in the upper reaches of this section, which have resulted in collapse of river bank. The configuration of the confluence of the Ciberang river is intricate, leading to collapses of downstream river bank.

Outflow from the Ciberang, the Cisimeut and the Upper Ciujung rivers, which join at Rangkasbitung, have frequently given damage to the city. Some short cut works have already been provided on the large bends of the Ciberang and the Ciujung rivers around Rangkasbitung to protect the city.

On the Ciberang river, the section of about 3.5 km from Rangkasbitung to the Cisimeut confluence has the mean riverbed gradient of about 1/2,500 and the river width of about 100 m. Some groynes are provided near the Cisimeut confluence and on a river bend near Rangkasbitung.

The Upper Ciujung river, for about 5.5 km upstream from the Ciberang confluence has the mean riverbed gradient about 1/2,400 and the river width of about 70 m. Some groynes and bank protection are provided on river bends near Rangkasbitung to protect the road and village yard.

2.2 Existing Structures

The main structures along the Ciujung river are the Pamarayan weir, several bridges and groynes.

(1) Pamarayan weir

The Pamarayan weir is an important structure on the Ciujung river, which was completed in 1918 to divert the river water into the Ciujung irrigation scheme. The weir has a total crest length of 160 m with 10 gates of 12 m in span and 6 m in height. During the flood in November 1981, the gate hoists were operated by manpower, however, they were motorized with diesel engine driven generator in 1982. Severe bank erosion and scouring in the river section directly downstream from the weir were recently rehabilitated by PROSIDA (Ref. Fig. H-3).

(2) Bridges

The following seven bridges cross over the Ciujung river.

- Tirtayasa bridge	3.3 km from river mouth
- Gas-pipeline bridge	17.7 km from river mouth
- Kragilan bridge	18.3 km from river mouth
- Highway bridge	18.6 km from river mouth
- Rangkasbitung railway bridge	54.8 km from river mouth
- Rangkasbitung road bridge	54.8 km from river mouth
- Ciberang bridge	56.8 km from river mouth

Besides, there is a bypass plan (Ref. Fig. H-4) to alleviate the congestion of traffic in Rangkasbitung City, and a part of its construction work has been already started. Along with this, there is a project to build a bridge across the Ciujung river (53.9 km from the river mouth), though no construction work has been started yet.

(3) Bank protection (groyne)

Along the Ciberang, Cisimeut and Upper Ciujung rivers around Rangkasbitung, there is a plan to installl groynes in the section confrouting with flood flow for the purpose of bank protection, and construction work is being carried forward. The present condition of the said work and the structure of the groyne are as shown in Fig. H-5 (1) and Fig. H-5 (2).

2.3 Flow Capacity

(1) Objective river section

A study will be made of the flow capacity in the following sections:

- Ciujung river (18.4 km from Pamarayan weir to Ciberang river confluence)
- Ciberung river (14.0 km from Ciujung river confluence to Karian dam site)
- Upper Ciujung river (17.6 km from Ciberang river confluence)

The cross sections to be used in this study are based on the data supplied by P3SA for each river, of which the cross sections of the Ciujung river and Ciberang river were surveyed in 1982 and the cross section of the Upper Ciujung river was surveyed in 1984. The longitudinal distances between each section were measured on the topographic map of 1/5,000 scale prepared by P3SA in 1984.

(2) Calculation method and roughness coefficient

The flow capacity is estimated by non-uniform flow calculation for each river section. The Manning's roughness coefficient (n) is determined by applying the relation between the water-level and the flow rate during the flood in November, 1981 to the estimated rating curve (Ref. Table H-2, Fig. H-6) by non-uniform flow calculation obtained on the assumption that n = 0.035, 0.03 and 0.025. Then, at the Kragilan bridge, n = 0.0292 and at Rangkasbitung, n = 0.0274 (Ref. Fig. H-6). Also, n is determined by the law of friction resistance against running water of riverbed material by the use of a typical mean grain size and riverbed gradient in each section, according to the results of survey on riverbed material (Ref. Fig. H-7). Then, on the lower stream from the Pamarayan weir, n = 0.026~0.028; on its upper stream, n = 0.029. Thus, the Manning's roughness coefficient (n) used to calculate the flow capacity of the Ciujung river is assumed to be 0.03, considering the meanderings and bank resistance of the river.

(3) Calculated water lever and flow capacity

The water level of the Ciujung river in the present channel condition for the discharge of 500~1,500 m^3/s is calculated as shown in Fig. H-8. Also, the flow capacity at ground height on the left and right banks in each calculated section is determined as shown in Fig. H-9. As a result, the average flow capacity may be summarized as follows:

River section	Flow capacity (m^3/s)
Ciujung River	
Pamarayan weir to Rangkasbitung	400
Ciberang River	
Rangkasbitung to Cisimeut river confluence	400
Upstream of Cisimeut river confluence	300
Upper Ciujung River	
Ciberang river confluence to 8 Km	300
8 Km to 18 Km	200

2.4 Sand Gathering

Sand in the riverbed of the Ciujung river has been gathered as materials of construction works, which has shown an increasing prospect recently. The volume of gathered sand has recently amounted to about 120,000 m^3 annually in the river section upstream from the Pamarayan weir. Careful observation and management would be necessary, because the performance of gathering sand in the river may have some problems on the stability of the river channel when the gathering volume exceeds the supply from the upstream catchment.

The actual condition of gathering sand in the river is as shown in the following table, accoring to the survey conducted by the Regional Office of DPUP.

	Downstream of Pamarayan weir	Upstream of Pamarayan weir
Annual gathering volume	60,000 m^3/year	120,000 m^3/year
Number of employees	about 80	about 200
Local price	3000～4000 Rp/m^3	1500～2000 Rp/m^3
Price including transportation cost	4000～6000 "	4000～5000 "

These are values estimated on regular licensed gatherers. If unlicensed gathering is included, the actual volume of sand gatherd is expected to increase by about 30% over the above-mentioned figures, that is, it is estimated that sand of about 240,000 m^3 is being gathered annually on the whole.

3. FLOOD DAMAGE

3.1 General

A flood damage survey around the objective section of the Ciujung river was conducted by the Study Team assisted by P3SA staff. The survey was based on the data from Regional Offices DPUP and information obtained in the flooded area. The collected data consist of the inundated area, number of submerged buildings, area of flooded farmland, and submerged depth. As a result of survey, the inundated situations caused by the floods in November 1981 and November 1983 are revealed clearly. The flood in November 1981 is reported to have inflicted the largest damage in the past.

3.2 Flood Damage Survey

Damage caused by the flood in November 1981 and November 1983 are assessed under the following method provided with economic condition for evaluation. The unit prices of crops are commonly based on the farm gate price on this agro-economic study. The houses, buildings and household effects are objectively estimated in view of net economic viability.

(1) Inundated area

Based on the topographic map of 1/5,000 scale newly prepared by P3SA and the land use map of 1/25,000 scale which was drawn up during 1977/1978, the inundated areas caused by the floods in November 1981 and November 1983 are divided according to the form of land use and submerged depth. Table H-3 shows the inundated area during the floods in November 1981 and November 1983, classified by the submerged depth, on the river section from the Pamarayan weir to Rangkasbitung. The situation of land utilization in and around the area inundated by the flood of November, 1981 is as shown in Fig. H-10.

(2) Damage to houses and buildings, and household effects

Based on the data obtained from the inquiries made at the flooded site, damage of submerged houses and household effects are estimated, using the following conditons:

i) Based on the data from BAPPEDA Rangkasbitung and from the results of the said inquiries, unit damage values of houses and household effects are set at the appraisement given in Table H-4.

ii) As the estimated damage of household effects differs depending on the submerged depth, the rate as shown in Table H-5 is used, which is obtained by refering to values used in other surveys conducted in Indonesia, for example, that for Ular river.

iii) The floor level of houses is set at 10 cm above ground level.

iv) As for the damage rate of houses and household effects, values adopted in the Outline of Economic Survey on Flood Control prepared by the Ministry of Construction, Japan are used as shown in Tables H-6 and H-7.

Total number of submerged houses and buildings caused by the flood in November 1981 and November 1983 are tabulated in Table H-8. Total damages to houses and buildings, and household effects and stored goods caused by the above mentioned floods are estimated under the aforementioned conditions, amounting to Rp.3815 x 10^6 by the November 1981 flood and Rp.1103 x 10^6 by the November 1983 flood for the area from Pamarayan to Rangkasbitung.

(3) Damage to Crops

The form of utilization of farm land in the inundated area by the flood in November, 1981 and the flood in November, 1983 is classified on the basis of a 1/25,000-scale land utilization map. Flooded areas classified by form are shown in Table H-9. In the paddy fields within the inundated area, no crops had been planted at the time of flooding mentioned above, hence it is assumed that the crops have suffered no damage, taking into account the present condition of cultivation. Cassava and maize are cultivated in most of flooded fields, and therefore, both are regarded as typical field crops. The average damage ratios to cassava and maize are assumed to be 10% and 100% respectively. In flooded orchards, banana and bamboo are planted together, and the bamboo plays a role of protecting fruit trees, thus suffering little flood damage.

Thus, the amount of the relevant crop damage is calculated by multiplying of the unit damage value, damage ratio and net planted area. Whereas, the unit damage value is determined on the basis of gross output by multiplying the farm gate prices in 1984 of cassava & maize and the mean cropping yield at the inundated area, with deduction of the prospcetive portion of the production input to be ignored after the inundation. Damage to farm crops during the flood in November, 1981 and the flood in November, 1983 in the section from Pamarayan to Rangkasbitung are RP. 34 million and RP. 19 million, respectively. Details are shown in Table H-10 (1) and Table H-10 (2).

(4) Loss due to suspension of business activities

Following the method adopted in the Outline of Economic Survey on Flood Control, the loss due to suspension of business activities is set at 6% of the total damage to buildings and household effects.

(5) Damage to public works and agricultural facilities

As detailed data on the damage to public works and agricultural facilities are not available, the method described in the Outline of Economic Survey on Flood Control is adopted in present survey. For the area from Pamarayan to Rangkasbitung, the damage rate is estimated at 90.5% of the damage amount of buildings and household effects.

(6) Total flood damage

When the above-mentioned damages are totalled, the whole damage caused by the floods in November 1981 and November 1983 amounts to Rp. 7,531 million and Rp. 2,187 million, respectively for the area from Pamarayan to Rangkasbitung. Table H-11 gives the breakdown.

3.3 Average Annual Decrement of Flood Damage

The average annual decrement of flood damage is estimated as follows.

- From the result of non-uniform flow calculation of the Ciujung river, the non-damage flood discharge at Rangkasbitung is estimated at about 500 m^3/s which will approximately correspond to the probability of 1/1 under the present river condition.
- From the discharge rating curve at Rangkasbitung gauging station (Fig. H-11 (1)) the flood discharge in November 1981 is estimated at 1,150 m^3/s based on the flood mark at Rangkasbitung bridge. In the same way, the flood discharge in November 1983 is estimated at 665 m^3/s. The relation between flood discharge and damage is shown in Fig. H-11 (2).
- From the result of flood runoff analysis, which will be given in 4 "Flood runoff" of Paragraph 4.3 "Flood Control Plan", the flood discharge of 1,150 m^3/s in November 1981 will correspond to the probability of about 1/8 under the present river condition. In the same way, the flood discharge of 665 m^3/s in November 1983 will correspond to about 1/2 under the same condition.

- Annual flood damage of other probability will be estimated by interpolation or extrapolation based on above figures of damage and probability.
- Thus the average annual decrement of flood damage on the probability of 1/10 will be estimated at about Rp. 2.57 billion in the river section from the Pamarayan weir to Rangkasbitung (Ref. Table H-12).

4. FLOOD RUNOFF

4.1 Rainfall-Runoff Model and Basic Data

(1) Rainfall-runoff model

To determine the design high-water discharge of a river, it is necessary to use a rainfall-runoff model for grasping the characteristics of catchment, channel and flooding and for adequately estimating the mitigation of inundation by river improvement and the effect of flood regulation by dam. In the present study, the storage function method is used to make runoff analysis of the flood in November, 1981, for which the hourly data of rainfall and river discharge are available. The basic formulas used in the storage function method are as follows:

i) Runoff from subbasin

Basic formula

$$\left.\begin{aligned} S &= kq^{p} \\ \frac{ds}{dt} &= f \cdot R_{ave} - q \end{aligned}\right\} \quad \text{-----------------------------} \quad (4\text{-}1)$$

Where k,p; constants for basin

s; depth of storage (mm)

q; depth of runoff (mm/hr)

f; primary runoff ratio

Rave; average rainfall in a basin (mm/hr)

dt; calculation time (hr)

Adding the base runoff Qb to the above, the total basin runoff Q will be obtained from the equation as follows:

$$Q = \frac{1}{3.6} f1 \cdot A \cdot q + \frac{1}{3.6} (1 - f1) \cdot A \cdot qsa + Qb \quad \text{--------------------} \quad (4\text{-}2)$$

Where f1; primary runoff ratio

qsa; depth of runoff by rainfall after point of saturation (mm/hr)

Qb; base runoff (m^3/s)

Q; total runoff from basin (m^3/s)

ii) Calucalation for a river channel and flooding area.

$$\frac{ds}{dt} = Ij - Q \text{ -- } (4\text{-}3)$$

$$\left.\begin{array}{ll} S = KQ^p - T_1Q & \text{River Channel} \\ S = KQ^p & \text{Flooding area (non velocity)} \end{array}\right\} \text{ ------ } (4\text{-}4)$$

Where Ij; inflow into a river channel (m^3/s)

$Q_1(t) = Q(t+T_1)$; discharge at the lower boundary of a river channel taking account of a time lag (m^3/s)

S ; apparent storage, in a river channel and flooding area (m^3/s. hr)

T_1; time lag (hr)

Prior to applying the storage function to the runoff analysis of the Ciujung river, a rainfall-runoff model was prepared by dividing the catchment and river channel at the confluences of principal tributaries, the Pamarayan weir, Kragiran Bridge and other principal points (Ref. Fig. H-12 and H-13).

(2) Basic data

Constants k, p, f_1, etc. in the storage function can be obtained through its verification by hydrologic data on flood events in the past. The flood in November, 1981 will be adopted for the verification of the storage function, because it is the only flood event of which the hourly data of rainfall and river discharge are available in the basin. As the gauging station at Rangkasbitung was washed away during that flood, the discharge data at Kragilan gauging station are employed for the verification of the equation constants. (Ref. Fig. H-16).
On the other hand, the raingauge stations and daily rainfall data concerning the flood in November, 1981 are as shown in Fig. H-15 and Table H-13. Also, the rainfall patterns on five raingauge stations, where hourly rainfall data were obtained, are shown in Fig. H-14.

4.2 Rainfall and Flood Runoff Analysis

(1) Rainfall analysis

Regarding rainfall to be used in the calculation of runoff from each subbasin, the basin-mean rainfall by the Thiessen method will be used.

The Thiessen polygon and coefficients obtained by the raingauge stations where daily and hourly data on the flood in November, 1981 are available are as shown in Fig. H-15 and Table H-14. The results of calculations on the basin-mean rainfall during the flood in November, 1981 are as shown in Table H-15. Also, regarding the basin-mean hourly rainfall in each subbasin, from the data obtained by the five observation stations where hourly data are available, one of them is to be selected on the basis of the following considerations and its rainfall pattern is to be adopted.

i) The station must be located within the subbasin.

ii) The station must be located near the subbasin.

iii) The station must have superior correlation with the basin-mean daily rainfall during the flood in November 1981

The basin-mean hourly rainfall will be estimated in such a way that the total rainfall (Ri) observed by the station adopted will agree with the total basin-mean rainfall (Rave). Representative station number in each subbasin and the coefficient of conversion to the basin-mean rainfall (Rave/Ri) are as shown in Table H-16.

(2) Runoff analysis

Constants of storage function are to be determined by trial calculation so that they will agree with the observed discharge during the flood in November, 1981. In this analysis, verification calculation is to be performed by estimating the constants of basin storage function k and p, primary run-off coefficient f_1, saturation rainfall Rsa, channel storage function (considering inundation) and other constants, so that the calculated discharge at the Kragilan point will match the observed discharge.

The relation between the calculated discharge and the observed discharge at Kragilan is as shown in Fig. H-16. The constants of subbasin and river channel used in this caiculation are as shown in Table H-17. The calculated discharge and the observed discharge at each point are as shown in the following table.

(Unit: m^3/s)

	Kragilan	Pamarayan	Rangkasbitung
Observed discharge	1070	1330	1150
Calculated discharge	1080	1173	1284

4.3 Probable Flood Discharge under Present River Condition

(1) Estimated probable discharge

Probable flood discharges for the return periods of 5 years, 10 years, 25 years and 50 years are calculated on the basis of rainfall analysis (Ref. Table H-17) and runoff study of the November 1981 flood. Calculation results is as listed in Table H-19 (1) corresponding to specific return periods. They are summarized as follows:

Qpro (m^3/s)

Return period (year)	10 yrs	50 yrs
Kragilan Gauge	1070	1440
Pamarayan Weir	1120	1590
Rangkasbitung	1220	1730

Where, Qpro shows the probalbe flood discharge corresponding to specific return period in the present river condition.

The hyetograph used in the calculation is based on the probable daily rainfall in each subbasin according to the analytical results of Appendix B Hydrology. The rainfall pattern is established in such a way as to match the 24-hour hyetograph when the total rainfall becomes the largest during the rainfall storm in November, 1981 (Ref. Table H-18).

(2) Probable flood discharge by observed flow data

On the other hand, the results of calculations on probable discharges according to experienced annual maximum flood discharge data (Ref. Table H-20) at Kragilan and Rangkasbitung are as shown in Table H-19 (2). From these results, the return periods of discharges 1070 m^3/s at Kragilan and 1150 m^3/s at Rangkasbitung during the flood in November 1981 are estimated at 15 years in both areas.

5. FLOOD CONTROL PLAN

5.1 General

(1) Study priciple

As described in 1. Introduction, the flood control plan in this study is focussed on flood mitigation in and around Rangkasbitung.

The proposed Karian reservoir is located at no great distance from Rangkasbitung, which will be very effective to regulate the flood outflow from the Ciberang river. However, it has a relatively small catchment of 288 km^2, occupying only about 20% of the whole catchment area at Rangkasbitung, which totals to 1,383 km^2 comprising catchments of the Ciberang, the Cisimeut and the Upper Ciujung rivers.

Accordingly, considering the unregulated flood outflow from the Cisimeut and the Upper Ciujung rivers, a river improvement plan will be set up to protect the objective floodprone areas together with the flood regulation by the proposed Karian reservoir.

(2) Design scale

The level of flood control plan in Indonesia has generally been set up for the return period ranging from 20 to 50 years, sometimes with lesser return periods for the first stage.

Although the Study Area remains in its rather depressed situation at present, it has a prospective advantage for development as follows. It has a favourable location on the main route linking Jakarta and Sumatra. The construction of new Jakarta-Marak highway is well under way. The land use will be promoted by proposed improvement and development of Ciujung, Cicinta and K-C-C irrigation schemes. Further industrial development is expected in the Study Area. All of these will accrue increase of population and enhancement of economic activities in the Project Area.

Accordingly, considering the importance of the Area and possible improvement of its socio-economic condition mentioned above, the proposed Karian dam will be planned to have a flood control storage for the design flood inflow of 50-year return period.

The level of river improvement will be planned with lesser return period of 10 years, taking account of the present socio-economic condition of the area and other instances of river improvement in Indonesia.

The lower reaches of the Ciujung river have already been improved recently with the design flood discharge of 1,100 m^3/s, which will be re-estimated to correspond to a flood of around 15-year return period at the Kragilan gauge if derived from its flood flow data from 1970 through 1983 (Ref. Table H-19 (2)).

Thus the river improvement for the objective section will be planned with the design flood of 10-year return period, taking account of flood regulation by the proposed Karian reservoir and also good correspondence with the design flood discharge of downstream reaches.

5.2 Basic High Water

The concept of the basic high water will be employed for the flood control planning in this study. The basic high water is a basic flood-hydrograph which is used as the basis for flood control planning. It is estimated under the condition of no flood regulation measures and no flooding along the river course. The basic high water is generally derived from the design storm rainfall of a probability of exceedance corresponding to the required safety of flood control.

Based upon the estimated basic high water, the flood control plan will be set up with the optimum distribution of projected flood discharge into the river improvement and the flood regulation measures such as the dam, the retarding basin and the diversion channel.

Employing the storage function and considering the river-channel condition without flooding, the basic high water at main points along the Ciujung, the Ciberang and the Upper Ciujung rivers are estimated as shown in Table H-21 corresponding to specific return periods. They are summarized as follows.

Basic High Water (m^3/s)

Return period (years)	10 yrs	50 yrs
Kragilan gauge (Ciujung)	1,500	2,100
Pamarayan weir (Ciujung)	1,300	1,900
Rangkasbitung (Ciujung)	1,300	1,900
Karian dam site (Ciberang)	550	800

The computed basic high water will be used as the basis for flood control planning. The flood control plan of the Ciujung river will be set up by distributing the projected flood discharge into flood regulation by the proposed Karian reservoir and the river improvement.

5.3 Flood Regulation by Karian Dam

The flood regulation at the proposed Karian dam will be planned by an ungated overflow-type spillway with its overflow crest positioned at the full supply level of the reservoir.

(1) Equation for flood regulation by Karian dam

The flood regulation by Karian dam is calculated as follows:

$$V(t+\Delta t) = V(t) + \left(\frac{Qi(t) + Qi(t+\Delta t)}{2} - \frac{Qo(t) + Qo(t+\Delta t)}{2} \right) \Delta t \quad \text{----} \quad (5\text{-}1)$$

$$Qo = C.L.\ h^{3/2}$$

Where: V; Storage Volume (m^3) (=f(h))

Qi; Inflow discharge (m^3/s)

Qo; Outflow discharge (m^3/s)

C; Discharge coifficient (=2.0)

L; Spillway crest length (m)

h; Overflow depth (m)

Δt; Interval of calculation time (sec)

(t),(t+Δt); Suffix of calculation time

(2) Estimated effect of flood regulation by Karian dam

The required storage volume for flood control is estimated at 33 million m^3 above the ungated overflow crest, which will regulate the flood inflow of 800 m^3/s, corresponding to the basic high water of 50-year return period, to the outflow of 210 m^3/s at the dam site.

For the basic high water of 10-year return period, the inflow of 550 m^3/s will be regulated to the outflow of 160 m^3/s at the dam site. This plan is based upon the undermentioned study. The effect of flood regulation at Karian dam is calculated with respect to four cases in the crest length of ungated overflow type spillway, i.e., L = 30 m, 40 m, 50 m, 70 m and 100 m. The stage-capacity curve of Karian reservoir used in this calculation is shown in Appendix-K Dam and Reservoir. The results of calculation on the effect of flood regulation at the proposed Karian dam site corresponding to each crest length (L) are as shown in Table H-22 (1). Also, discharge at Rangkasbitung, Pamarayan and Kragilan after flood regulation by Karian dam for the flood discharge of 10-year return period (10-year basic hight water) corresponding to each crest length L are as shown in Fig. H-17.

As a result, taking into consideration correspondence with the PROSIDA's design discharge 1100 m^3/s downstream from Kragilan, topographic restrictions on the right abutment of the Karian dam site, etc., the spillway crest length L is assumed to be 50 m. Meanwhile, the results of calculation on the effect of flood regulation at the dam site for the return periods of 5 years, 10 years and 25 years with L = 50 m are as shown in Table H-22 (2) (Ref. Fig. H-18).

5.4 Design Flood Discharge Distribution

The design flood discharge distribution along the river is estimated, based upon the basic highwater of 10-year return period and taking account of the effect of flood regulation by the Karian reservoir, as shown in Table H-21 and Figs. H-19 and H-20. They are sumarized as follows:

		Basic high water (m^3/s)	Design flood discharge (m^3/s)
Kragilan	(Ciujung)	1,500	1,100 /1
Pamarayan	(Ciujung)	1,300	1,100
Rangkasbitung	(Ciujung)	1,300	1,100
Rangkasbitung	(Upper Ciujung)	700	700
Rangkasbitung	(Ciberang)	900	700

/1 Under the present river condition from Kragilan to Pamarayan.

The above table shows that, under the present river condition in the section from Kragilan to Pamarayan, the flood of 10-year return period at Kragilan will coincides with the design flood of 1,100 m^3/s by PROSIDA after flood regulation by the Karian reservoir and river improvement on the objective section.

Accordingly, if the river section from Kragilan to the Pamarayan weir is subject to improvement sometime in the future, an careful study will be necessary of its effect on the lower reaches and the countermeasures to be taken.

Table H-21 shows calculated values of flood discharge with 100 m^3/s or 10 m^3/s order up. Raw calculated values may be given as shown in the following table, and it is evident that some effect of flood control by Karian dam can be obtained for Rangkasbitung and the downstream of Kragilan as well.

Present Condition

(Unit: m^3/s)

Point	Return Period (years)			
	5	10	25	50
Kragilan	929	1063	1333	1439
Rangkasbitung	999	1216	1495	1728

After Completion of the Project
(Karian Dam + River Improvement)

(Unit: m^3/s)

Point	Return Period (years)			
	5	10	25	50
Kragilan	919	1045	1310	1417
Rangkasbitung	896	1082	1340	1567

6. RIVER IMPROVEMENT

6.1 General

Main problems concerned in the flood control of the Ciujung river will be enumerated such as aggravation of the highwater level in the upstream reaches from the Pamarayan weir due to sediment on the riverbed, remarkable meanderings in the river section upstream thereof, and severe bank erosion liable to collapse around Rangkasbitung near the confluence of the Ciberang and the Upper Ciujung rivers. Their countermesures will be contemplated as follows.

- Dredging of riverbed in the upstream reaches from the Pamarayan weir.
- A series of short cut in the section of meanderings between 8.3 km point and 15.5 km point upstream from the Pamarayan weir.
- Improvement of the Ciberang - Upper Ciujung confluence around Rangkasbitung by short cut.
- Provision of groynes and revetments on river bends and meanderings confronting with flood flow.

Three alternative plans are studied to find out the most reasonable plan, with consideration on the riverbed stabilization, execution and economic aspects as presented in Table H-23 and Fig. H-21. They will be sumarized as follows.

Section	Case 1	Case 2	Case 3
Pamarayan Weir to 15.5 km (No.85)	Dredging of River Bed and Embankment		
15.5 km to 22.7 km (No.64)	Short Cut	Short Cut	Dredging/1 and Embankment
Around Rangkasbitung	Short Cut/2	Embankment	Embankment
Improvement Length (Km)	21.5	22.9	25.0
Construction Cost (x 10^6 Rp)	15,060	13,790	13,780

/1 River improvement along the present river channel.

/2 Improvement of Ciberang - Upper Ciujung confluence by short cut.

From technical viewpoints on river improvement and maintenance, the most desirable plan will be case-1 followed by case-2. However, considering the economic aspects as well, case-2 will be proposed to be subject to the preliminary design and economic analysis in this Report.

6.2 Design Principle

River improvement must be planned in such a way as to allow a design discharge in safety with consideration given to plane, longitudinal and cross-sectional arrangements as a whole, and to provide a stable river channel taking into account utilization during normal times as well. The undermentioned Ciujung river improvement plan (Case 2) has been selected as a result of studying the three alternatives above and taking into account the above-mentioned basic principle and economic aspects.

(1) Manning's roughness coefficient "n"

The improved cross section of the river will be designed with the Manning's roughness coefficient "n" of 0.030, taking account of the result of analyses on rivebed materials and considering river meanderings, bank erosion and planning safety.

(2) Typical cross section of dyke (Ref. Fig. H-22)

The typical cross section of dyke will be designed with crown width of 4 m at minimum and both side-slopes of 1:2, considering the stability of dyke and a function of maintenance road. A freeboard of 1 m will be provided above the design high water level.

The berm of 3 m width will be provided in 3 to 5 m height from the crown on the riverside slope of the dyke, and in 2 to 3 m height from the crown on the land-side slope, considering the possible seepage within the embankment.

(3) Plane arrangement (Ref. Fig. H-23)

Generally, the plane arrangement of the dyke and the river channel will be designed to be in smooth accomodation with expected flood flow, however, a series of short cut will be designed on developed meanderings in the river section between 8.3 km and 15.0 km upstream from the Pamarayan weir, to increase the flow capacity and to stabilize the river channel.

These short cuts will be provided in the section where the length of the present river channel increase more then 2 times owing to meanderings. The meandering characteristics of the Ciujung river are as shown in Fig. H-24, and the section No. 85~65 in which the ratio of increase in river channel length β (Ref. Fig. H-24) owing to meanderings is larger than 1 corresponds to this. The length of the present river channel of 18.3 km, between the Pamarayan weir and Rangkasbitung, will be reduced to 15.2 km by designed short cuts.

(4) Longitudinal profile arrangement (Ref. Fig. H-25)

The riverbed elevation upstream from the Pamarayan weir has risen to around EL. 8.0 m at present, which is about 3 m higher above the sill of the weir. The heavy sedimentation has raised the flood water stage which has resulted in aggravation of flood condition along the river.

The longitudinal river profile will be designed with an improved riverbed slope, starting from around the sill elevation of the weir and linking to the present riverbed elevation near the lower end of the short cut section. Lowering of the riverbed will be done by dredging.

The design high water level will be decided starting from the design HWL EL. 11.0 m at the Pamarayan weir and according to the design river cross-section. The location of the short cut is shown in Fig. H-23. The change in channel length and riverbed gradient by short cut is summarized below .

	Channel Length L (km)	Riverbed Gradient I	
Present	18.26	1/3000	
After Short Cut	15.24	1/3000	1/2310
Reduction	3.02	-	

Meanwhile, for reference, the result of study on the effect of lowering of water level at Rangkasbitung for the design high-water discharge of 1100 m^3/s in the present river channel condition is described below.

The lowering of water level will be 0.32 m by dredging, 0.72 m by short cut, and 0.9 m by both dredging and short cut (Ref. Fig. H-26).

(5) Cross-sectional arrangement

For the river section with ample space at present, the double cross section will be designed. Considering the required flow capacity and topography of the objective section, the improved river width and the riverbed width will be designed mostly as follows:

	Ciujung	Ciberang	Upper Ciujung
Improved river width (m)	100	85	70
Improved riverbed width (m)	60	50	50

The cross section in the alternative plan (Case-2) is shown in Fig. H-27. In this case, the design river width and channel configuration are to be the same in each alternative plan, and the design flood water level and embankment height are to be based on the needed water level according to the non-uniform flow calculation.

6.3 River Structure

(1) Groyne and revetment:-

The types of groyne and revetment will have to be selected according to the river characteristics with consideration upon economic aspects and maintenance as well. For the Ciujung river, piled groynes and gabion revetment will be designed on river banks confronting with flood flow (Ref. Fig. H-28).

(2) Treatment of small tributary confluence

The treatment of small tributary confluence will be designed by the open levee, if the interior ground lies above the high-water level of the Ciujung river. However, the sluice will be designed if the high-water level of the Ciujung river exceeds the interior ground level. The sluice will be designed by three types type-I (H 1.5 m x B 1.5 m x 1), type-II (H 2.0 m x B 2.5 m x 2) and type-III (H 3.0 m x B 3.0 m x 2), according to dimension of the tributary (Ref. Fig. H-29).

(3) Other facilities

The maintenance road will be designed on the crown of the dyke with gravel surface (Ref. Fig. H-22 (2)). In the section of open levee, some connection with the existing road will be provided.

The drainage ditch will be designed at the land-side toe of the dyke according to the topography, if necessary.

7. CONSTRUCTION PLAN AND ESTIMATE OF COST AND BENEFIT

7.1 Construction plan

(1) Main works

The main items of channel impromement works in the Ciujung river are dredging, excavation and embankment. The work volume of the main items according to the proposed plan (Case 2) referred to in Chapter VI is as shown below (Ref. Table H-24).

Dredging	$560 \times 10^3\ m^3$
Excavation	$1404 \times 10^3\ m^3$
Embankment	$521 \times 10^3\ m^3$

In addition, there are groynes and gabion revetments in the sections. confronting with flood flow, and drainage culvert.

(2) Preparatory works

Preparatory works are composed of,

- Transportation road and access road,
- Office and quarters,
- Topographic survey and soil survey for detailed design and supervision, and
- Other works (Clearing works must be executed at the sites of embankment and excavation and some other temporary works will be required.)

(3) Construction plan

Required construction works, land acquisition and compensation for river improvement referred to in Chapter VI are as shown in Table H-24 and H-25. The construction plan of main civil works is described below.

- Dredging

Dredging will be carried out in the river section for about 8.3 km upstream from the Pamarayan weir. According to the result of field survey, this section has the water depth from 2 m to 6 m and riverbed materials are mostly of sandy nature on the surface. A 1,000 HP diesel dredger will be employed with an average dredging capacity of about 25,000 m^3 per month. Spoil from dredging will be deposited in spoil banks nearby the river.

- Excavation

Excavation will be carried out mainly by bulldozer, backhoe and dragline. Excavated soil will be conveyed by dump trucks and partly be utilized for embankment. The rest of them will be deposited in the old channel, which has an enough capacity of about 2.1 million m^3 to receive the soil from dredging and excavation.

- Embankment

Embankment will be carried out with materials from borrow pits nearby and partly with excavated soils by a combination of bulldozer, backhoe, vibration roller and vibration compacter. The embankment height will be mostly from 2 m to 3 m in the lower section and mostly from 1 m to 2 m around the city of Rangkasbitung.

(4) Construction schedule

Construction work is to be executed in the order considering the effect of decreasing water level on Rangkasbitung. Dredging up to No. 85 Point upstream from the Pamarayan weir will be started at first and will be completed in 3 years. Next, short cut work will be executed in the section from No.85 point to No.64 point, which is most effective to lower the flood stage of Rangkasbitung, and embankment will be carried out from the Pamarayan weir to No.64 point. Finally, construction work centers around embankment upstream from No.64 point including upper Ciujung and Ciberang rivers.

7.2 Cost Estimate

(1) Composition of construction cost

The construction cost of river improvement works consists of earth work, bank protection, sluice and equipment, land acquisition, engineering services and administration and physical contingency. The construction cost is estimated on the basis of prices in 1984. Also, estimation is made using the following exchange rate as of 1984.

US$1 = Rp. 1050 = ¥240

The construction cost consists of costs required for civil works land acquisition and house compensation, engineering services and administration cost, and contingency.

The cost required for civil works consists of costs for preparatory works, main civil works and the miscellaneous. The cost for civil works is estimated by multiplying work quantity by unit cost. The cost for preparatory works is assumed to be 8% of the total cost of the main civil works and the miscellaneous is assumed to be 10% of the total cost of preparatory and civil works.

For administration and engineering services, the foreign currency portion is assumed to be 15% and the local currency portion 8% against the total of direct construction cost, and land acquisition cost. The physical contingency is assumed at 15% of the total cost of the above. Price contingency is taken into account at annual escalation rate of 5% for foreign currency portion and 12% for local currency portion.

(2) Construction cost

The work quantities and construction cost are shown in Table H-26 with their breakdowns. With regard to the proposed plan (Case 2), the cost of river improvement alone is summarized below with the breakdown of foreign and local currency portions.

(Unit: Rp. x 10^6)

Item	Foreign Currency	Local Currency	Total
1. Direct Construction cost	5,320	3,973	10,293
2. Land Acquisition	0	404	404
3. Administration and Engineering	949	350	1,299
4. Physical Contingency	1,091	710	1,801
Sub-total	8,360	5,437	13,797
5. Price Contingency	2,433	4,463	6,896
Total	10,793	9,900	20,693

Also, the shared Karian dam construction cost by flood control sector is shown as follows:

Item	Foreign Currency	Local Currency	Total
1. Direct Construction cost	3,443	2,719	6,162
2. Land Acquisition	0	1,444	1,444
3. Administration and Engineering	517	332	849
4. Physical Contingency	595	674	1,269
Sub-total	4,555	5,169	9,724
5. Price Contingency	1,374	3,854	5,228
Total	5,929	9,023	14,952

Construction cost of Karian dam is shown in Appendix-J Dam and Reservoir. The cost of intake and tunnel which is required for purposes other than flood control is deducted from the total Karian dam construction cost. Then, this cost is allocated at the ratio of flood control storage (33 x 10^6 m^3) to active storage (252 x 10^6 m^3).

Also, the Table H-27 shows the annual disbursement schedule for river improvement.

(3) Operation, maintenance and replacement cost

Annual operation and maintenance cost is assumed to be 0.5% of the direct construction cost estimated above. As for the replacement of the facilities, it is considered that the metal structures such as gates, are replaced only once during the entire period of the project life. The total replacement cost for the gates of box culvert is estimated at Rp. 1,746 x 10^6.

7.3 Benefit

(1) Average annual flood damage decrement

Generally, the benefit by flood control is referred to as the amount of flood damage mitigated through river improvement and flood regulation by dam. The average annual damage in and around Rangkasbitung upstream from the Pamarayan weir in the Ciujung river is estimated at Rp. 2.57 x 10^6 as shown in Section 3.3. When river improvement work in the Ciujung river and construction of Karian dam are completed, there will be no flood damage up to a design scale of 10-year return period. Accordingly, the amount of average annual flood damage decrement will be Rp. 2.57 x 10^6.

(2) Other benefits

- Besides, the installation of groyne and revetment will prevent the destruction of housing land, roads, farmland, etc. caused by the collapse of river banks during flood. The contents of evaluation on damage will include the price of land destroyed, house construction and moving costs, the cost of construction of a road in another route, reduction in the output owing to a decrease in the planting area, etc.

  For reference, according to the result of field survey, the area of land destroyed in the past 10 to 20 years is assumed to be as follows:

housing land	: 0.65 ha
road	: 0.85 ha
wet paddy field	: 0.3 ha
upland crop field	: 1.0 ha

The prices of these land, reconstruction cost and a decrease in crop production are assumed to be approximately Rp. 247 x 10^6 in current price. In terms of average annual damage, this amount is equivalent to Rp. 16.7 x 10^6, and this can be expected as a benefit brought about through prevention of the collapse of river banks.

- Moreover, as secondary effect by river improvement in the Ciujung river, the following two points can be considered: One is "Land on the right bank of the Ciberang river along the old river channel in Rangkasbitung as well as on the right bank downstream from the railway bridge will be protected against flood damage and can be utilized as housing land.", and the other is "Sand in the Ciujung river is currently in demand as construction material, and river sand found in the areas from Kragilan over to Rangkasbitung is being gathered (Ref. Section 2.4). From this point of view, dredged sand in the upstream of Pamarayan can also be utilized as construction material."

8. FUTURE PROBLEMS

In the present survey, measures for flood control in and around Rangkasbitung have mainly been studied and a river improvement plan for the section upstream from the Pamarayan weir has been proposed. The problems that have been made clear in the present study and the matters that should be investigated before making the detailed design may be summarized as follows.

(1) Improvement of hydrologic data

- Only a series of hydrologic data on the flood in November, 1981 has been used for the flood runoff analysis in this study. However, regarding the constants of storage funciton, it will be desirable to verify other flood events and confirm their appropriatness.

- For that purpose, it will be necessary to set up automatic rain gauge stations in the Ciberang, Cisimeut and Upper Ciujung river basins to record hourly rainfall in each basin.

- As for river stage and discharge data, efforts should be made to improve the accuracy of rating curves through continuous observation and discharge mesurement during high water stage at Kragilan, Pamarayan weir and Rangkasbitung. Also, discharge measurement during high water stage at Sabagi gauging station will be important in grasping the runoff characteristics of the Ciberang river.

(2) Survey

- For the detailed design, it will be necessary to newly carry out plane, longitudinal and cross-sectional surveys.

- The range of these surveys will be from the Pamarayan weir to Rangkasbitung including the Ciberang river (up to the Cisimeut river confluence) and the Upper Ciujung river (up to 5 km from the Ciberang river confluence).

- In order to improve the precision of flood survey and make clear the river-channel plan and the compensation quantity, the plane map should be provided with 0.5 m contours in the inundated area along river channels, and the size and location of houses, as well as roads, bridges and tributaries should be plotted in the plane map. Also, the scale should be 1/2500.

- Longitudinal and cross-sectional surveys should be conducted at intervals of 250 m and should also include bridges, principal tributairies and confluences.

(3) Soil survey

- A soil survey will be required in working out a dredging plan, designing short-cut sections, embankment, box culverts, etc. and drawing up an execution plan.

- The survey should include boring and sampling according to its purpose in the stage of detailed design. Relevant tests should also be carried out.

(4) Types of groyne and treatment of confluence at Rangkasbitung

- In the present survey, piled groynes have been proposed considering the good achievements in Japan. However, their effect may vary with the meandering characteristics of the river, riverbed materials and riverbed gradient. When executing construction work, therefore, it will be desirable to execute in good order and make necessary improvements while watching the effects of groynes.

- If all construction works must be completed within 3 years like the present plan, it is desirable to determine the installation locations and intervals of groynes in such a way that a sufficient effect can be obtained by hydraulic model test and other similar river experiences.

- Especially, for treatment of the confluence of the Upper Ciujung and Ciberang rivers, it is desirable that groynes and revetments be selected on the basis of a careful study using hydraulic model tests, because these rivers are located adjacent to an urban district and important facilities such as road bridge, and railway bridge.

(5) Study on riverbed stabilization

- The stabilization of the riverbed can be predicted by examining the longitudinal distribution of sediment transport. The proposed channel in the present plan, has been determined along the present riverbed gradient. It is desirable that its stability be confirmed by a sediment transport formula adding further survey on riverbed materials with sampling at intervals of 1 - 2 km.

(6) Flood control in downstream reaches from Pamarayan weir

The river section downstream from Kragilan has recently been improved, leaving the section between Kragilan and the Pamarayan weir to be subject to problem in the future.

If the river section between Pamarayan and Kragilan is subject to improvement sometime in the future, a careful study will be necessary beforehand of its influence on the lower reaches downstream from Kragilan and the countermeasures to be taken. The study should be made with some additionally necessary data by preparatory surveys such as longitudinal, cross-sectional and plane topographic surveys along the objective river section and also by analyses of riverbed materials.

For reference, some considerations on the above-mentioned river improvement will be given below, based on the results of the present study and the local condition.

i) Roughness coefficient and flow capacity of lower reaches

Beforehand planning the river improvement downstream from the Pamarayan weir, it would be necessary to investigate the roughness coefficient within the lower reaches and to confirm the flow capacity thereof.

The investigation of roughness coefficient should be made by aforementioned analyses of riverbed materials and observed data on water stage and discharge at Kragilan gauging station.

The roughness coefficient within the lower reaches may be expected to have a smaller value than that of upper reaches from the Pamarayan weir, considering the smooth alignment of the river and the smaller grain size of riverbed material as seen from Fig. H-7.

ii) Shortcut and internal drainage

A shortcut may be planned on a large river bend upstream from Kragilan to stabilize the river channel and also to improve the internal drainage of the Cikambuy river which flows down by K-C-C district.

iii) Conservation of flood-retarding effect

To plan conservation of flood-retarding effect in the river section between Kragilan and the Pamarayan weir, some proper area may be specified for conservation of flood-retarding effect by surveying topography and land use, or some retarding basin may be planned to mitigate the flood burden on the lower reaches.

However, judging fro- the difference of basic high water peaks at Pamarayan and Kragilan on Fig. H-20, the flood discharge at Kragilan will be increased by about 200 m^3/sec after improvement of the objective section. Perhaps this discharge increment will not be covered by above-mentioned suggestions and an additional improvement might be necessary on the river section downstream from Kragilan.

REFERENCE

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3. "Report of November 1981 flood", Seksi pengairan Serang, November 1981.

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5. "Report of flood in Banten", P3SA DPU, November 1981.

6. "Mannual for river and sabo works in Japan", Ministry of construction, Japan, 1976.

7. "Outline of economic survey on flood control", Ministry of construction, Japan, March 1980.

8. "Laporan penyelidikan hidrolis dengan model river training Sungai Ciujung di udik bendung Pamarayan", DPMA, Augustus 1982.

9. "Nota perhitungan pengamanan dan rencana biaya Sungai Ciujung di seksi pengairan Serang", DPUP Jawa Barat, September 1978.

10. "Study report on Padang area flood control project", Appendix, JICA, December 1983.

Table H-1

CHARACTERISTIES OF CIUJUNG RIVER BASIN

River Name/Point	Cachment Area CA (km^2)	Length of River Course L (km)	River Slope I	Form Factor F ($=A/L^2$)
Ciujung River.				
River Mouth	1850	142	1/6000 to 1/5000	0.092
Kragilan Bridge	1812	124	1/3200	0.118
Pamarayan Weir	1451	105	1/3000	0.132
Rangkasbitung	1383	87		0.184
Upper Ciujung River.				
Ciberang River Confluence	594	77	1/2400 to 1/70	0.149
Cibeet River Confluence	273	52		0.089
Ciberang River.				
Ciujung River Confluence	789	87	1/2500	0.105
Cisimeut River Confluence	305	83	1/1800	0.044
Karian Dam Site	288	72	1/1800 to 1/40	0.056
Cisimeut River.				
Ciberang River Confluence	458	64	1/2000	0.114
Ciminyak River Confluence	221	55	1/2000 to 1/40	0.074

Table H-2 CIUJUNG RIVER WATER LEVEL ELEVATION BY NON-UNIFORM FLOW CALCULATION

Unit: Elevation(m)

No.	Point	n	Discharge Q (m^3/s)					
			500	750	1000	1250	1500	2000
183	Jeunging	0.025	0.777	1.734	2.451	2.810	3.202	3.931
		0.030	1.111	2.075	2.652	3.134	3.568	4.368
		0.035	1.421	2.320	2.940	3.456	3.924	4.790
150	Kragilan	0.025	3.143	4.216	5.075	5.769	6.394	7.496
		0.030	3.597	4.736	5.623	6.380	7.055	8.247
		0.035	4.006	5.194	6.132	6.938	7.659	8.935
	Pamarayan	0.025	7.899	8.824	9.630	10.349	11.006	12.197
		0.030	8.256	9.276	10.155	10.941	11.663	12.966
		0.035	8.594	9.703	10.652	11.504	12.285	13.695
58	Rangkasbitung	0.025	15.673	16.601	17.388	18.093	18.742	19.913
		0.030	16.060	17.070	17.940	18.713	19.419	20.700
		0.035	16.416	17.510	18.448	19.284	20.035	21.438

Remarks : No. : Measuring Point

n ; Mannings roughness coefficient

Water level of Jeunging and Kragilan by M/P study report (July 1983).

Table H-3 INUNDATED AREA FROM PAMARAYAN TO RANGKASBITUNG (Nov. 1981 & Nov. 1983 - Flood)

(Unit: ha)

	Land Use	Inundated Depth (m)					Total
		0.00 to 0.49	0.50 to 0.99	1.00 to 1.49	1.50 to 1.99	2.00 to 2.49	
November 1981 Flood	Wet Paddy Field	180	30	10	-	10	230
	Upland Crop Field	110	170	160	200	100	740
	Tree Crop	50	30	40	20	10	150
	Village	10	20	25	10	5	70
	Others	10	20	20	-	10	60
	Total	360	270	225	230	135	1,250
November 1983 Flood	Wet Paddy Field	10	10	-	-	-	20
	Upland Crop Field	180	150	50	-	-	380
	Tree crop	30	10	10	-	-	50
	Village	20	10	5	-	-	35
	Others	10	10	-	-	-	20
	Total	250	190	65	-	-	505

Table H-4 APPRAISEMENT OF HOUSES AND BUILDINGS, AND HOUSEHOLD EFFECTS OR STORED GOODS OF 1984 PRICE LEVEL

(Unit: $Rp.10^6$)

Kind of Houses and Buildings	Appraisement		
	Houses and Buildings	Household Effects or Stored Goods	Total
Residence	4.2	1.8	6.0
Shop	4.2	4.2	8.4
School	36.0	3.6	39.6
Mosque	12.0	3.6	15.6

Table H-5 RATE OF APPRAISEMENT OF HOUSEHOLD EFFECTS BY INUNDATED DEPTH ABOVE FLOOD LEVEL

(Unit: %)

Kind of Houses and Buildings	Inundated Depth above Floor level (m)						
	0 to 0.5	0.5 to 1.0	1.0 to 1.5	1.5 to 2.0	2.0 to 2.5	2.5 to 3.0	over 3.0
Residence	55	80	90	95	99	100	100
Shop	40	65	75	90	95	99	100
School & Mosque	55	85	95	99	100	100	100

Table H-6 DAMAGE RATE OF INUNDATED HOUSES AND BUILDINGS

Inundated Depth above Floor (m)	Damage Rate
0 - 0.49	0.053
0.50 - 0.99	0.072
1.00 - 1.49	0.109
1.50 - 1.99	0.109
2.00 - 2.49	0.534

Source: Outline of Economic Survey on Flood Control, Ministry of Construction, Japan

Table H-7 DAMAGE RATE OF INUNDATED PROPERTIES

Kind of Properties	Damage Rate
Household Effects of Residence	0.690
Stored Good of Shop	0.597
Properties of School, Mosque	0.632

Source: Outline of Economic Survey on flood Control, Ministry of Construction, Japan

Table H-8 NUMBER OF INUNDATED HOUSES AND BUILDINGS FROM PAMARAYAN TO RANGKASBITUNG (Nov. 1981 and Nov. 1983 - Flood)

(Unit: number)

	Kind of Houses and Buildings	Inundated Depth (m)					Total
		0.00 to 0.49	0.50 to 0.99	1.00 to 1.49	1.50 to 1.99	2.00 to 2.49	
	Residence	280	600	1,020	440	60	2,400
November	Shop	5	10	20	10	0	45
1981 Flood	School	0	2	0	0	2	4
	Mosque	1	4	15	4	2	26
	Total	286	616	1,055	454	64	2,475
	Residence	730	250	30	-	-	1,010
November	Shop	15	5	-	-	-	20
1983 Flood	School	-	-	2	-	-	2
	Mosque	10	3	1	-	-	14
	Total	755	258	33	-	-	1,046

Table H-9 INUNDATED CROP AREA FROM PAMARAYAM TO RANGKASBITUNG

(Nov. 1981 and Nov. 1983 - Flood)

(Unit:ha)

Crops	Nov. 1981	Nov. 1983
Wetland Paddy	-	-
Upland Crops		
Maize	600	330
Cassava	140	50
Sub-total	740	380
Tree Crop/1	150	50
Total	890	430

Remark: /1 = Mixed planting of banana and bamboo

Table H-10 CROP DAMAGE VALUES FROM PAMARAYAM TO RANGKASBITUNG BY FLOOD IN NOV. 1981 AND NOV. 1983

(1) Nov. 1981 Flood

Crops	Gross Inundated Area (ha)	Net Planted Area (ha)	Unit Damage Value (Rp/ha)	Average Damage Factor	Damage Value/1 (Rp 10^6)
Wetland and Paddy	-	-	-	-	-
Upland Crops					
Maize	600	480	68,000	1.00	32.6
Cassava	140	56	300,000	0.10	1.7
Sub-total	740	536			
Tree Crops	150	75	-/2	-	-
Total	890	611			34.3

(2) Nov. 1983 Flood

Crops	Gross Inundated Area (ha)	Net Planted Area (ha)	Unit Damage Value (Rp/ha)	Average Damage Factor	Damage Value/1 (rp 10^6)
Wetland Paddy	-	-	-	-	-
Upland Crops					
Maize	330	264	68,000	1.00	18.0
Cassava	50	20	300,000	0.10	0.6
Sub-total	380	284			
Tree Crops	50	25	-/2	-	-
Total	430	309			18.6

Remarks: /1 = Values based on the market price at the end of 1984

/2 = No crop damage occured

Table H-11 ACTUAL FLOOD DAMAGE AT 1984 PRICE
(Nov. 1981 - Nov. 1983 - Flood)

(Unit: Rp 10^6)

Item	Nov. 1981	Nov. 1983
Houses and Buildings, Household Effects	3,815.0	1,103.3
Crops	34.3	18.6
Suspension of Business Activities	228.9	66.2
Public Facilities	3,452.6	998.5
Total	7,530.8	2,186.6

Table H-12 CALCULATED CHART OF AVERAGE ANNUAL DAMAGE

(Unit: Rp x 10^6)

Probability	Occurrence Probability (1)	Amount of Damage (2)	Average Amount of Damage (3)	(4) (1) x (3)	Average Annual Damage
1/1 (1.000)		0			0
	0.500		1,093.3	546.7	
1/s (0.500)		2,186.6			546.7
	0.375		4,858.7	1,822.0	
1/8 (0.125)		7,530.8			2,368.7
	0.025		7,915.4	197.9	
1/10 (0.100)		8,300.0			2,566.6

Table H-13 DAILY RAINFALL IN NOVEMBER 1981

Unit ; mm

Rainfall Gauging Station No.	Name	Date 9	10	11	12	13	14	15	16	17	18	Total
9	Bojong Datar	-	194.0	3.0	16.0	90.0	57.0	-	227.0	75.0	112.0	774.0
22	Cimanuk	-	100.0	-	-	52.0	9.0	16.0	115.0	28.0	19.0	339.0
23	Serang	16.5	-	-	-	-	15.0	19.0	50.0	-	-	100.5
23 E	Cipanas	5.5	-	-	-	5.0	-	7.5	26.0	2.0	-	46.0
24	Baros	73.0	40.0	-	-	15.0	-	42.0	63.0	22.0	-	255.0
24 A	Nyapah	-	7.0	-	-	8.0	5.0	14.0	30.0	-	19.0	83.0
24 B	Petir	-	-	-	-	5.0	8.0	-	-	-	-	15.0
26	Pandeglang	9.0	90.0	-	-	45.0	1.0	11.0	60.0	73.0	8.0	297.0
26 B	Cileles	10.3	-	5.0	70.0	31.0	100.0	75.0	25.0	10.0	-	326.3
30 B	Cikeusik	30.0	30.0	-	40.0	30.0	40.0	65.0	60.0	45.0	90.0	430.0
31 C	Cipucang Pare	41.0	90.0	-	2.0	33.0	18.0	6.0	45.0	10.0	15.0	260.0
37	Rangkasbitung	51.0	-	13.0	30.0	-	8.0	46.0	54.0	8.0	-	210.0
37 B	Cikadu	-	32.0	-	24.0	-	-	48.0	68.0	-	-	172.0
43 B	Cilaki	-	83.0	10.0	30.0	90.0	34.0	68.0	30.0	-	-	345.0
44	Cipanas	30.0	10.0	3.0	70.0	20.0	-	20.0	80.0	-	-	233.0
A.13	Bolang Baji	0.8	-	-	6.4	2.1	4.2	15.8	20.9	1.6	-	51.8
B.24	Gunung Tunggal	85.9	1.0	6.4	83.5	20.4	31.0	96.3	0.0	3.9	-	328.4
B.28	Konkol Cisadang	2.8	36.3	14.5	12.3	5.7	24.0	80.7	2.3	-	-	178.6
B.36	Bantar Jaya	76.8	-	1.3	77.8	14.1	5.6	62.8	45.1	7.5	-	291.0
B.38	Bojong Barang	-	-	2.0	68.5	19.8	16.1	65.6	49.5	13.9	0.4	235.8
B.45	Ranca Songgom	-	-	9.7	1.0	1.9	19.7	120.5	24.5	7.0	0.9	185.2

Table H-14 COEFFECIENT OF THIESEN POLYGON ON NOVEMBER 1981 STORM

(Unit %)

Rain Gauging Station No.	Karian Dam	Ciberang Cisimeut Conf.	Cisimeut Ciberang Conf.	Ciberang Ciujung Conf.	Upper Ciujung Ciberang Conf.	Rangkas-bitung Upper Basin	Rangkas-bitung to Kragilan	Kragilan
Sub Basin No.	1	1	2,3	1,4	5,6,7	1to7	8to12	1to12
9	-	-	-	-	2.47	1.06	-	0.81
22	-	-	-	-	8.74	3.76	-	2.87
23 E	-	-	-	-	-	-	11.08	2.62
24	-	-	-	-	-	-	12.58	2.97
24 A	-	-	-	-	-	-	26.25	6.21
26	-	-	-	-	16.71	7.18	9.78	7.79
26 B	-	-	-	-	13.49	5.80	-	4.42
30 B	-	-	-	-	-	-	2.19	0.54
31 C	-	-	-	-	0.91	0.39	-	0.30
37	-	0.99	1.54	2.73	6.21	4.22	30.63	10.47
37 B	14.36	18.15	1.54	9.75	-	5.56	7.49	6.02
43 B	24.87	23.48	49.51	37.81	8.67	25.30	-	19.31
44	59.02	55.73	-	21.54	-	12.29	-	9.38
B 24	-	-	19.80	11.50	10.99	11.28	-	8.61
B 28	-	-	-	-	21.88	9.40	-	7.17
B 36	1.75	1.65	15.95	9.90	-	5.65	-	4.31
B 38	-	-	9.46	5.49	0.14	3.19	-	2.44
B 45	-	-	2.20	1.28	9.79	4.92	-	3.76
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
CA (Km^2)	288	305	458	789	594	1383	429	1812

Remarks Sub basin No; Ref. Fig. H-12

CA ; Catchment area

Table H-15 AVERAGE RIVER BASIN DAILY RAINFALL OF NOV. 1981 STORM

(Unit: mm)

Basin Name	Ciberang	Cisimeut	Upper Ciujung	Rangkasbitung (upstream)	Rangkasbitung to Kragilan
Sub Basin No.	1.	2.3	5.6-7	1 to 7	8 to 12
Date 9	18.48	30.04	16.48	21.52	26.94
10	30.87	41.78	44.63	40.15	18.72
11	4.16	7.02	7.25	6.46	3.98
12	48.36	50.82	26.38	40.23	11.86
13	32.61	52.8	39.27	37.64	9.59
14	8.15	25.94	30.07	23.37	4.73
15	37.31	73.05	60.28	60.06	29.97
16	64.52	29.98	38.39	41.69	47.49
17	0.20	3.56	19.57	9.69	13.56
18	0.0	0.05	5.98	2.59	7.74
Total	244.66	315.04	288.30	283.40	174.58

Table H-16 COEFFICIENT OF CONVERSION (Rave/Ri) TO THE BASIN MEAN RAINFALL

Item	River Basin					
	Ciberang		Cisimeut	Upper Ciujung		Rangkasbitung to Kragilan
Subbasin No.	1	4	2,3	5	6.7	8,9,10,11,12
R_{ave} (mm)	244.6	244.6	315.0	288.3	281.3	174.6
Rainfall Gauging Station No.	B-24	B-38	B-24	B-28	B-45	B-36
R_i (mm)	328.4	235.8	328.4	178.6	185.2	291.0
R_{ave}/R_i	0.745	1.037	0.959	1.614	1.519	0.600

Remarks: Subbasin No. Ref. Fig. H-12 R_i: Point total rainfall of each rainfall station

R_{ave}: Subbasin average total rainfall

Table H-17 STORAGE FUNCTION COEFFICIENT OF SUBBASIN AND CHANNEL

CHARACTERISTICS AND STORAGE FUNCTION COEFFICIENT OF SUB-BASIN

Basin No.	Area CA (Km^2)	River Length in watershed L (km)	Average Slope in watershed I	K	P	Tl (hr)	Base flow (m^3/s)	River basin of quaternary volcanic products	River basin of other products	fl	Rsa (mm)
1.	305	72.0	1/80	94.61	0.333	3.3	4.5	41 (%)	59 (%)	0.82	177
2.	179	41.0	1/85	79.46	"	1.9	2.6	31	69	0.84	162
3.	279	63.5	1/85	91.93	"	2.9	4.2	35	65	0.83	170
4.	26	7.0	1/230	61.04	"	0	0.4	0	100	0.93	100
5.	273	51.5	1/110	93.60	"	2.4	4.0	16	84	0.89	132
6.	241	29.5	1/65	64.59	"	1.3	3.5	47	53	0.5	194
7.	80	22.5	1/40	50.25	"	1.0	1.2	64	36	0.75	228
8.	68	12.5	1/220	72.97	"	0	1.0	0	100	0.93	100
9.	41	17.5	1/500	107.32	"	0.8	0.6	53	47	0.78	206
10.	126	36.5	1/90	85.21	"	1.7	1.8	0	100	0.93	100
11.	48	17.0	1/550	109.72	"	0.8	0.7	56	44	0.77	212
12.	146	31.0	1/90	73.32	"	1.4	2.1	0	100	0.93	100

Remarks: K. P: Coefficients of storage function for basin

TI : Time lag (hr)

fl : primary run off ratio

Rsa : Rainfall until point of saturation

STORAGE FUNCTION COEFFICIENT OF CHANNELS

Channels No.	Length L (Km)	Tl (hr)	K	P	Qc (m^3/s)	Nov. 1981 Year Flooding Area (Km^2)
A	11.3	2.25	26.20	0.63	500	7.43
B	7.4	1.47	16.90	0.62	500	2.17
C	18.3	3.35	63.00	0.55	400	8.42
D	3.1	0.75	9.72	0.62	400	2.47
E	10.8	1.88	12.30	0.66	300	(1.61)
F	8.9	1.77	15.48	0.65	300	(1.61)
G	7.9	2.00	13.20	0.67	300	1.61
H	18.0	4.17	24.90	0.67	200	(1.61)

Remarks: TI : time lag (hr)

K. P: coefficients of storage function for channel

Qc : flow capacity of channel (m^3/s)

( ) : assumed flooding area of E.F. and H channel to be equal to that of G channel, 1.61 km^2

STORAGE FUNCTION OF FLOODING (UNDER PRESENT CONDITION)

A		B		C		D		E		F		G		H	
Q	S	Q	S	Q	S	Q	S	Q	S	Q	S	Q	S	Q	S
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	738	200	451	180	1096	50	110	50	162	140	384	50	182	50	342
300	953	300	580	300	1450	100	169	100	257	300	631	100	289	100	545
500	1314	500	797	400	1700	300	334	300	531	500	879	300	603	300	819
800	1900	800	1400	800	3650	500	1364	500	1364	800	1050	500	1364	500	1364
1100	5180	1100	2100	1100	5000	600	1652	700	1943	1100	1650	700	1943	700	1943
1300	5900	1300	2600	1300	5900	700	1943			1300	2050				
1500	8800	1500	3100	1500	6700	800	2235			1500	2500				
2000	15000	2000	4500	2000	8800	1000	2825								

Remarks: A; B----- H; channel number

Q : discharge (m^3/s)

S : Channel and flooding storage (m^3/s. hr)

Table H-18 COEFFICIENT OF PROBABLE RAINFALL IN SUBBASIN

River Name Point	Catchment Area (Km^2)	Area Reduction Factor a	Subbasin No	Point Rainfall		R_{pro} (mm)			
				Station No.	R_{24} (mm)	1/50	1/25	1/10	1/5
Ciberang River									
Karian dam site	288	0.82				217	198	172	152
			1	B-24	96.3	(1.84)	(1.69)	(1.47)	(1.29)
Cisimeut Confluence	305	0.80				212	194	168	148
			1	B-24	96.3	(1.76)	(1.62)	(1.40)	(1.28)
Ciujung Confluence	789	0.63				205	185	157	135
			1 to 3	B-24	96.3	(1.34)	(1.21)	(1.03)	(0.88)
			4	B-38	108.3	(1.19)	(1.08)	(0.91)	(0.79)
Cisimeut River									
Ciberang Confluence	458	0.75				200	179	150	126
			2.3	B-24	96.3	(1.56)	(1.39)	(1.17)	(0.98)
Upper Ciujung River									
Ciberang Confluence	594	0.76				236	211	177	149
			5	B-28	80.7	(2.22)	(1.99)	(1.67)	(1.40)
			6.7	B-45	141.5	(1.27)	(1.13)	(0.95)	(0.80)
Ciujung River									
Rangkasbitung	1383	0.61				215	193	163	139
			1 to 3	B-24	96.3	(1.36)	(1.22)	(1.03)	(0.88)
			4	B-38	108.3	(1.21)	(1.09)	(0.92)	(0.78)
			5	B-28	80.7	(1.63)	(1.46)	(1.23)	(1.05)
			6.7	B-45	141.5	(0.93)	(0.91)	(0.70)	(0.60)
Rangkasbitung	1812	0.60				179	161	155	118
to Kragilan			8 to 12	B-36	100.9	(1.06)	(0.96)	(0.92)	(0.70)

Remarks: Subbasin No. : Ref. Fig. H-12
R_{24} : maximan 24 he point rainfall
R_{pro} : Probable daily rainfall by Thiessen Method
( ) : Coefficient of probable subbasin rainfall hyetograph
(= $a.R_{pro}/R_{24}$)
$r_{ave}(t) = r(t) \cdot (a \cdot Rpro/R_{24})$
r : denoted hourly rainfall (mm)

Table H-19 PROBABLE FLOOD DISCHARGE UNDER PRESENT CONDITION

(1) Estimated probable flood discharge by storage function

(Unit: m3/s)

Point	Return Period (years)			
	5	10	25	50
Kragilan	929	1063	1333	1439
Pamarayan	925	1114	1372	1582
Rangkasbitung	999	1216	1495	1728

(2) Estimated probable flood discharge by observed flood date (Gumbel Method)

(Unit: m^3/s)

Point	Return Period (years)				
	5	10	15	25	50
Kragilan	892	1013	1081	1165	1279
Rangkasbitung	852	1008	1096	1205	1351

Table H-20 EXPERIENCED ANNUAL MAXIMUM FLOOD DISCHERGE DATA AT KRAGILAN AND RANGKASBITUNG

Kragilan			Rangkasbitung		
Ranking	Year	Discharge (m^3/s)	Ranking	Year	Discharge (m^3/s)
1	80 81	1070.00	1	80 81	1150
2	73 74	905.20	2	78 79	772
3	75 76	860.99	3	77 78	712
4	71 72	834.48	4	76 77	697
5	70 71	771.07	5	75 76	688
6	76 77	764.17	6	82 83	665
7	74 75	736.80	7	71 72	637
8	69 70	694.57	8	79 80	590
9	82 83	678.00	9	73 74	552
10	72 73	639.60	10	74 75	534
11	79 80	607.31	11	72 73	510
12	78 79	517.88	12	81 82	222
13	81 82	439.00			

Table H-21

FLOOD DISCHARGE DISTRIBUTION OF CIUJUNG RIVER

Estimate Point	Basic High Water				After Flood regulation by Karian dam			
	Return Period (years)				Return Period (years)			
	5	10	25	50	5	10	25	50
Ciujung River								
Kragilan Bridge	1200 (1000)	1500 (1200)	1800 (1400)	2100 (1600)	950	1100	1300	1500
Pamarayan Weir	1100	1300	1600	1900	950	1100	1400	1600
Rangkasbitung	1100	1300	1600	1900	900	1100	1400	1600
Upper Ciujung River								
Rangkasbitung	550	700	950	1100	550	700	950	1100
Ciberang River								
Ciujung River Confluence	700	900	1100	1200	550	700	850	950
Cisimeut River Confluence	450	550	700	800	150	200	220	250
Karian dam Site	450	550	700	800	((140)) 450	((160)) 550	((190)) 700	((210)) 800
Cisimeut River								
Ciberang River Confluence	450	650	850	1000	450	650	850	1100

Remarks : ( ) ; under present condition of channel between Kragilan and Pamarayan

(( )); Karian dam outflow discharge

Table H-22 CALCULATION RESULT OF FLOOD REGULATION BY KARIAN DAM

(1) RELATION OF SPILLWAY CREST LENGTH AND FLOOD CONTROL EFFECT

(Under Flood of 50 year Return Period)

Iteme	Spillway Crest Length (m)				
	30	40	50	70	100
Inflow Discharge Qi $(m^3/5)$	800	800	800	800	800
Outflow Discharge Qo $(m^3/5)$	155	194	208	249	295
Qi - Qo	645	616	592	551	505
Overflow depth h (m)	1.88	1.74	1.62	1.46	1.29
Storage Volume V $(x\ 10^6 m^3)$	31.4	28.9	27.0	24.2	21.3
Disign Storage Volume 1.2V $(x\ 10^6 m^3)$	37.7	34.7	32.4	29.0	25.5

(2) RELATION OF PROBABLE FLOOD AND FLOOD CONTROL EFFECT

(Under Spillway Crest Length L = 50 m)

Item	Return Period (Years)			
	5	10	25	50
Inflow Peak discharge Qi (m^3/s)	450	550	690	800
Outflow peak discharge Qo (m^3/s)	140	160	190	210
Qi - Qo (m^3/s)	310	390	500	590
Storage Volume V $(x\ 10^6/m^3)$	19.6	21.8	24.9	27.0
Over flow depth h (m)	1.19	1.32	1.51	1.62

Table H-23 ALTERNATIVE PLAN OF RIVER IMPROVEMENT

Item	Case-1	Case-2	Case-3
Improvement Length (km)	21.5	22.9	25.0
Required Construction Main Works			
Dredging (x $10^3 m^3$)	559.9	559.9	1,052.5
Excavation (")	1,904.5	1,404.0	533.6
Embankment (")	624.0	674.3	534.8
Land Acquisition and Compensation			
Land	129.4	125.9	60.9
Houses	121	99	99
Construction Cost (Rp. x 10^6)			
Direct Construction Cost	11,241	10,293	10,254
Land Acquisition & Compensation	443	404	397
Administration & Engineering Survices	1,415	1,299	1,332
Physical Contingency	1,965	1,801	1,798
Sub-total	15,064	13,797	13,781
Prince Contingency	7,562	6,896	6,479
Total	22,626	20,693	20,260
Benefit (Rp. x 10^6/yr)	2,570	2,570	2,570
EIRR	10.1	10.5	10.5

Table H-24 REQUIRED CONSTRUCTION WORKS FOR CASE-2

Item	Unit	Ciujung River			Ciberang	Upper Ciujng	Total
		Pamarayan Weir to No.85 (a)	No.85 to No.65 (Short Cut) (b)	No.65 to No.55 (c)	No.54 to No.40 (c)	No.58 to No.46 (e)	
Distance	m	8351	3530	3283	3300	4410	22,874
Dredging	x10^3m^3	559.9	-	-	-	-	559.9
Excavation (1)	"	141.9	480.0	100.1	-	88.5	810.5
" (2)	"	-	580.0	-	-	-	580.0
" (3)	"	-	-	8.9	-	4.6	13.5
Embankment (1)	"	-	-	-	69.1	-	69.1
" (2)	"	223.6	-	78.7	-	-	302.3
" (3)	"	-	248.8	-	-	54.1	302.9
Sod facing	x10^3m^2	131.1	96.7	64.9	41.2	36.9	370.8
Wet masonary	"	-	-	2.8	-	-	2.8
Dry masonary	"	-	47.4	-	-	-	47.4
Gabion	x10m^{3}m^3	3.9	-	1.1	1.1	0.6	6.7
Groyn	pc	105	-	30	30	15	180.0
Drainage	x10^3m	4.2	7.0	1.6	1.5	2.2	16.5
Culvert Box							
I (1.5m x 1.5m x 1)	pc	-	-	-	1	-	1
II (2.5m x 2.0m x 2)	"	-	-	-	1	-	1
III (3.0m x 3.0m x 2)	"	1	-	1	-	-	2
Inspection Road	x10^3m	16.7	7.1	6.4	6.2	8.7	45.1

Remarks: Excavation (1); common , Embankment (1); borrowed materials (L = 1.0 km)
" (2); common, for short cut, " (2) " (L = o.5 km)
" (3); softrock , " (3) excavated materials

Table H-25 REQUIRED LAND ACQUISITION AND COMPENSATION FOR CASE-2

Item	Ciujung River			Ciberang River	Upper Ciujung River	Total
	Pamarayan Weir to No.85	Short Cut No.85 to No.64	Rangkasbitung No.64 to No.55	Rangkasbitung No.54 to No.40	No.58 to No.43	
(1) Land (ha)						
Paddy field	2.84	1.46	0.29	0.21	0.39	5.19
Upland	53.97	27.78	5.50	4.23	7.45	98.93
Forest and field	4.37	3.67	0.72	0.55	0.98	10.29
Settlement	0.53	-	0.43	1.80	0.68	3.44
Others	5.65	1.46	0.29	0.26	0.39	8.05
Total	67.36	34.37	7.23	7.05	9.89	125.90
(2) Compensation (nos)						
Permanent house	1	-	6	2	-	9
Semi permanent house	5	-	19	4	2	30
Emergency house	10	-	39	7	4	60
Total	16	-	64	13	6	99

Table H-26 RIVER CONSTRUCTION COST (CASE-2)

Unit :10^6

Item	Unit	Q'ty	F.C.	L.C.	Total
1. Direct Construction Cost			6,320	3,973	10,293
Preparatry works/			468	296	764
Civil works					
Dredging	10^3m^3	559.9	2,077	487	2,564
Excavetion (1)	10^3m^3	810.5	314	400	714
Excavetion (2)	10^3m^3	580.0	950	664	1,614
Excavetion (3)	10^3m^3	13.5	22	19	41
Embankment (1)	10^3m^3	69.1	187	114	301
Embankment (2)	10^3m^3	302.3	583	353	936
Embankment (3)	10^3m^3	302.9	159	108	267
Sodfacing	10^3m^3	370.8	-	70	70
Wet masonary	10^3m^3	2.8	40	34	73
Dry masonary	10^3m^3	47.4	434	379	812
Cabion	10^3m^3	6.7	56	146	202
Groyn	PC	180.0	75	235	310
Drainage ditch	10^3m^3	16.5	75	94	169
Culvbert Box					
I (1.5mx1.5mx1)	PC	1.0	34	7	41
II (2.5mx2.0mx1)	PC	1.0	53	35	88
III (3.0mx3.0mx2)	PC	2.0	116	77	193
Inspection Road	10^3m^3	45.1	145	121	266
Miscellaneous			532	334	866
2. Land Acquisition and Compensation			-	404	404
3. Administration and Engineering Services			949	350	1,299
4. Physical Contingency			1,091	710	1,881
Total			8,360	5,437	13,797
6. Price Contingency			2,433	4,463	6,896
Grand Total			10,793	9,900	20,693

Table H-27(1) ANNUAL DISBURSMENT SCHEDULE OF RIVER IMPROVEMENT COST (CASE-2)

(Unit : Rp. 10^6)

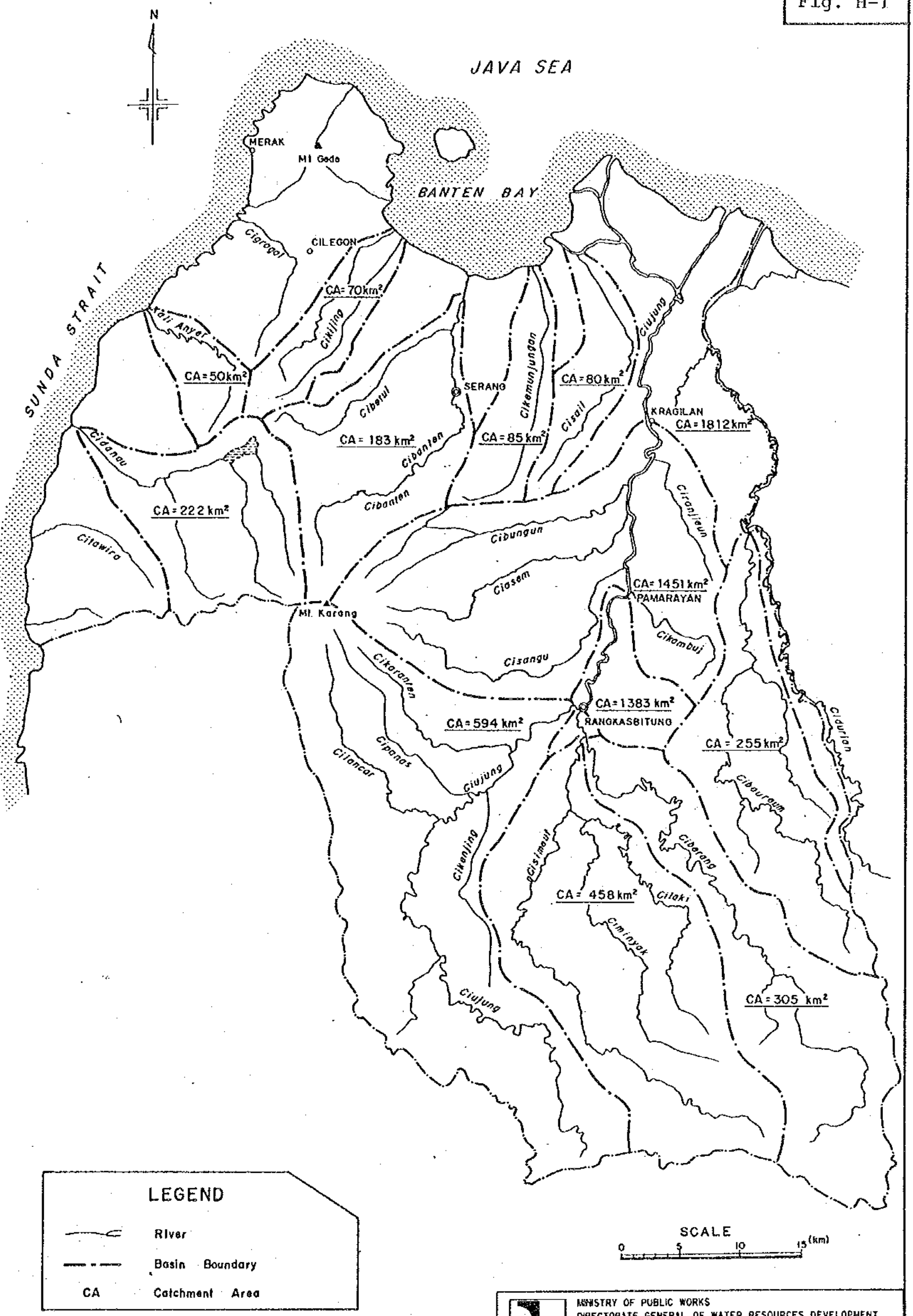
	Total		1986		1987		1988		1989		1990		1991	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Direct Construction Cost	6320	3793					970	576	2180	1380	2421	1568	749	449
2. Land Acquisition		404				211	-	112	-	31	-	-	-	-
3. Administration and Engineering Services	949	350	395	35	198	42	55	37	123	76	136	76	42	32
4. Physical Contingency	1091	710	76	38	38	48	150	104	337	218	374	232	116	70
Total	8360	5437	471	123	236	301	1175	829	2640	1755	2931	1878	907	551
5. Price Contingency	2433	4463	48	31	37	122	253	475	729	1388	997	1830	369	667
Grand Total	10793	9900	519	154	273	423	1428	1304	3369	3093	3928	3708	1276	1218

Table H-27(2) ANNUAL DISBURSMENT SCHEDULE OF SHARED KARIAN DAM CONSTRUCTION COST BY FLOOD CONTROL SECTER

(Unit : Rp. 10^6)

	Total		1986		1987		1988		1989		1990		1991	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Direct Construction Cost	5523	3472	-	-	-	-	848	503	1905	1206	2116	1371	654	392
2. Land Acquisition	-	343	-	-	-	180	-	95	68	-	-	-	-	-
3. Administration of Engineering Services	829	305	345	74	173	37	48	32	107	66	119	68	37	28
4. Physical Contingency	953	618	66	33	33	42	131	90	295	190	327	202	101	61
Total	7305	4738	411	107	206	259	1027	720	2307	1530	2562	1641	792	481
5. Price Contingency	2125	3891	42	27	32	105	221	413	637	1166	871	1598	322	582
Grand Total	9430	3629	453	134	238	364	1248	1133	2944	2696	3433	3239	1114	1063

Fig. H-1



MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
FEASIBILITY STUDY ON KARIAN
MULTIPURPOSE DAM CONSTRUCTION PROJECT

River Basin Around Project Area

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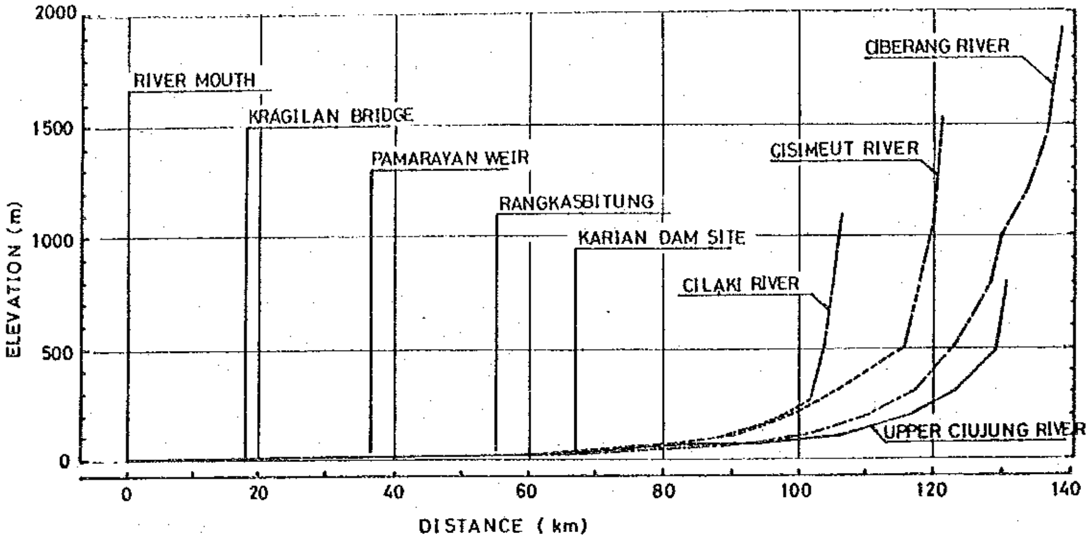
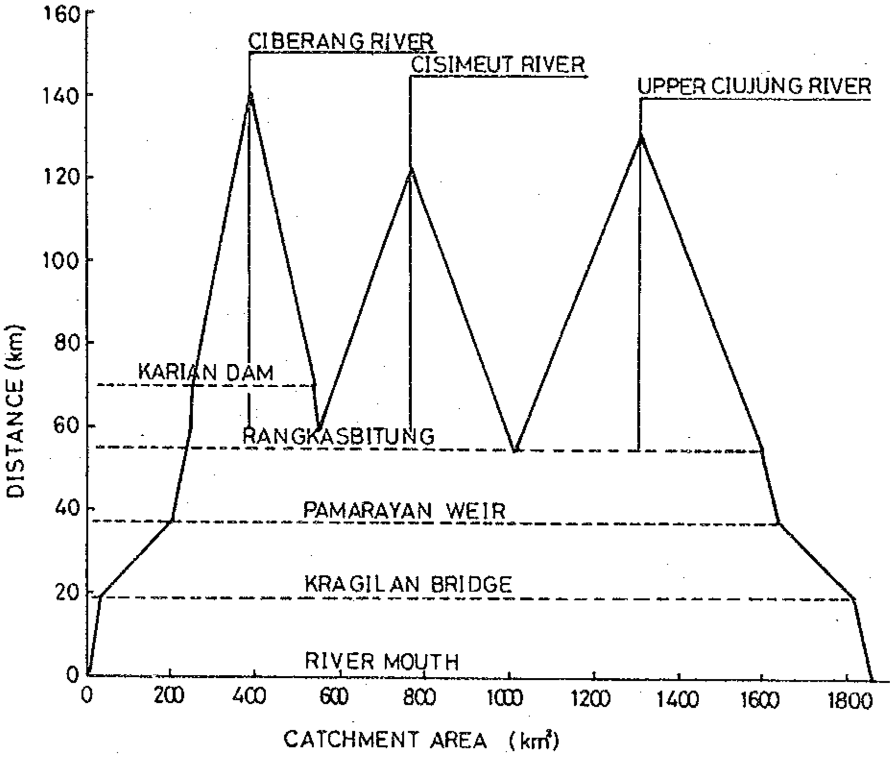
Fig. H-2

(1) PROFILE OF CIUJUNG RIVER BASIN



(2) CIUJUNG RIVER BASIN DIAGRAM



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FEASIBILITY STUDY ON KARIAN
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(1) Profile of Ciujung River Basin
(2) Ciujung River Basin Diagram

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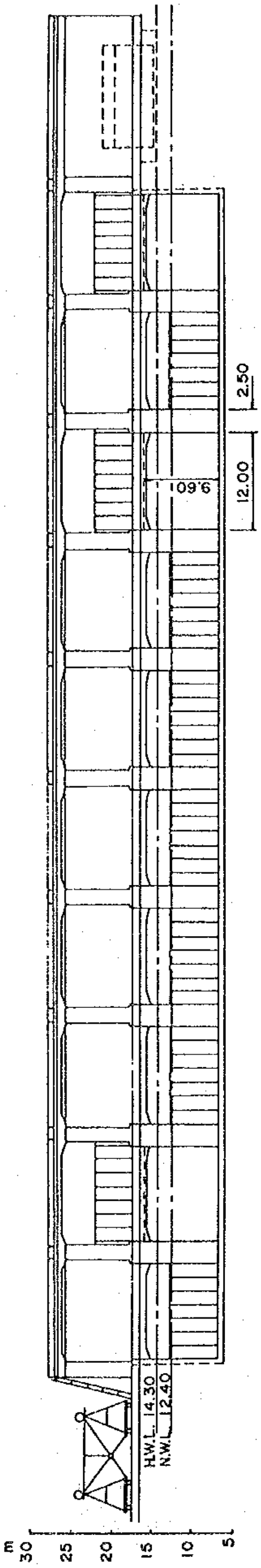
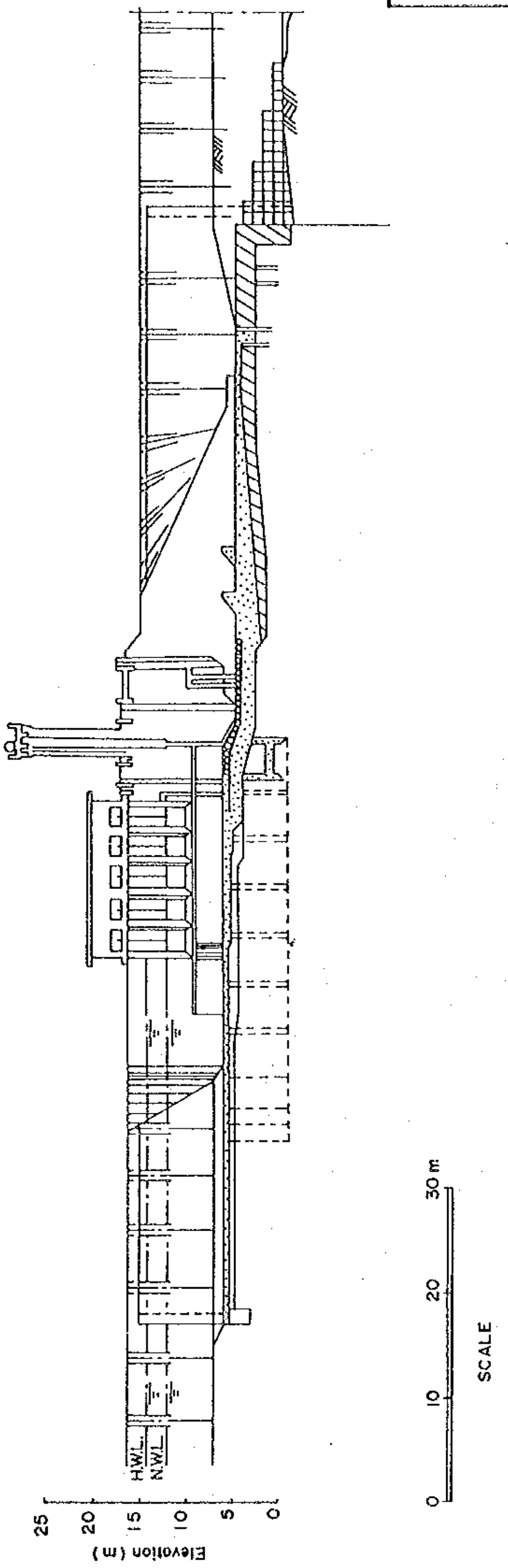
Fig. H-3





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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Pamarayan Weir

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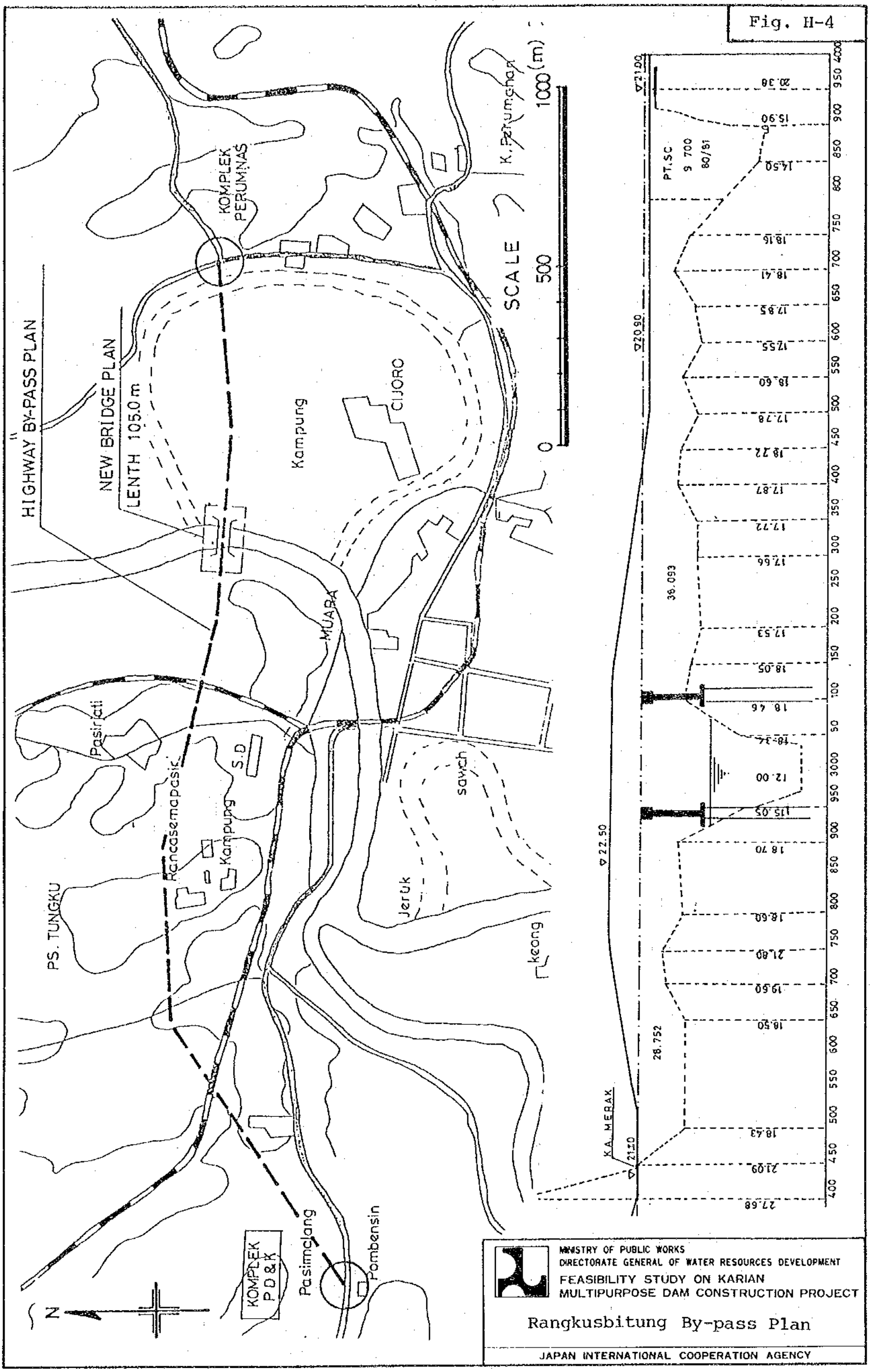
Fig. H-4



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FEASIBILITY STUDY ON KARIAN MULTIPURPOSE DAM CONSTRUCTION PROJECT

Rangkusbitung By-pass Plan

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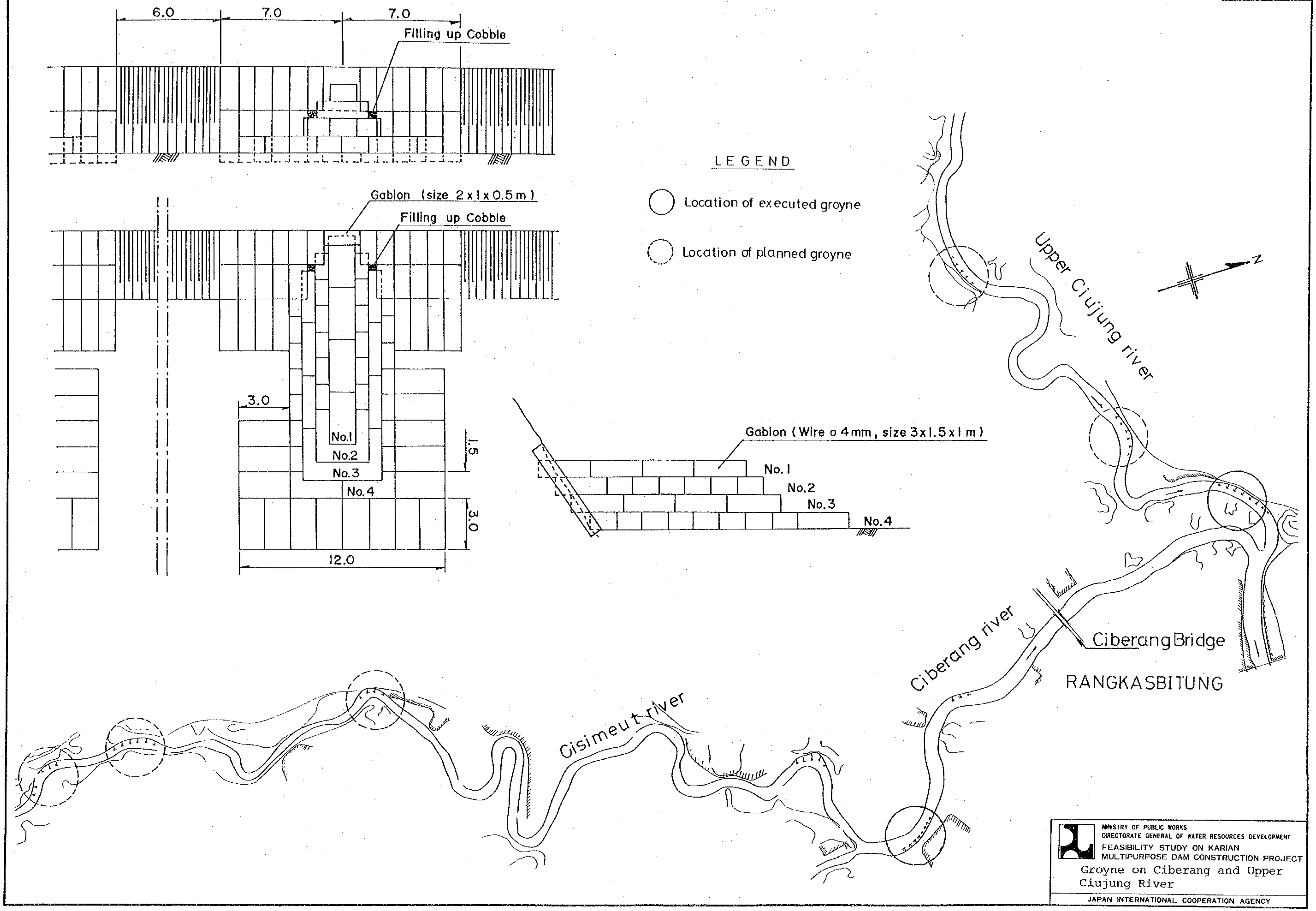
Fig. H-5



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Groyne on Ciberang and Upper Ciujung River

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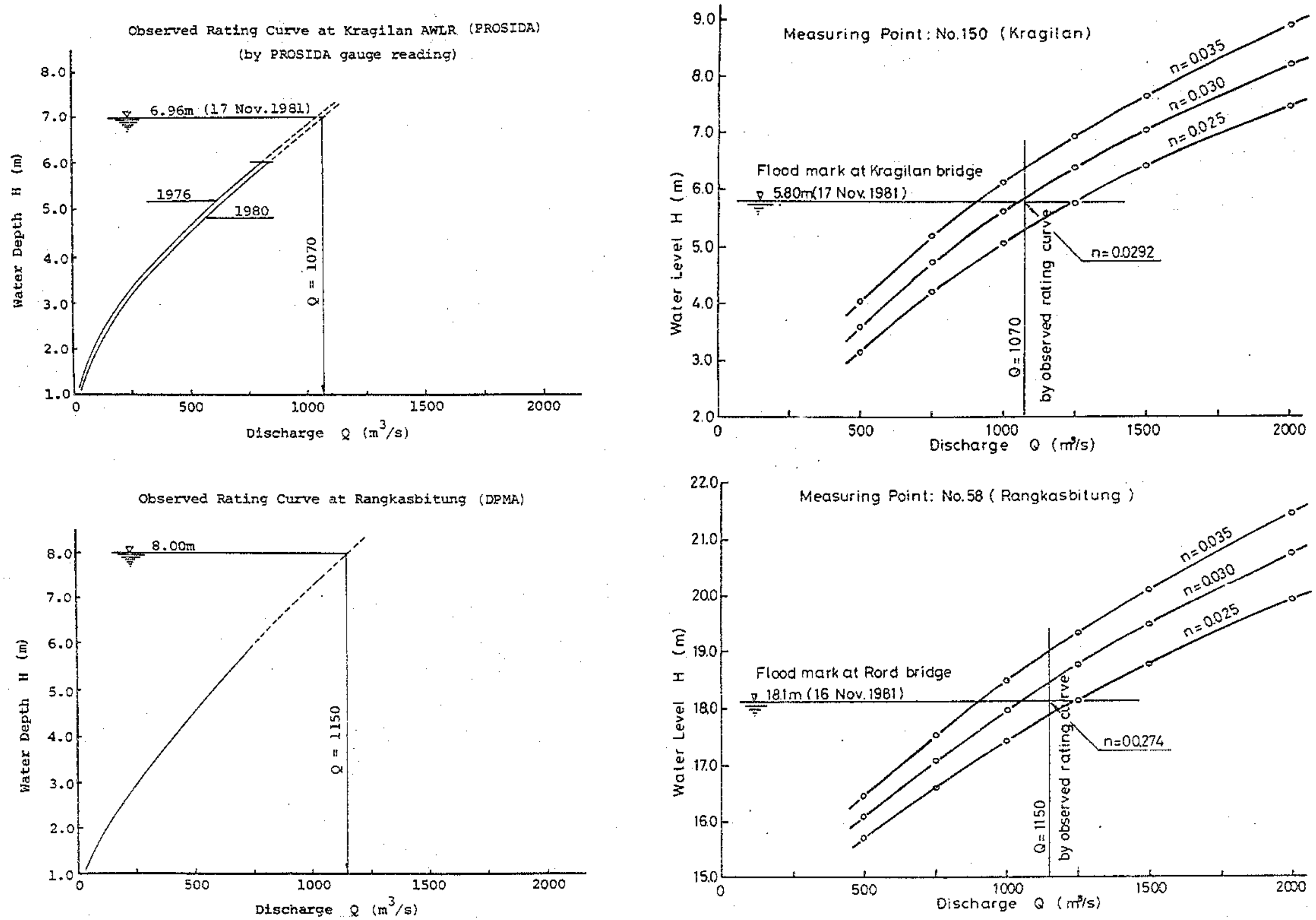
Fig. H-6



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Rating Curve and Manning's Roughness Coifficient by Nov. 1981 Flood

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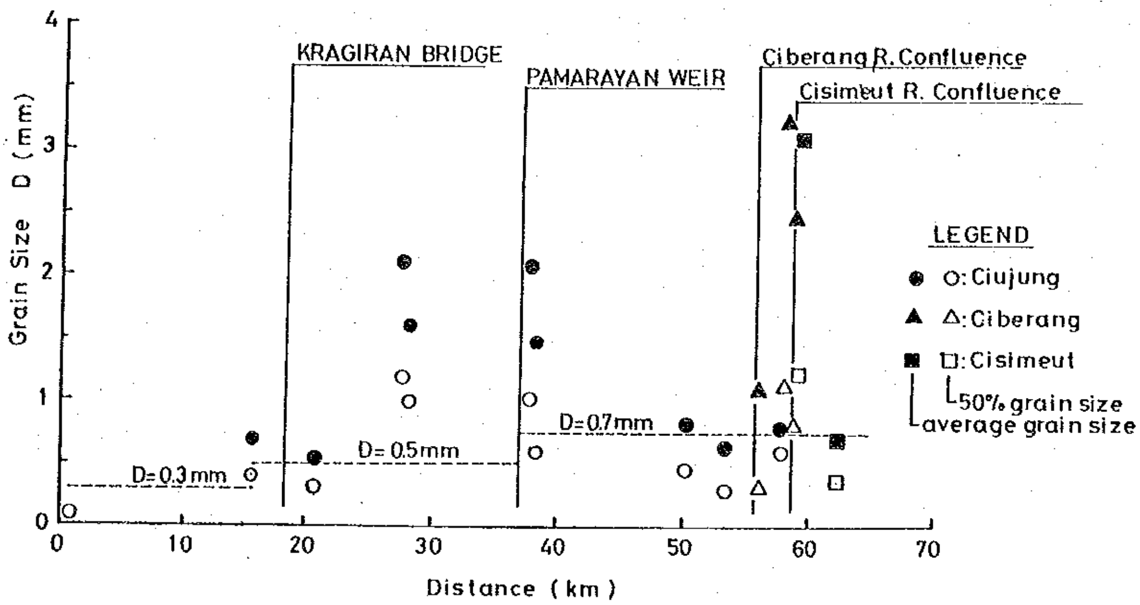
Fig. H-7



SUMPLE NO.	DISTANCE OF FROM TO RIVER MOUTH X(km)	D50/1 (mm)	Dm/2 (mm)	Pm/3 (%)
CIUJUNG RIVER				
U-11	15.7	0.4	0.7	76.2
U-8	20.8	0.3	0.5	89.9
U-6	21.0	0.3	0.5	86.5
U-5	27.5	1.3	2.1	89.5
U-10	27.9	1.0	1.6	73.3
U-4	37.4	1.0	2.1	84.9
U-7	38.2	0.6	1.5	78.0
U-3	43.5	0.5	0.8	79.3
U-2	53.1	0.3	0.6	80.7
UPPER CIUJUNG RIVER				
U-1	58.0	0.4	0.8	79.2
CIBERANG RIVER				
B-3	56.5	0.35	1.1	86.3
B-2	58.0	1.0	3.2	78.8
B-1	59.0	0.7	2.5	78.8
CISIMEUT RIVER				
S-1	59.0	1.5	3.1	73.2
S-2	62.5	0.4	0.7	87.2

REMARKS /1; 50% grain size
/2; AVERAGE GRAIN SIZE
/3; PARCENTAGE OF AVERAGE GRAIN SIZE

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Profile of Ciujung River Bed Materials

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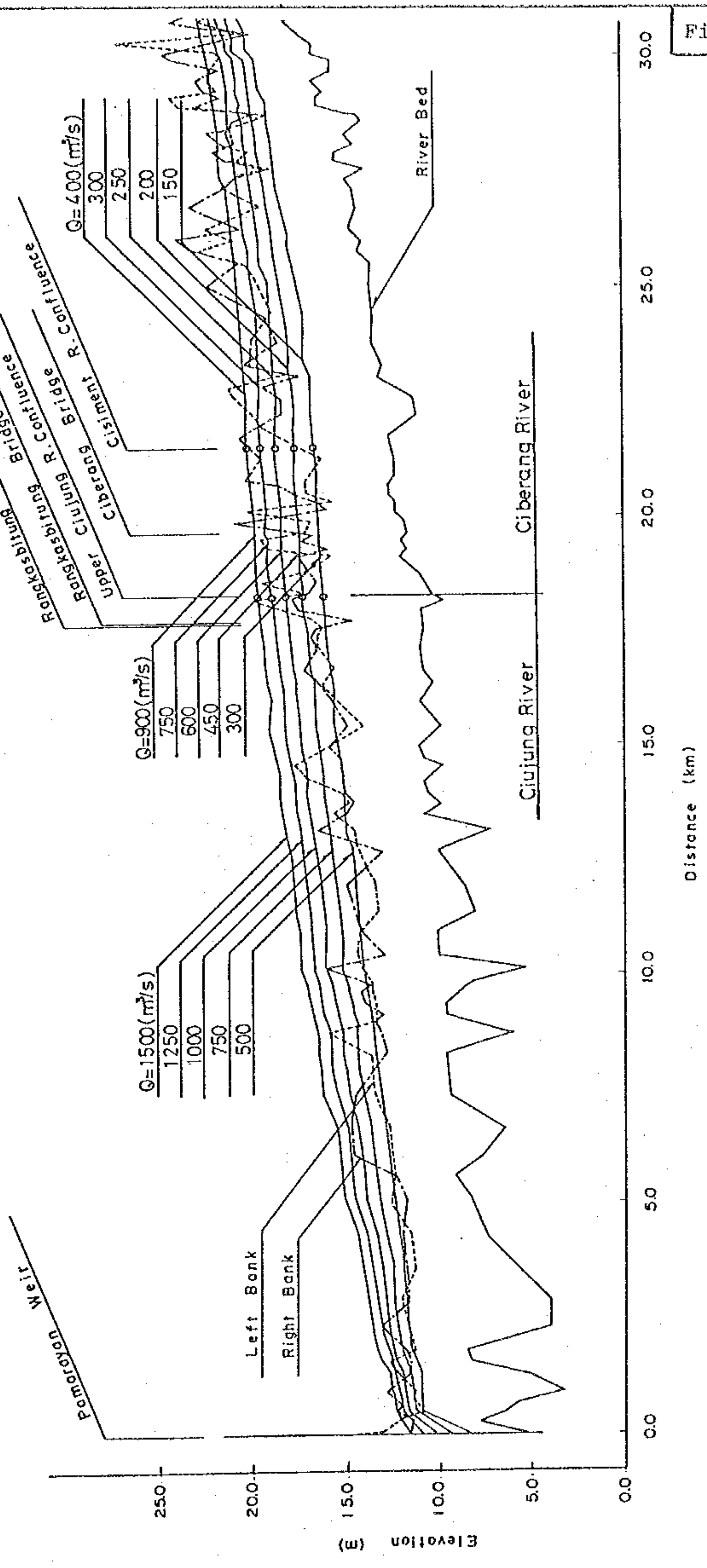
Fig. H-8(1)

(1) PRESENT LONGITUDINAL WATER LEVEL PROFILE OF CIUJUNG RIVER



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Present Longitudinal Water Level
Profile of Ciujung River

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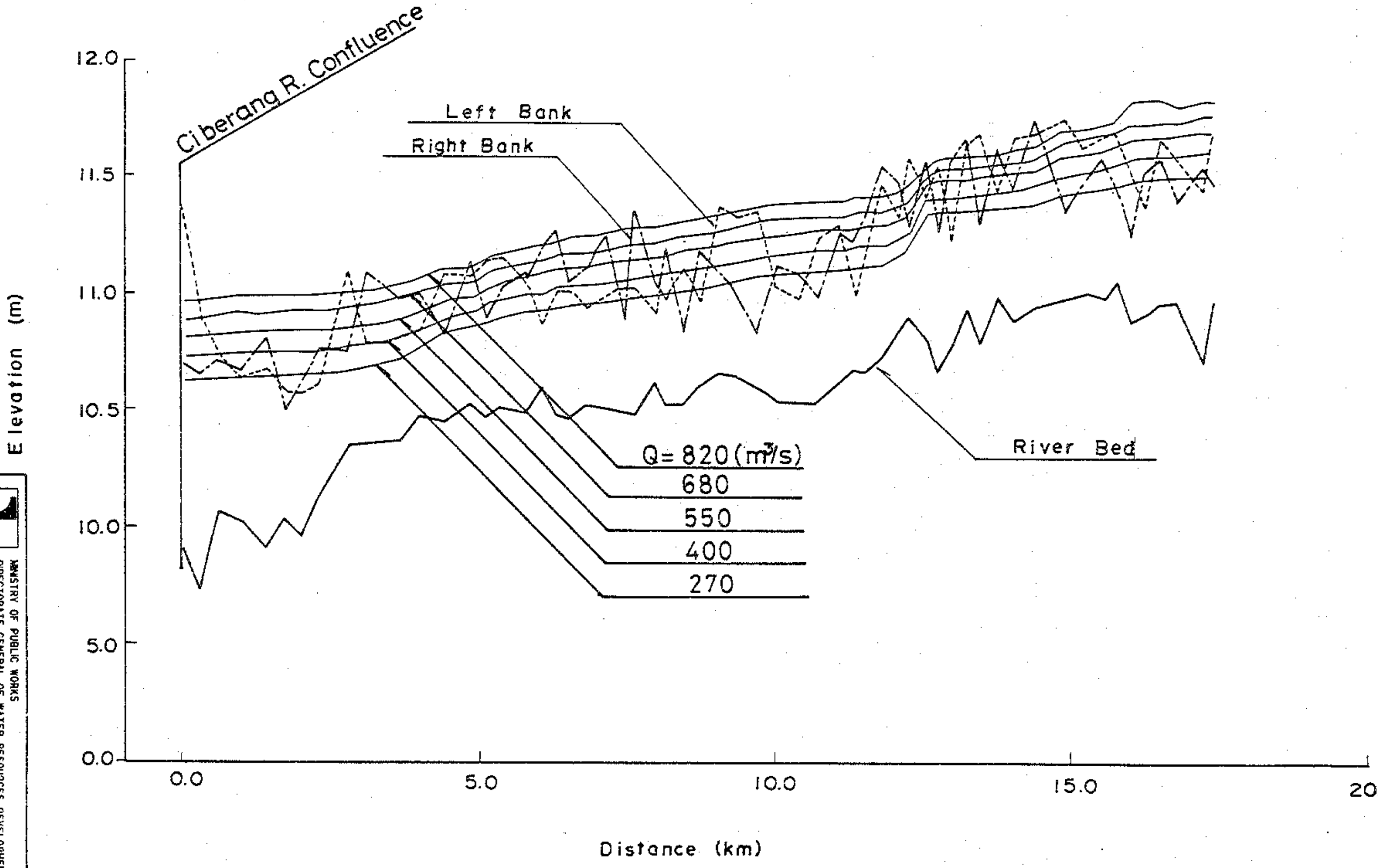
Fig. H-8(2)

(2) PRESENT LONGITUDINAL WATER LEVEL PROFILE OF UPPER CIUJUNG RIVER



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Present Longitudinal Water Level Profile of Upper Ciujung River

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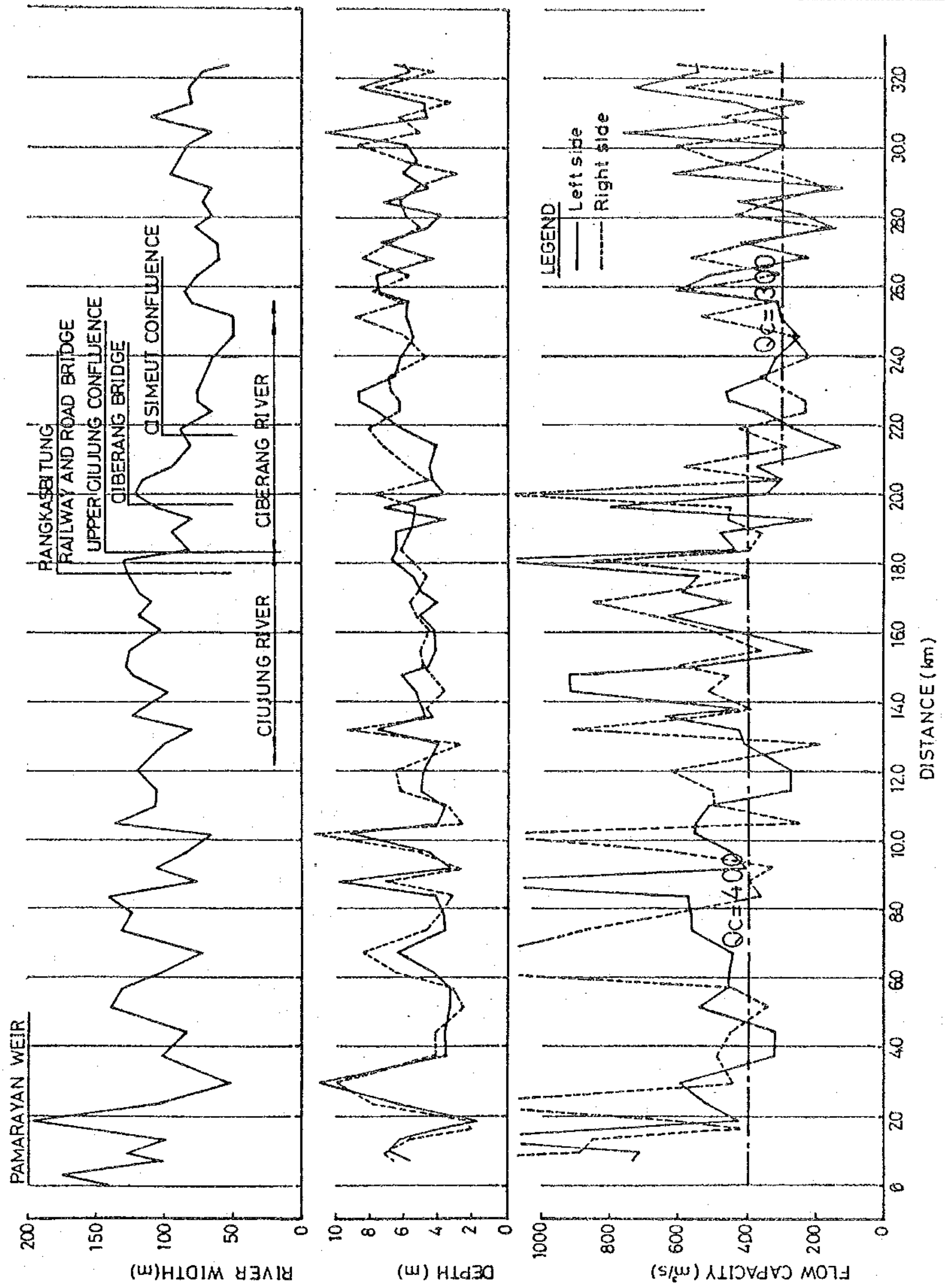
Fig. II-9(1)



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FEASIBILITY STUDY ON KARIAN
MULTIPURPOSE DAM CONSTRUCTION PROJECT

Flow Capacity and Characteristics of Ciujung River

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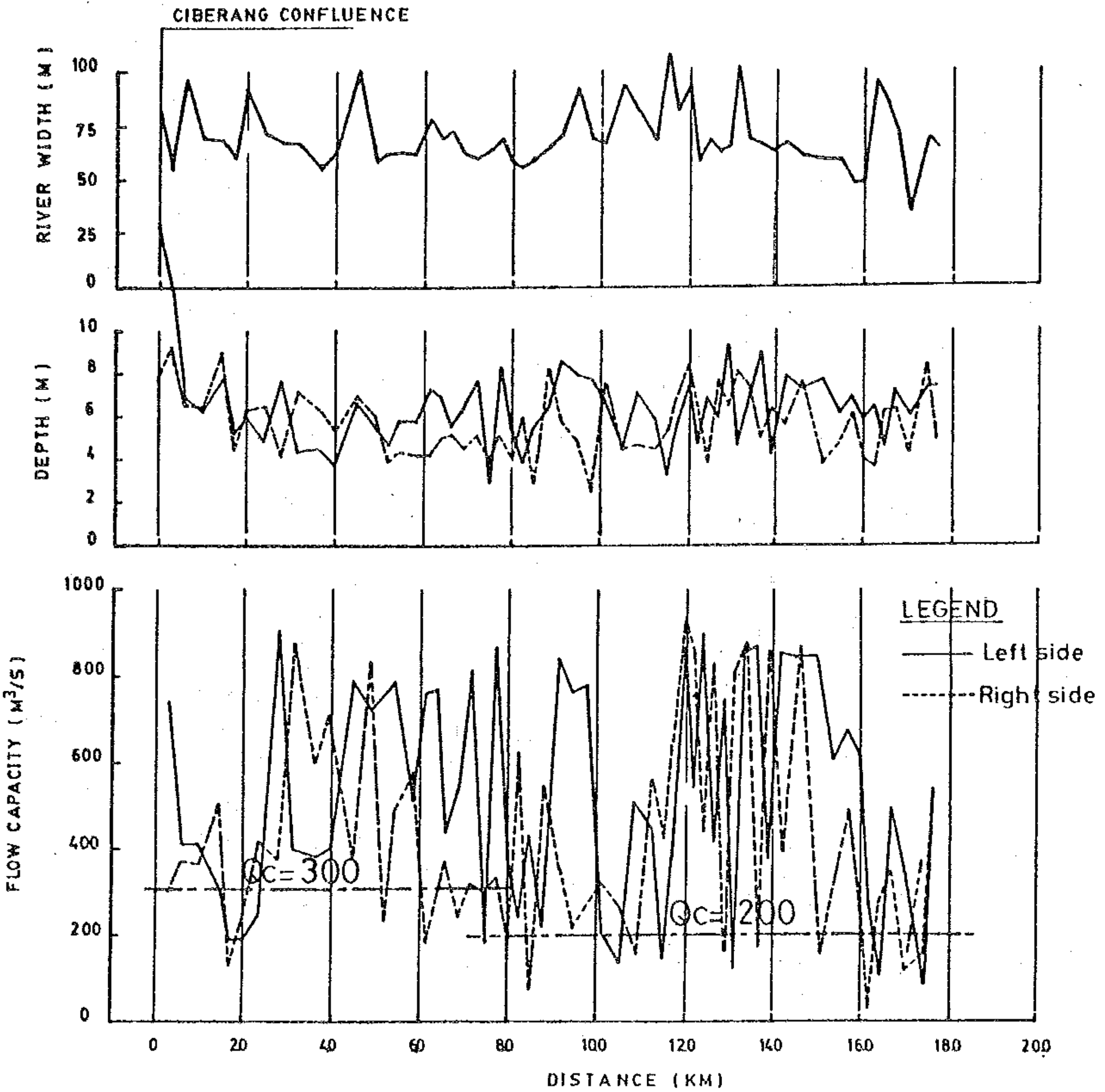
Fig. H-9(2)



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Flow Capacity and Characteristics
of Upper Ciujung River

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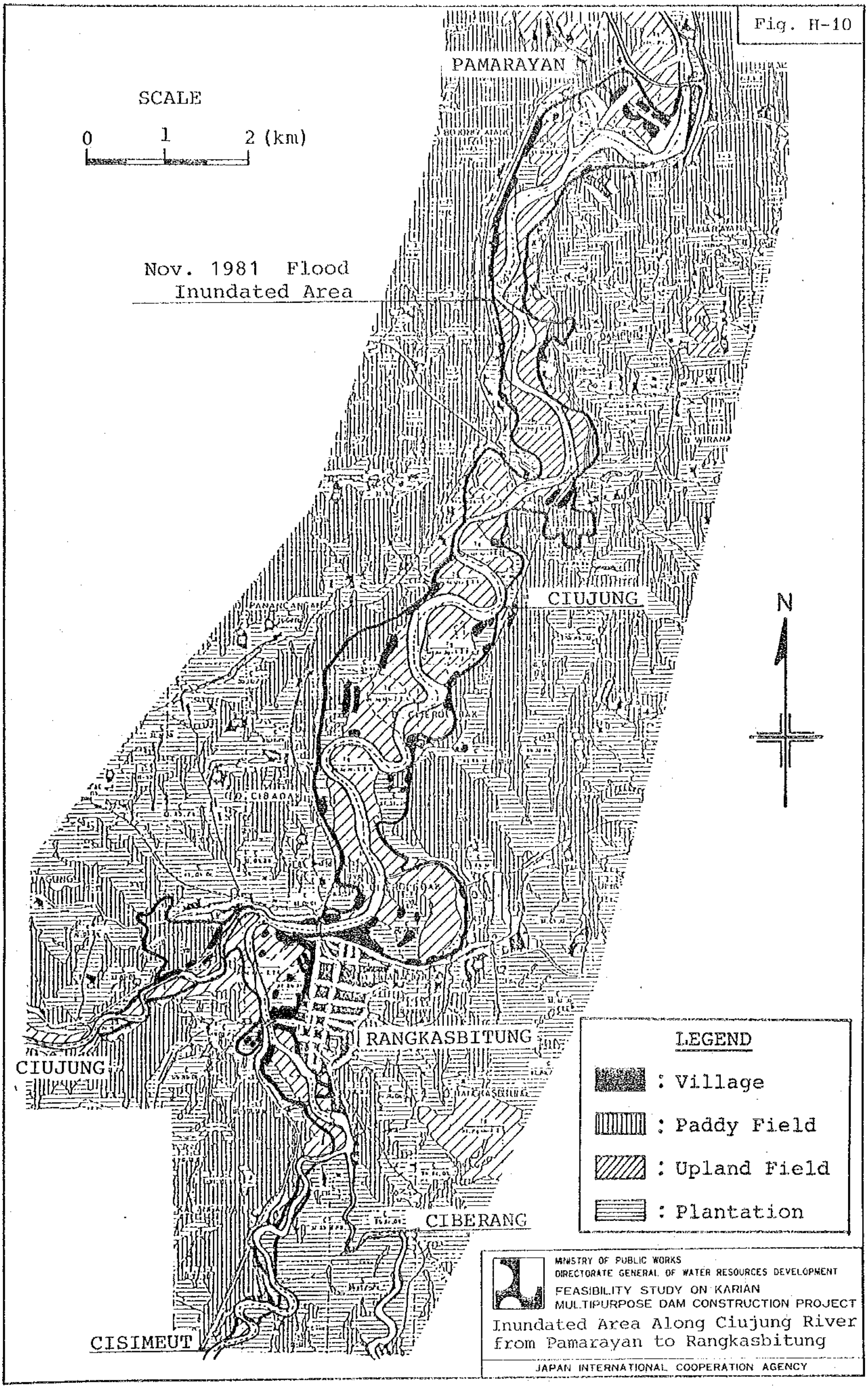
Fig. H-10



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Inundated Area Along Ciujung River from Pamarayan to Rangkasbitung

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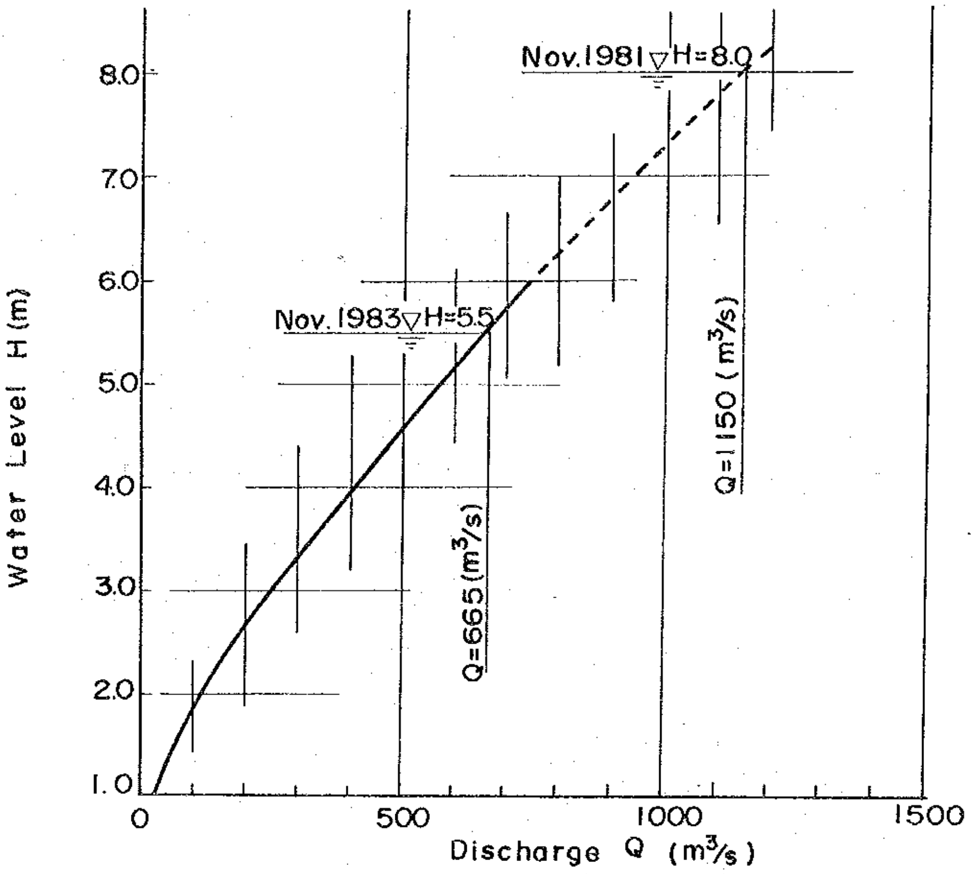
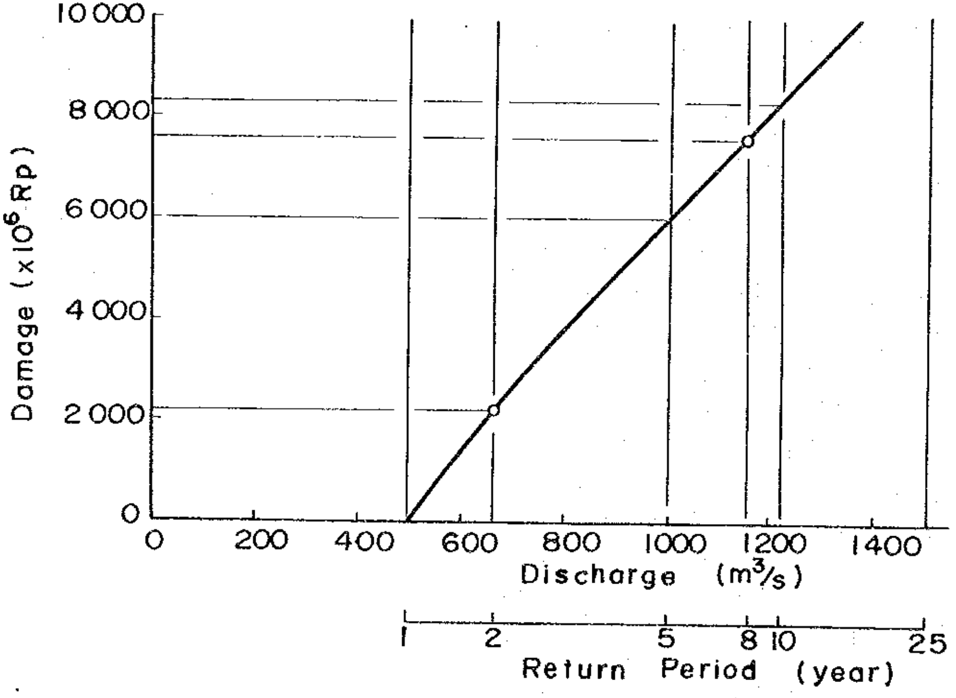
Fig. H-11

(1) OBSERVED RATING CURVE AT RANGKASBITUNG (DPMA)



(2) RELATION BETWEEN FLOOD DISCHARGE AND DAMAGE

(Upstream from Pamarayan)



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FEASIBILITY STUDY ON KARIAN
MULTIPURPOSE DAM CONSTRUCTION PROJECT

Relation between Flood Discharge and Damage

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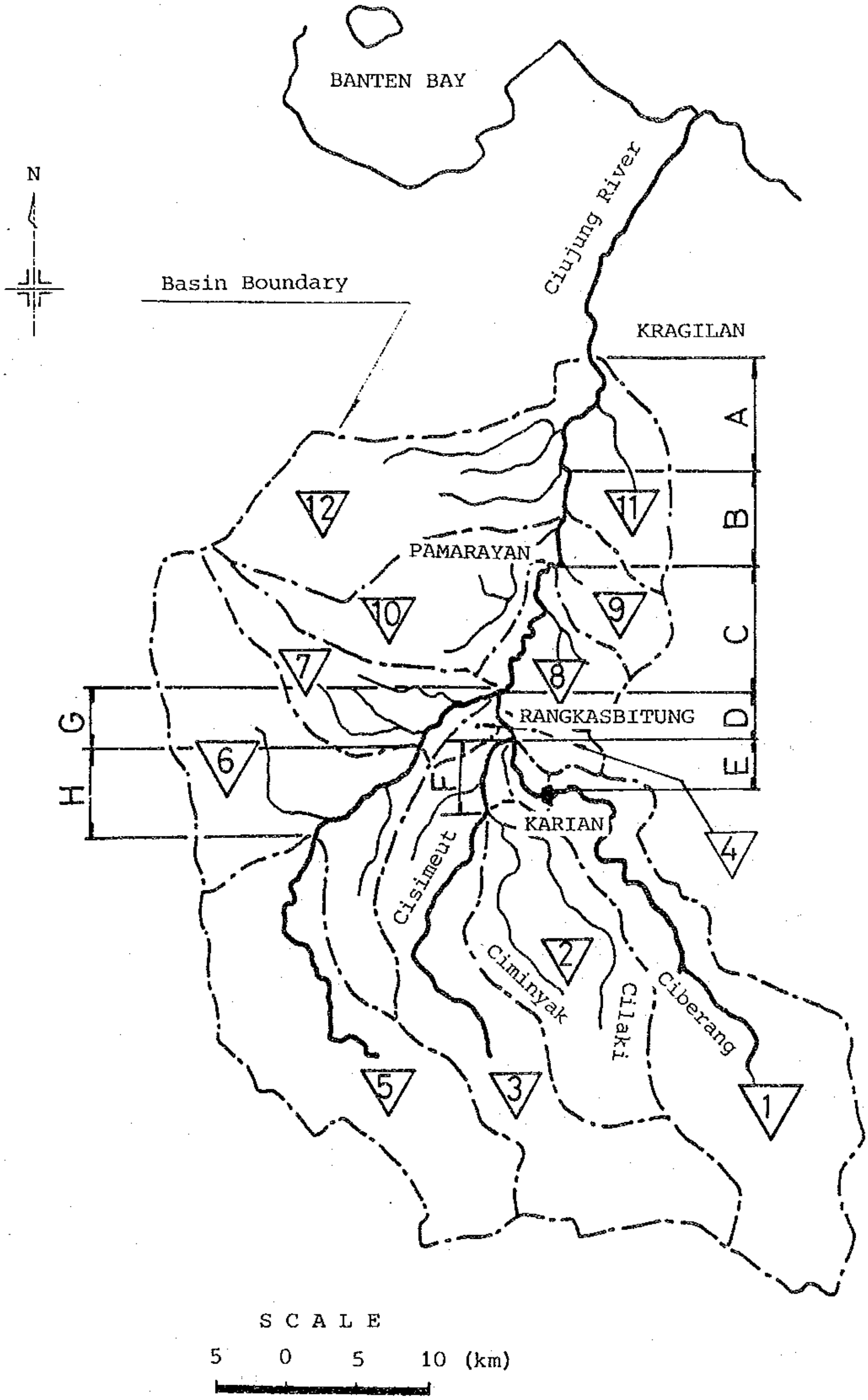
Fig. H-12



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Subbasin and Channel for Runoff Analysis

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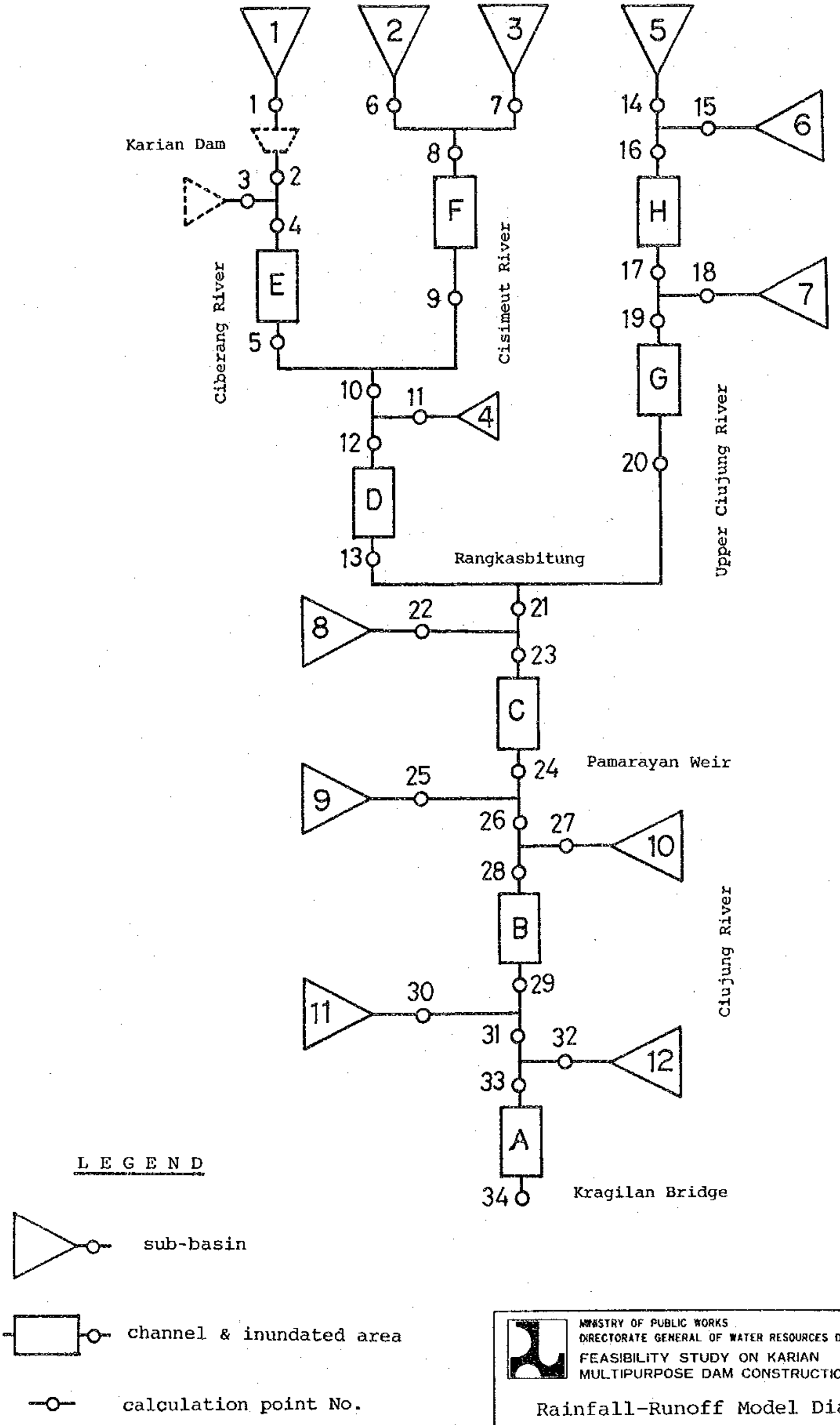
Fig. H-13



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Rainfall-Runoff Model Diagram

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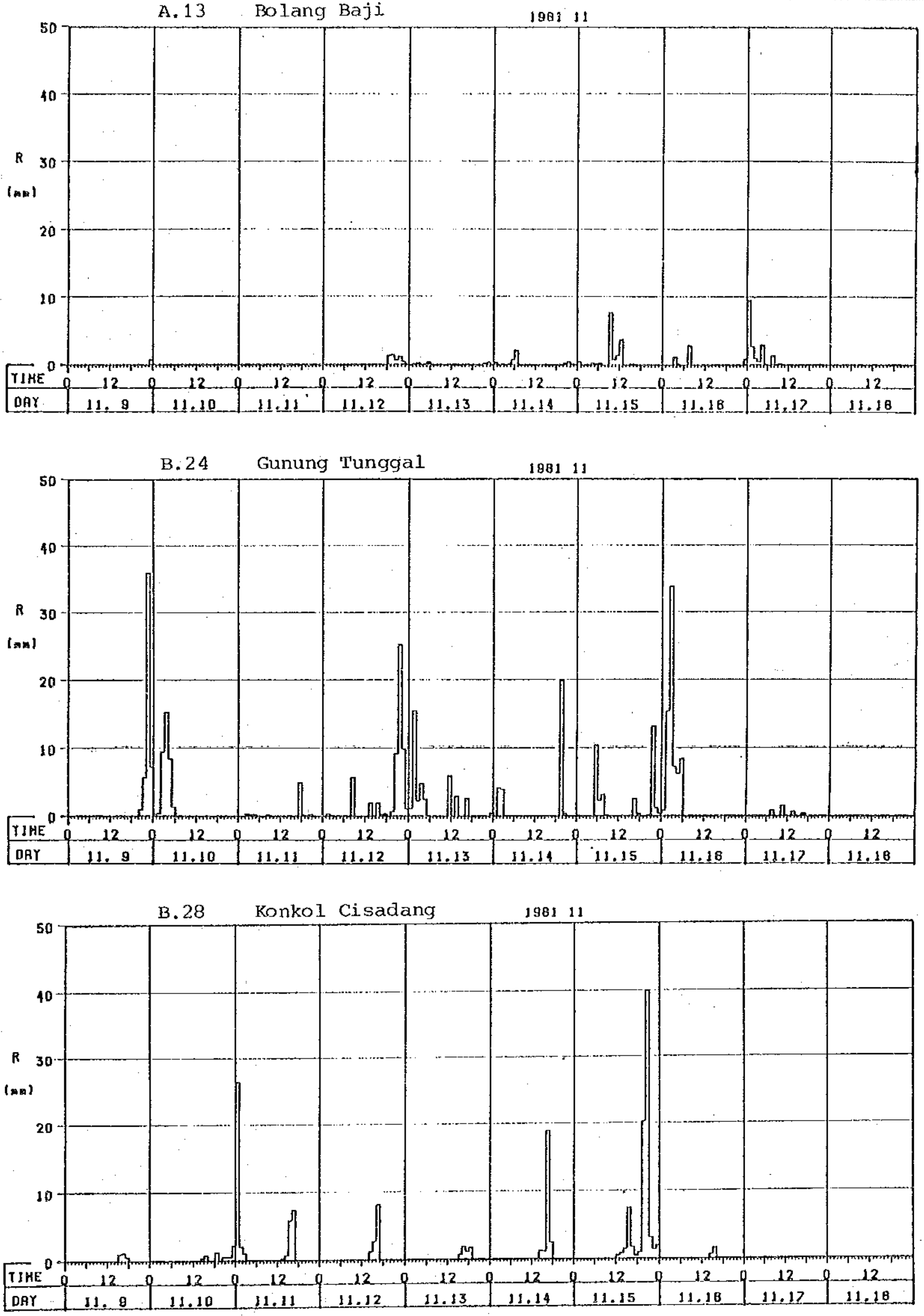
Fig. H-14(1)



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FEASIBILITY STUDY ON KARIAN
MULTIPURPOSE DAM CONSTRUCTION PROJECT

Hourly Rainfall data
in November 1981

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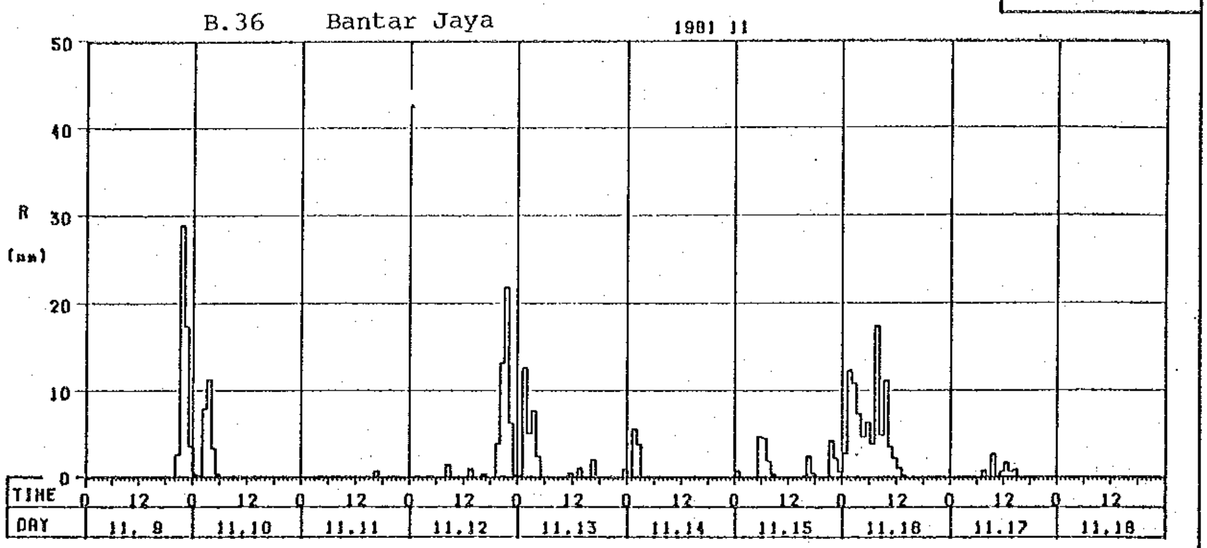
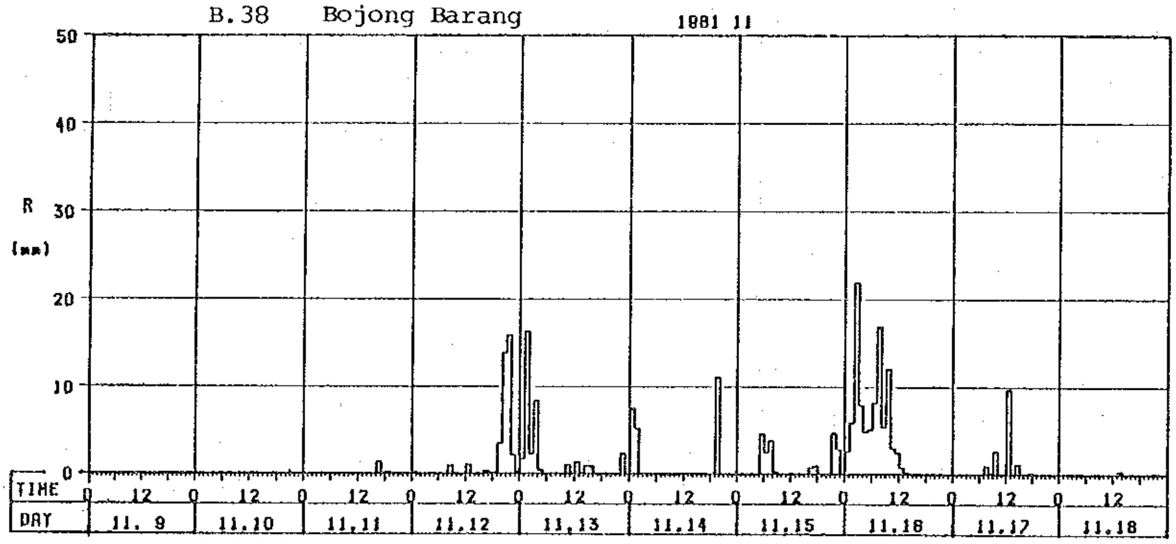
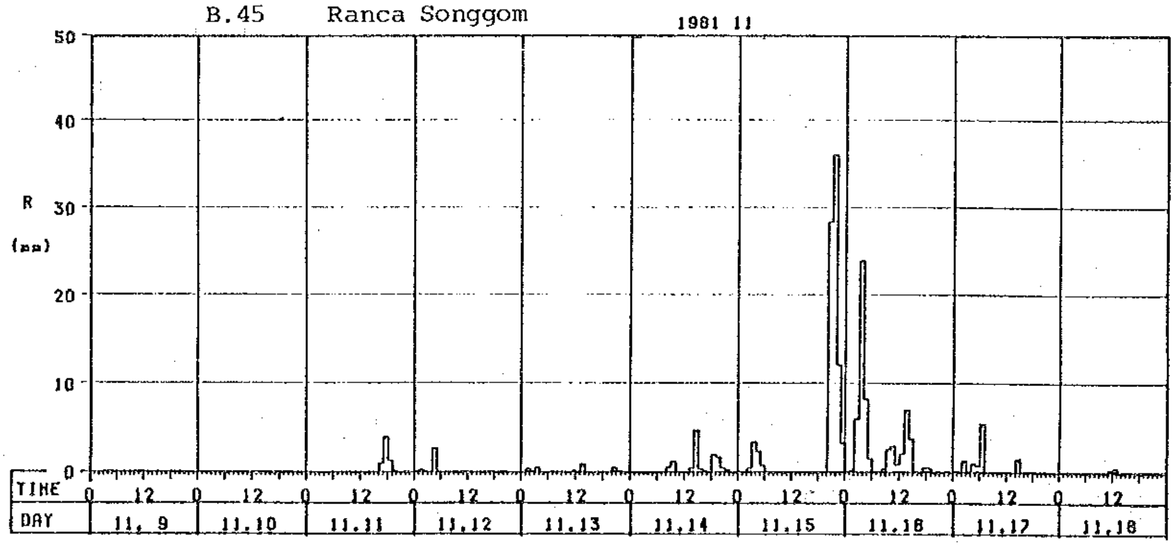
Fig. H-14(2)


B.36 Bantar Jaya


B.38 Bojong Barang


B.45 Ranca Songgom

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FEASIBILITY STUDY ON KARIAN
MULTIPURPOSE DAM CONSTRUCTION PROJECT

Hourly Rainfall data
in November 1981

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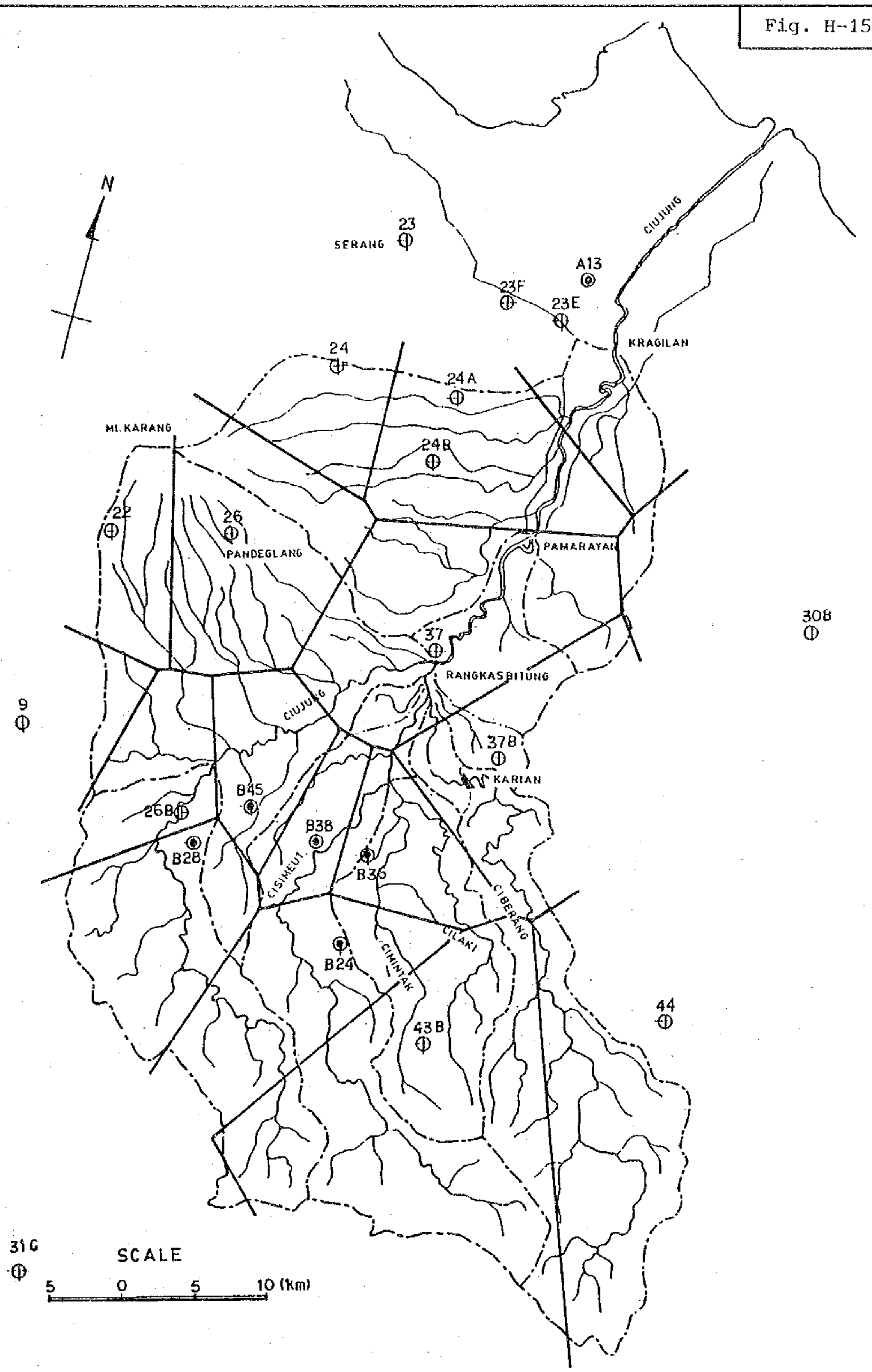
Fig. H-15



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Thiessen Plygon in
Noveber 1981 Storm

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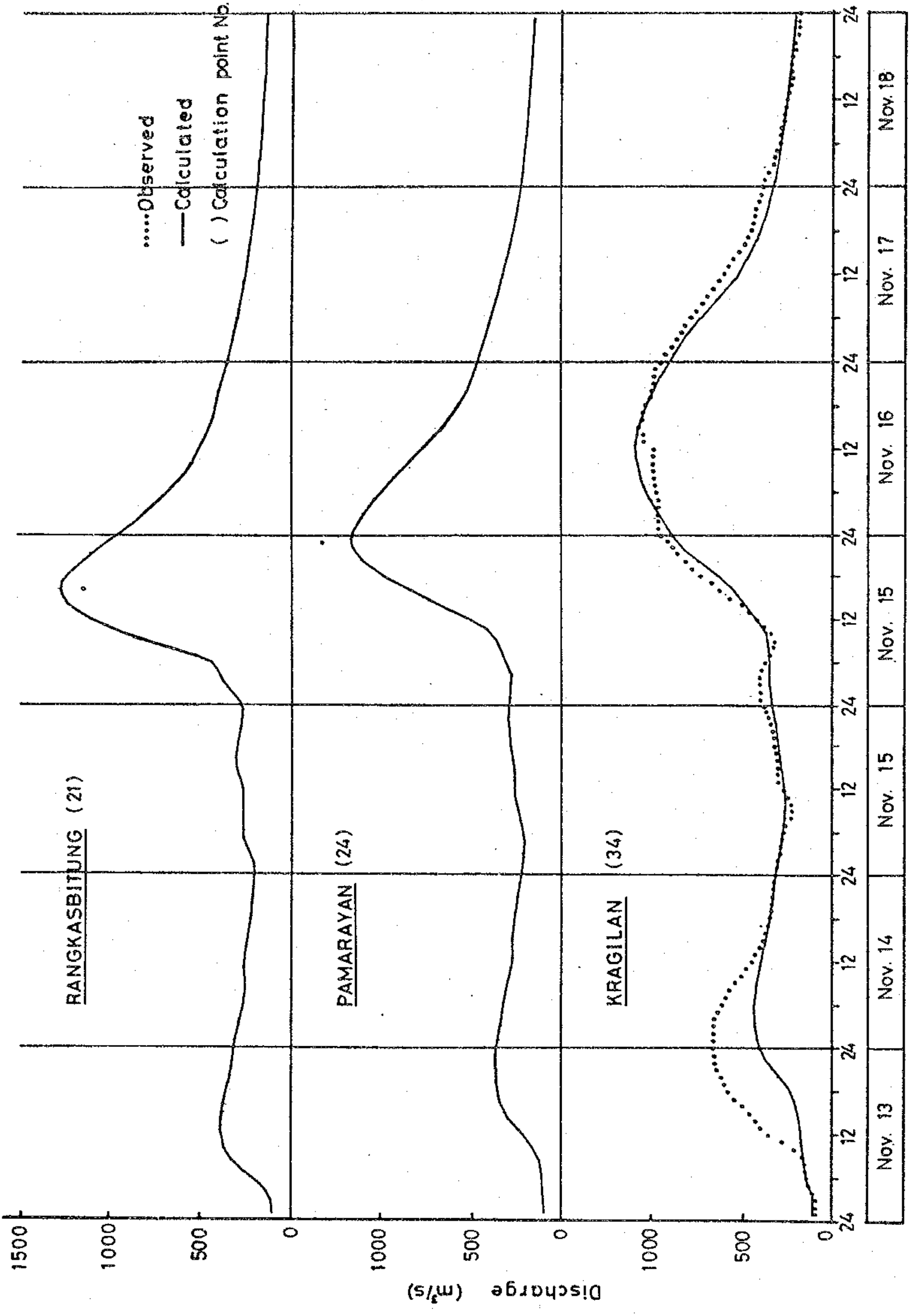
Fig. H-16



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Discharge Hydrograph
of Nov. 1981 Flood

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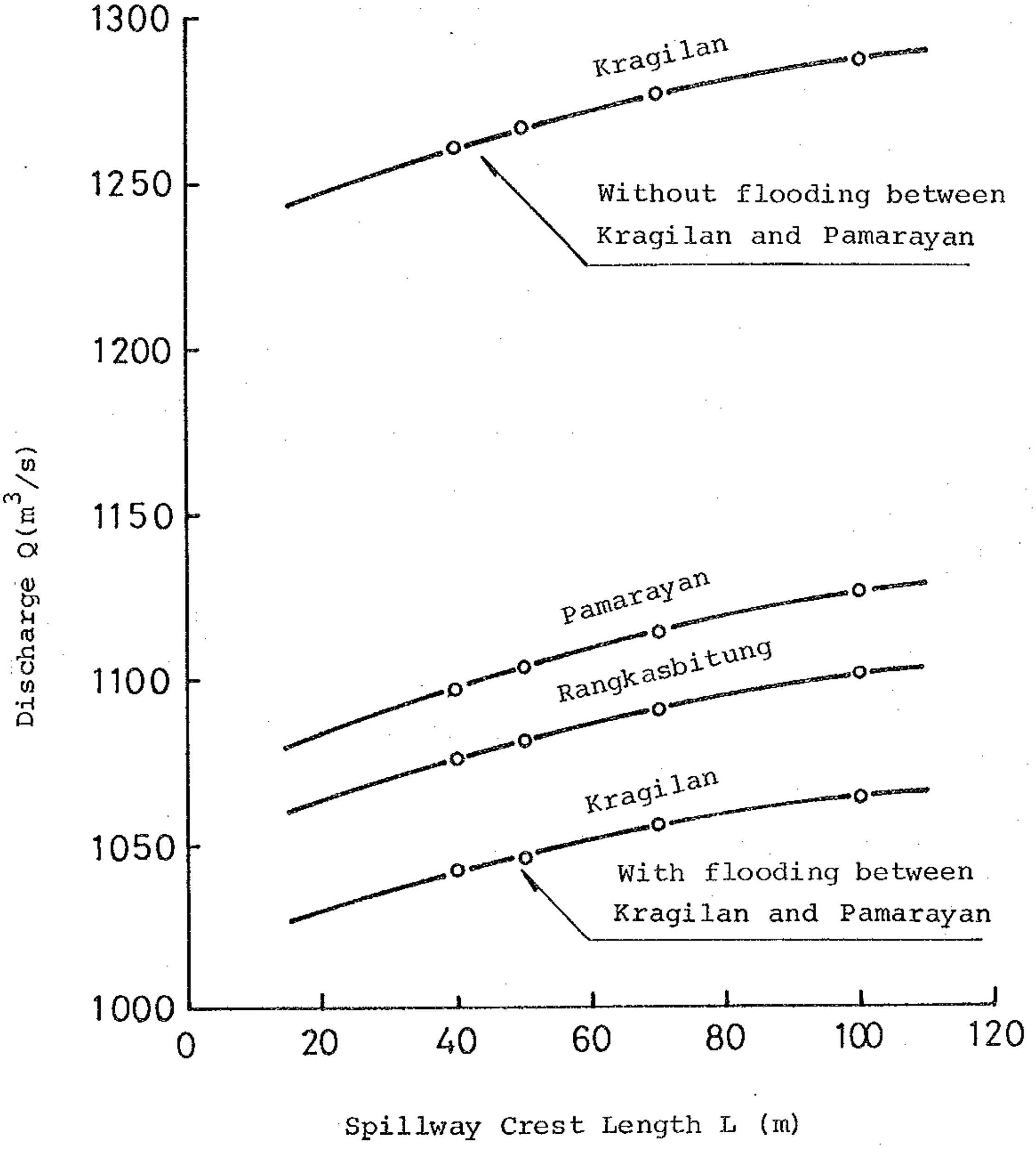
Fig. H-17

(Basic highwater of 10 year return period)



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FEASIBILITY STUDY ON KARIAN
MULTIPURPOSE DAM CONSTRUCTION PROJECT

Flood Regulation Effects by Karian Dam According to Spillway Crest Length

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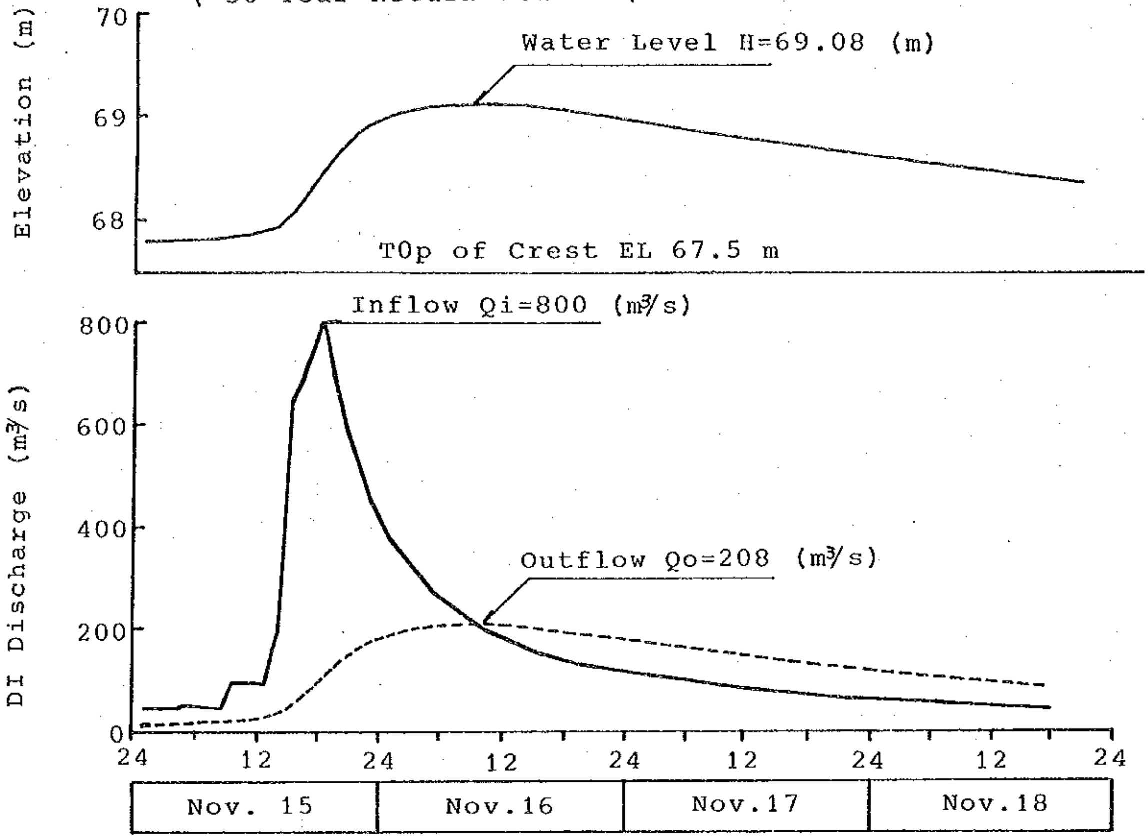
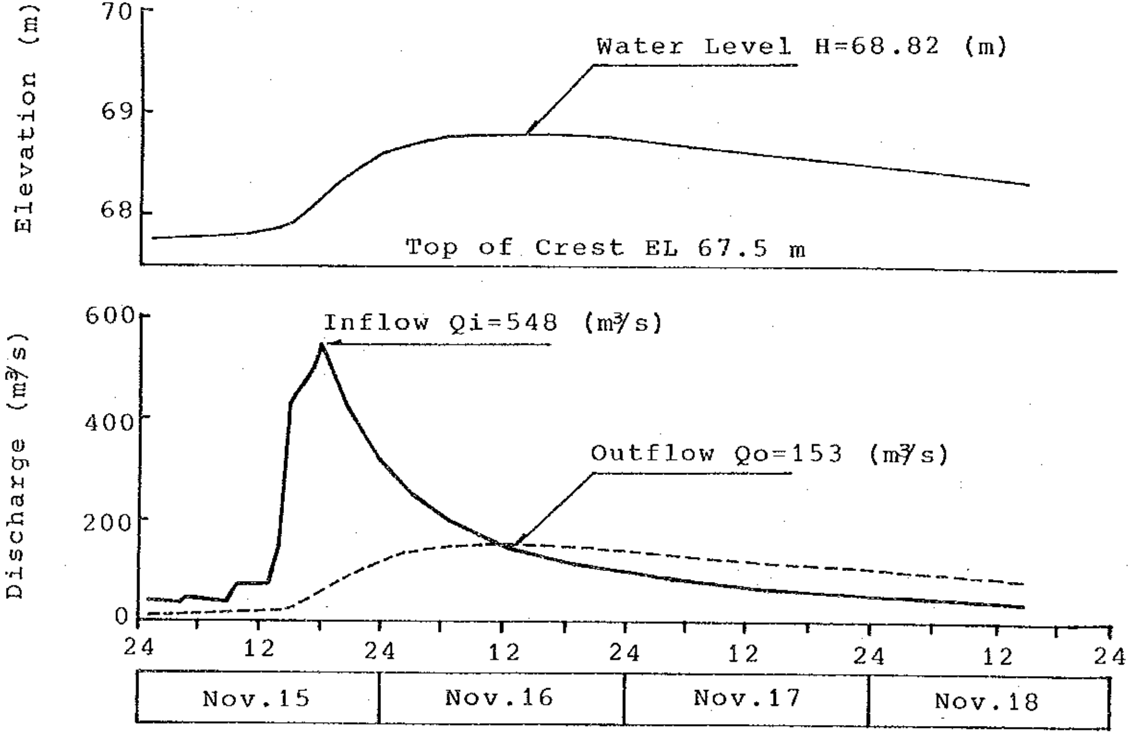
Fig. H-18

(50-Year Return Period)



(10-Year Return Period)



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Hydrograph of Flood Regulation by Karian Dam

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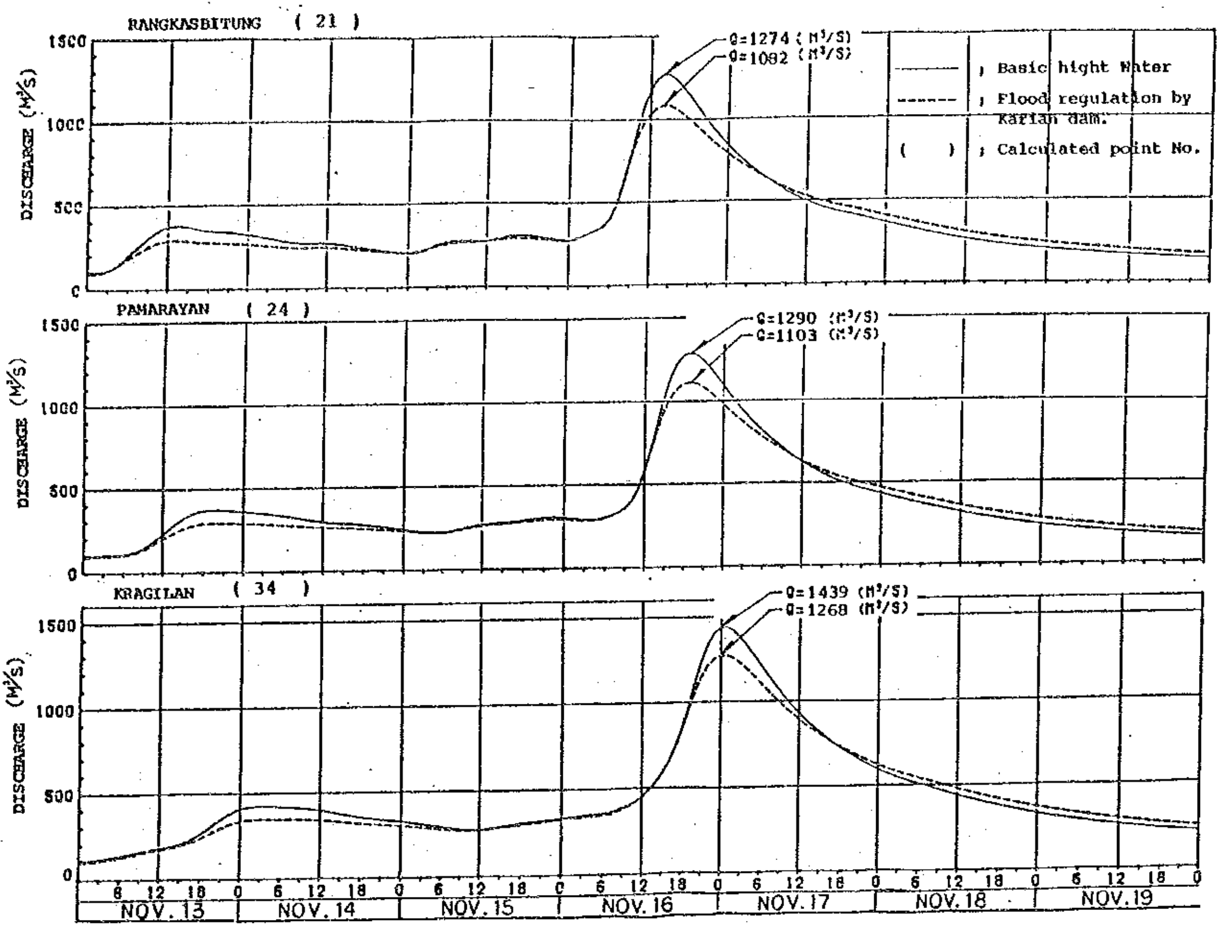
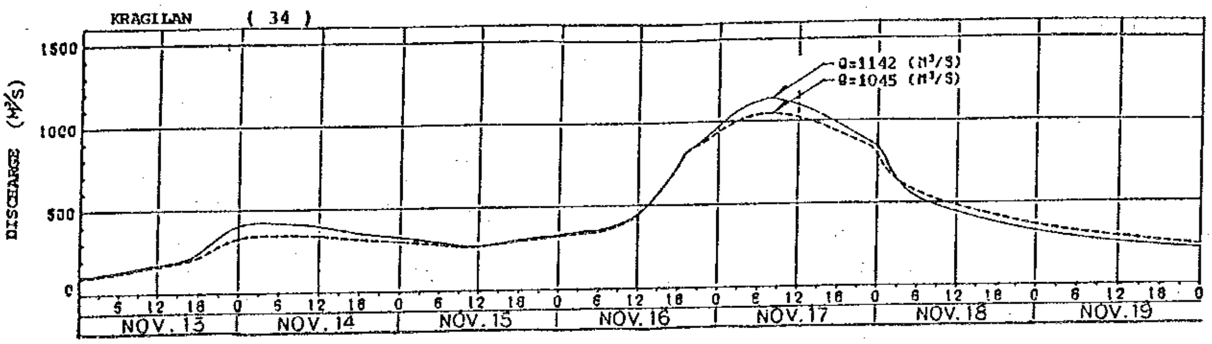
(10 YEAR RETURN PERIOD)





Under present condition with flooding in the section from Kragilan to Pamarayan weir

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Basic High Water and
Design Flood Hydrograph

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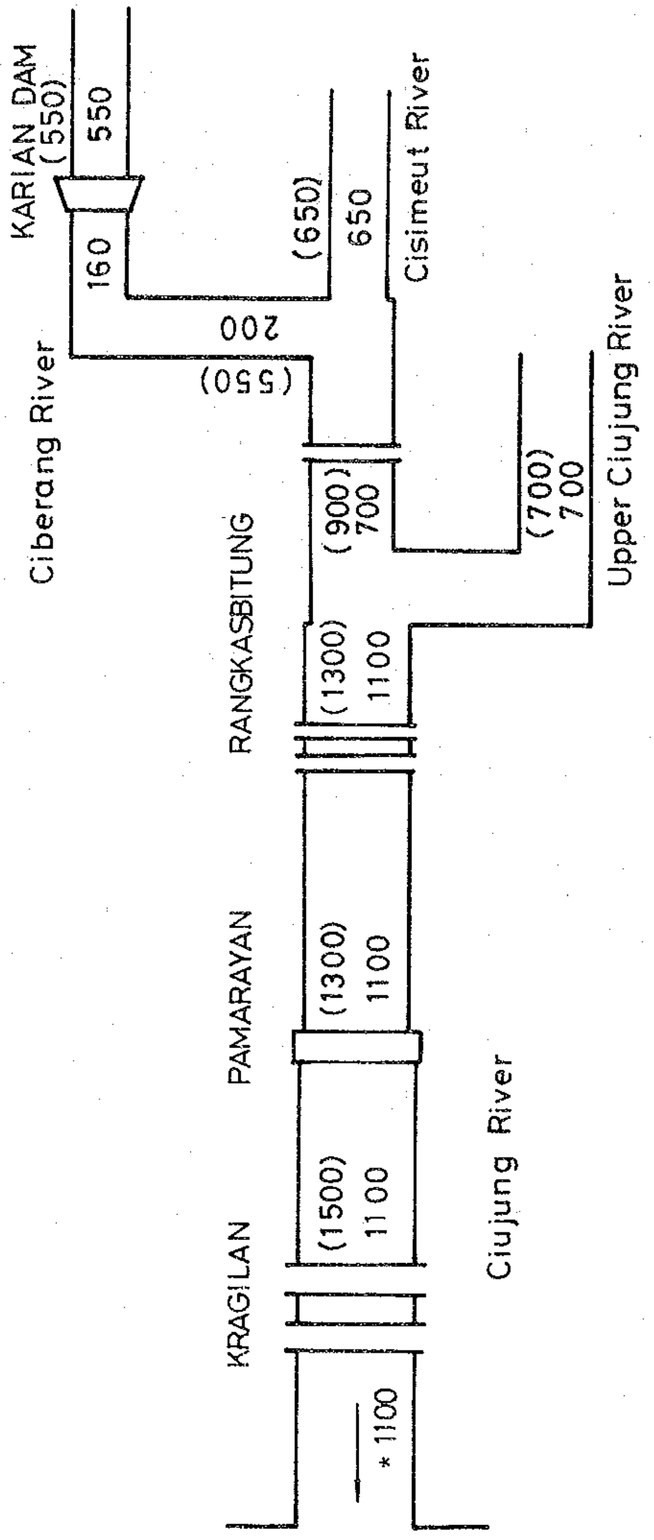
Fig. H-20

(10-Year Return Period)



Unit : m³/s

( ) :Basic High Water

* :Design Discharge by PROSIDA

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Design Discharge Distribution
of Ciujung River

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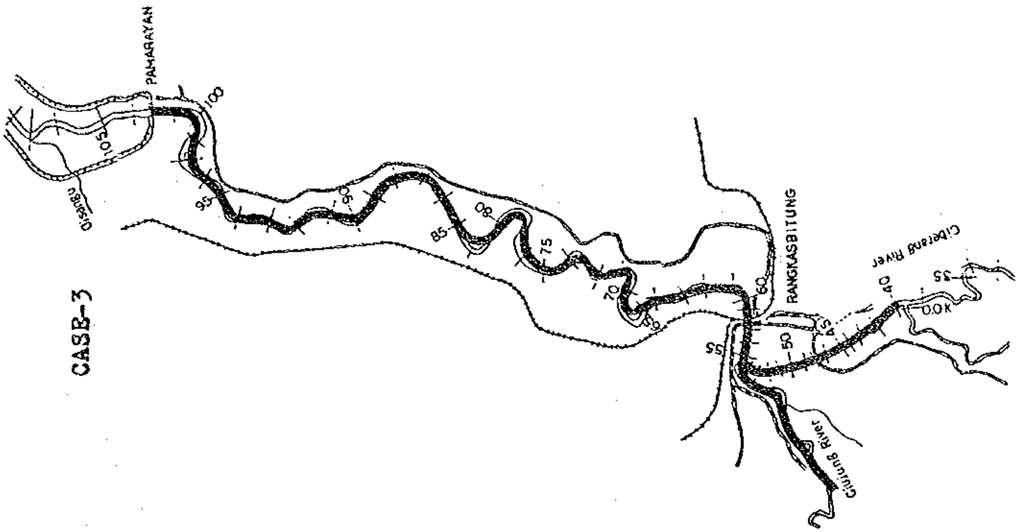
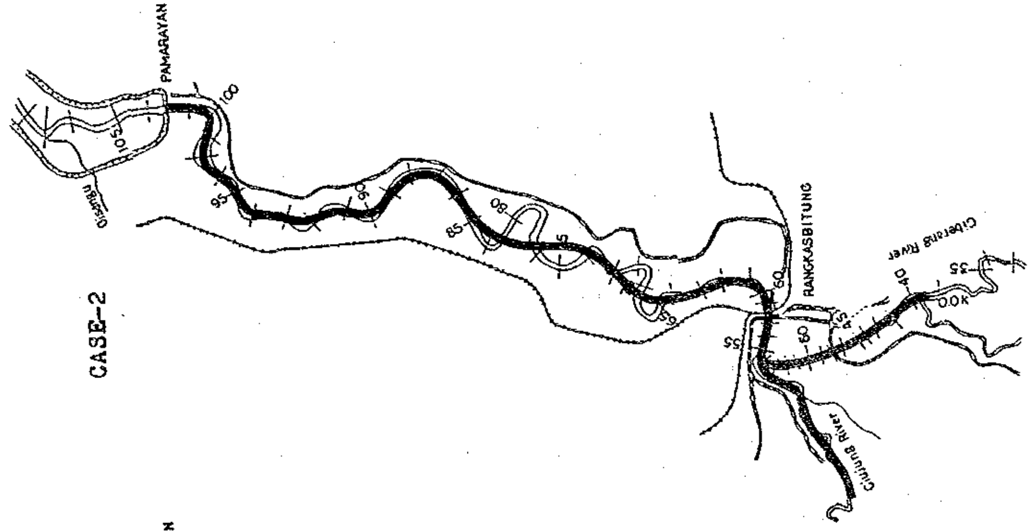
Fig. H-21

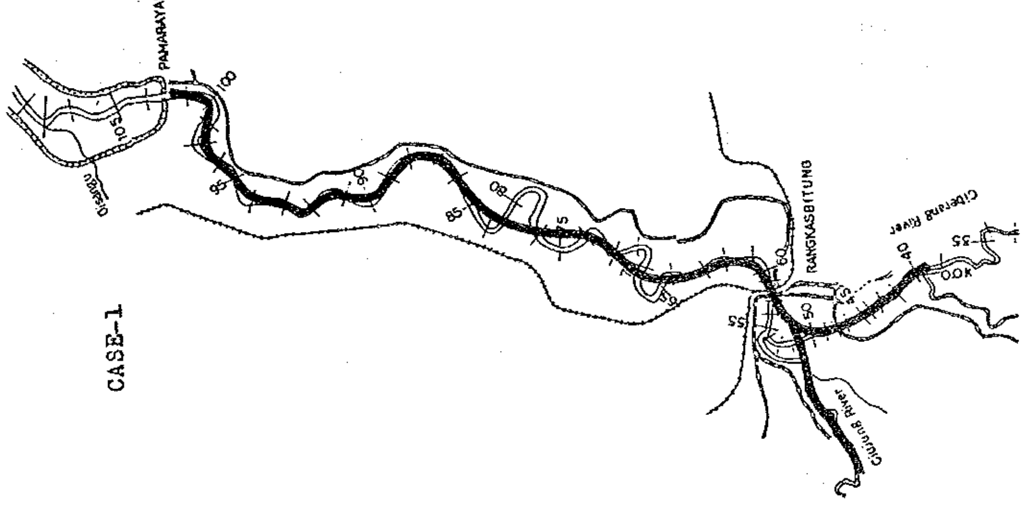
CASE-3



CASE-2



CASE-1



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Alternative Plans
of River Improvement

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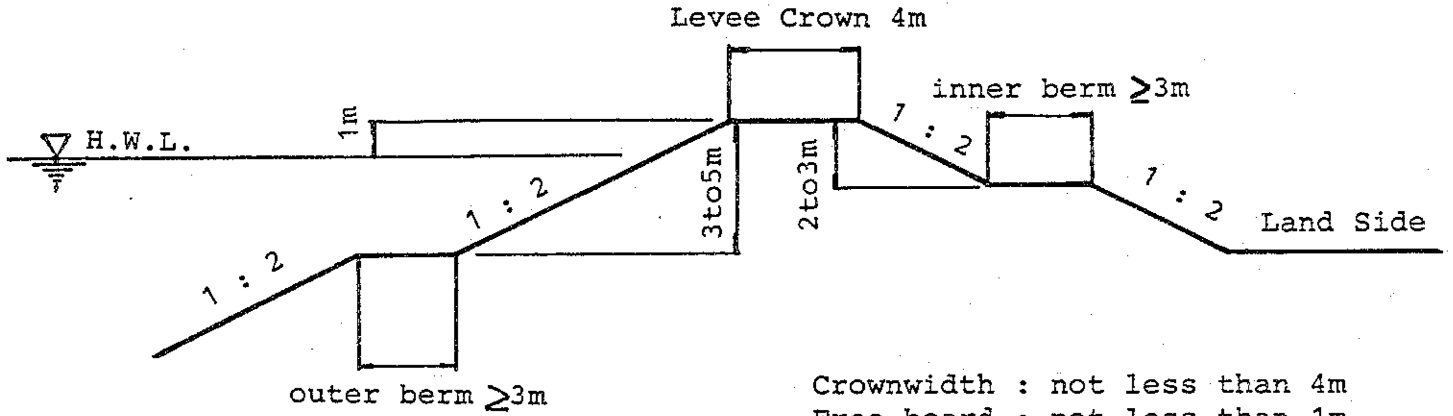
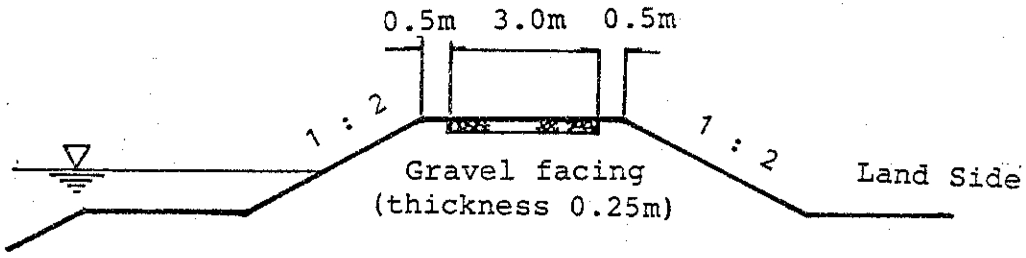
Fig. H-22

TYPICAL CROSS SECTION OF DYKE



Crownwidth : not less than 4m
Free-board : not less than 1m

INSPECTION ROAD



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Typical Cross Section of Dyke
and Inspection Road

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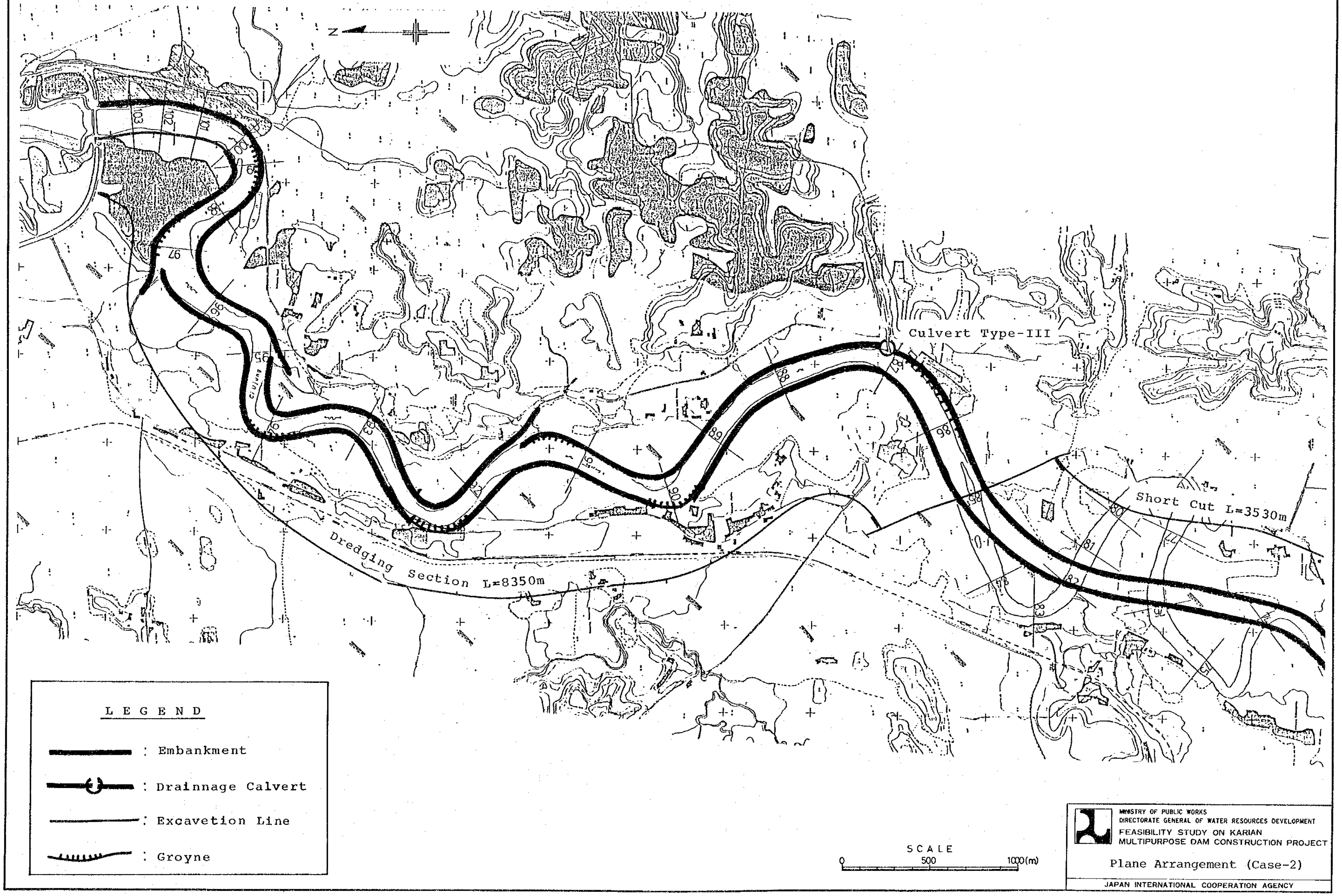
Fig. H-23(1)



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Plane Arrangement (Case-2)

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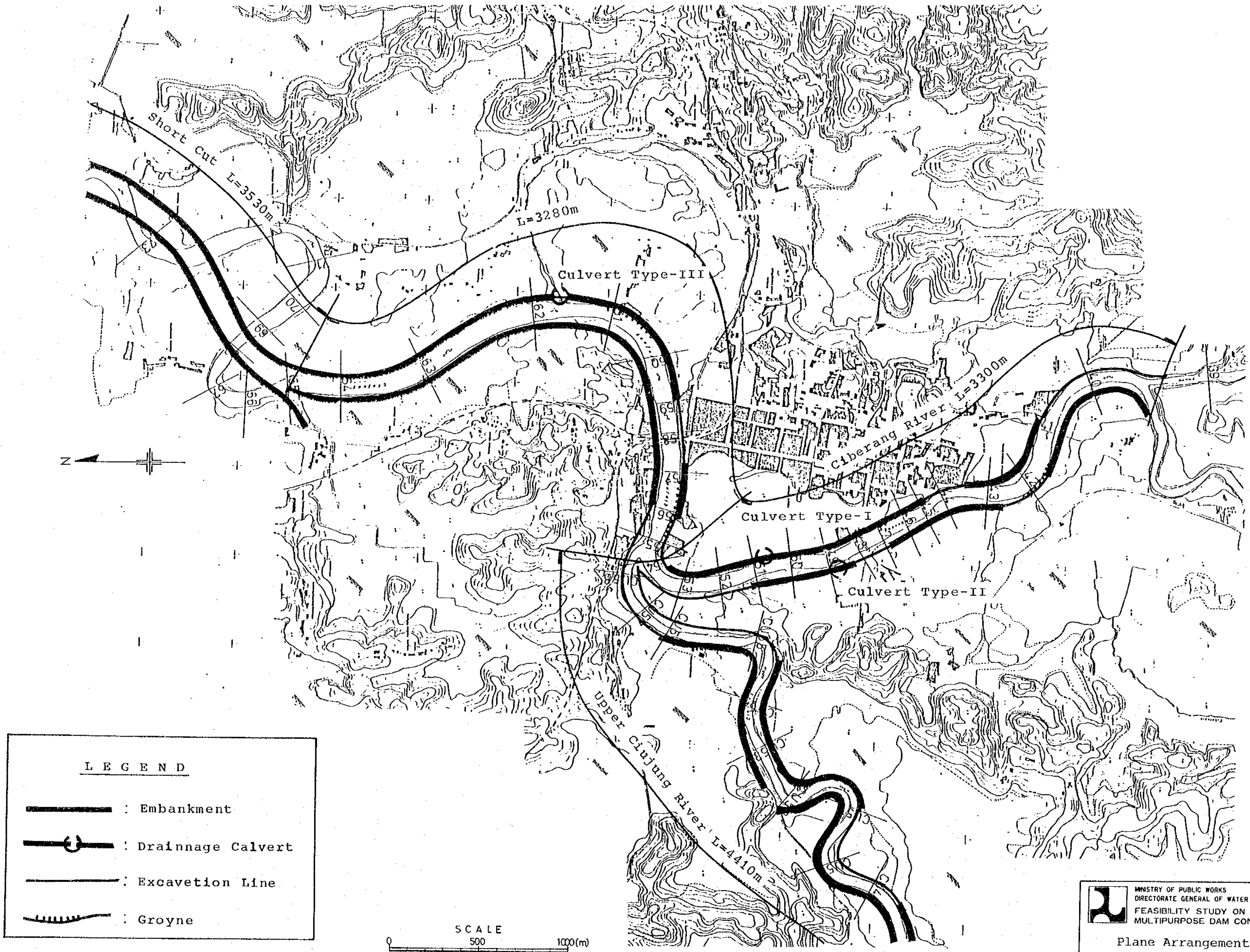
Fig. H-23(2)



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Plane Arrangement (Case-2)

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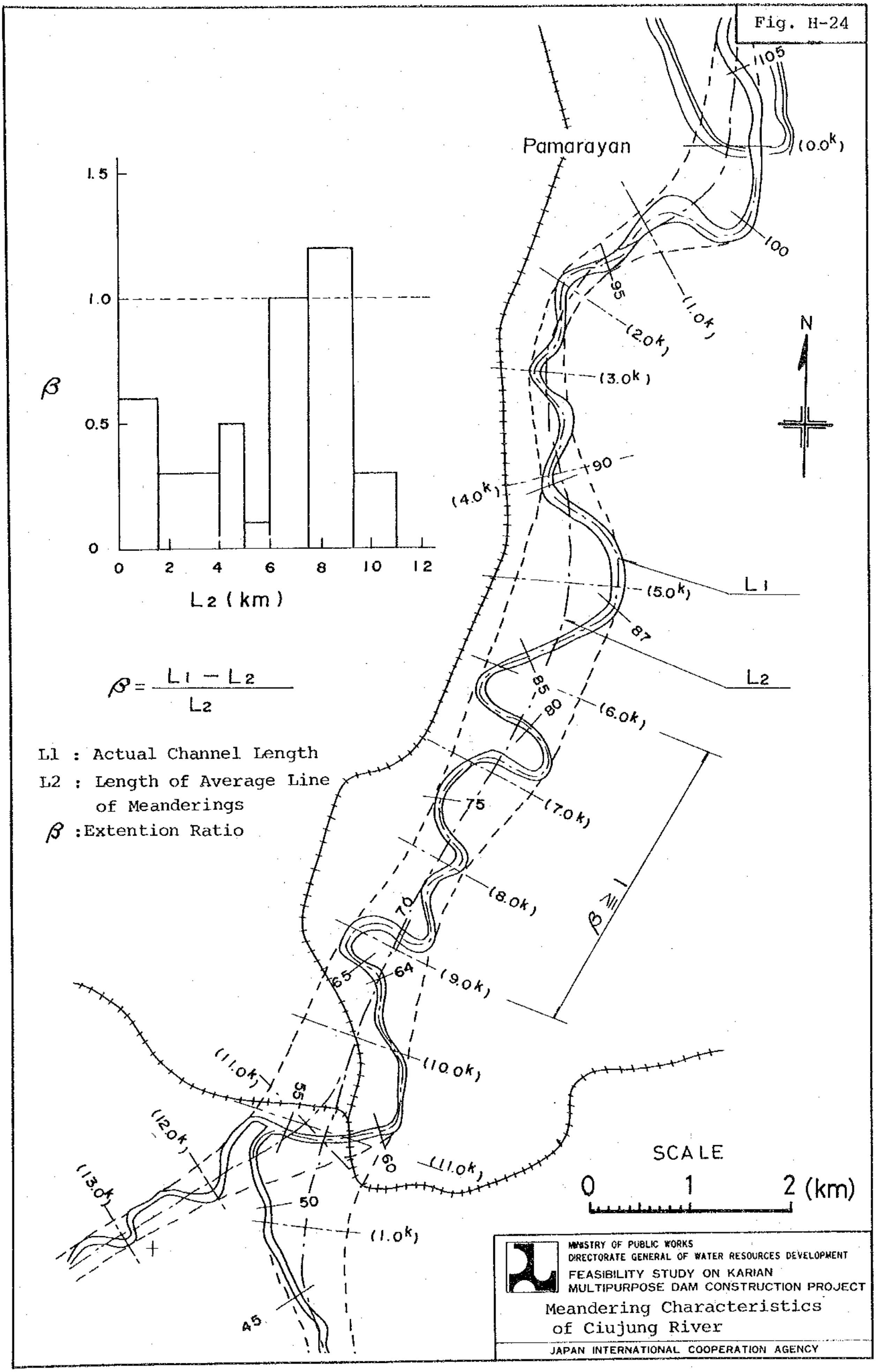
Fig. H-24



$$\beta = \frac{L_1 - L_2}{L_2}$$

L1 : Actual Channel Length
L2 : Length of Average Line of Meanderings
β :Extention Ratio

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Meandering Characteristics of Ciujung River

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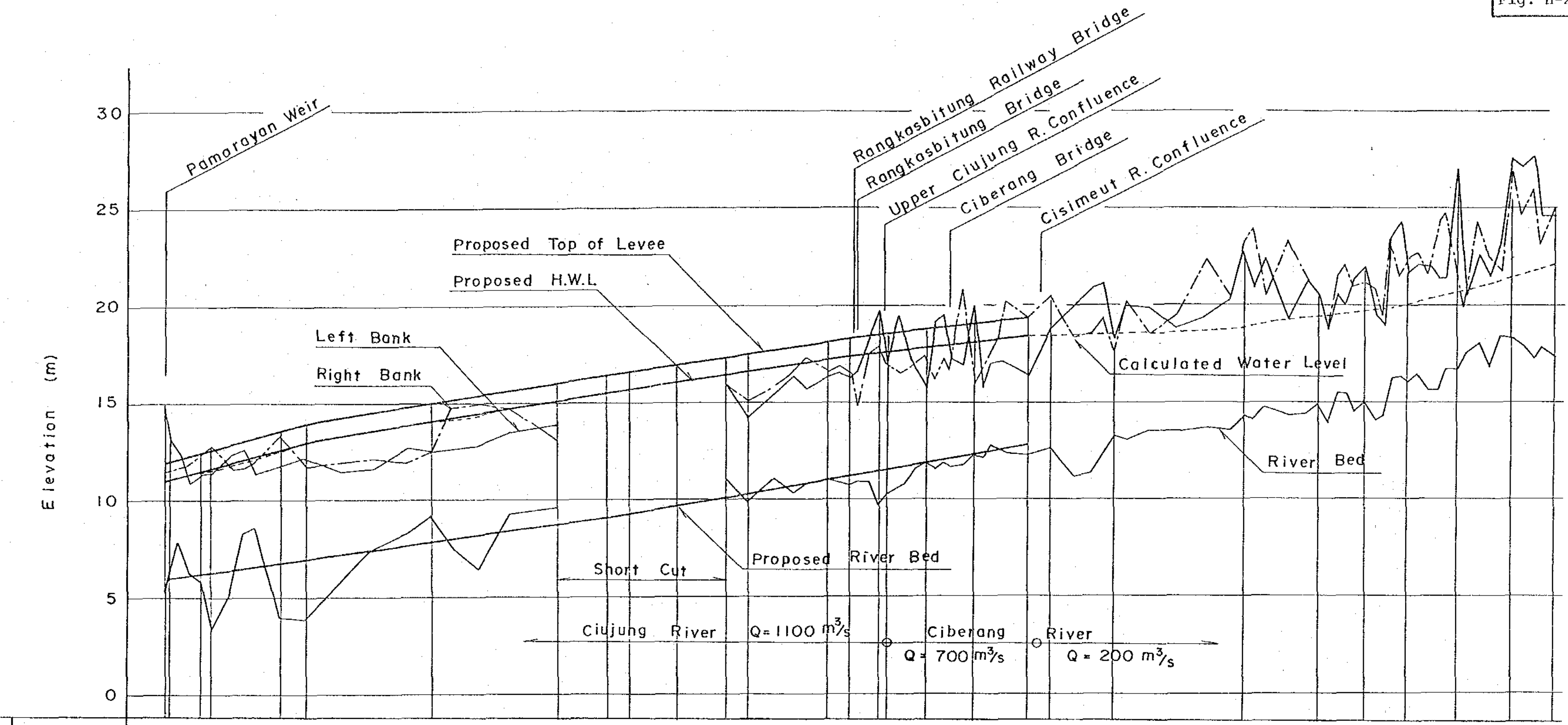
Fig. H-25(1)



Proposed Plan

HWL Gradient: 1/1550 (P.W.–94), 1/2430 (94–85), 1/2650 (85–58), 1/3280 (58–40)

River Bed Gradient: L = 9266 1/3040 (103–S83), L = 9 123 1/2 310 (S83–40)

Section NO.	Distance (m)	Top of Levee (ELm)	High Water (ELm)	River Bed (ELm)
P.W.	0	12.00	11.00	
103	85	12.05	11.05	6.00
100	735	12.37	11.37	6.21
99	955	12.62	11.62	6.29
95	2403	13.55	12.55	6.76
94	2953	13.91	12.91	6.94
90	5703	15.04	14.04	7.85
85	8351	16.13	15.13	8.72
S83	9351	16.51	15.51	9.05
S82	9851,	16.70	15.70	9.26
S80	10851	17.07	16.07	9.70
65	11881	17.46	16.46	10.14
64	12311	17.62	16.62	10.33
60	14011	18.27	17.27	11.07
58	14470	18.44	17.44	11.27
55	15089	18.63	17.63	11.53
54	15239	18.67	17.67	11.60
50	16076	18.93	17.93	11.96
45	17082	19.24	18.24	12.39
40	18214	19.58	18.58	
39	18714			
35	20014			
30	22744			

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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Longitudinal Profile of
Ciujung River (Case-2)

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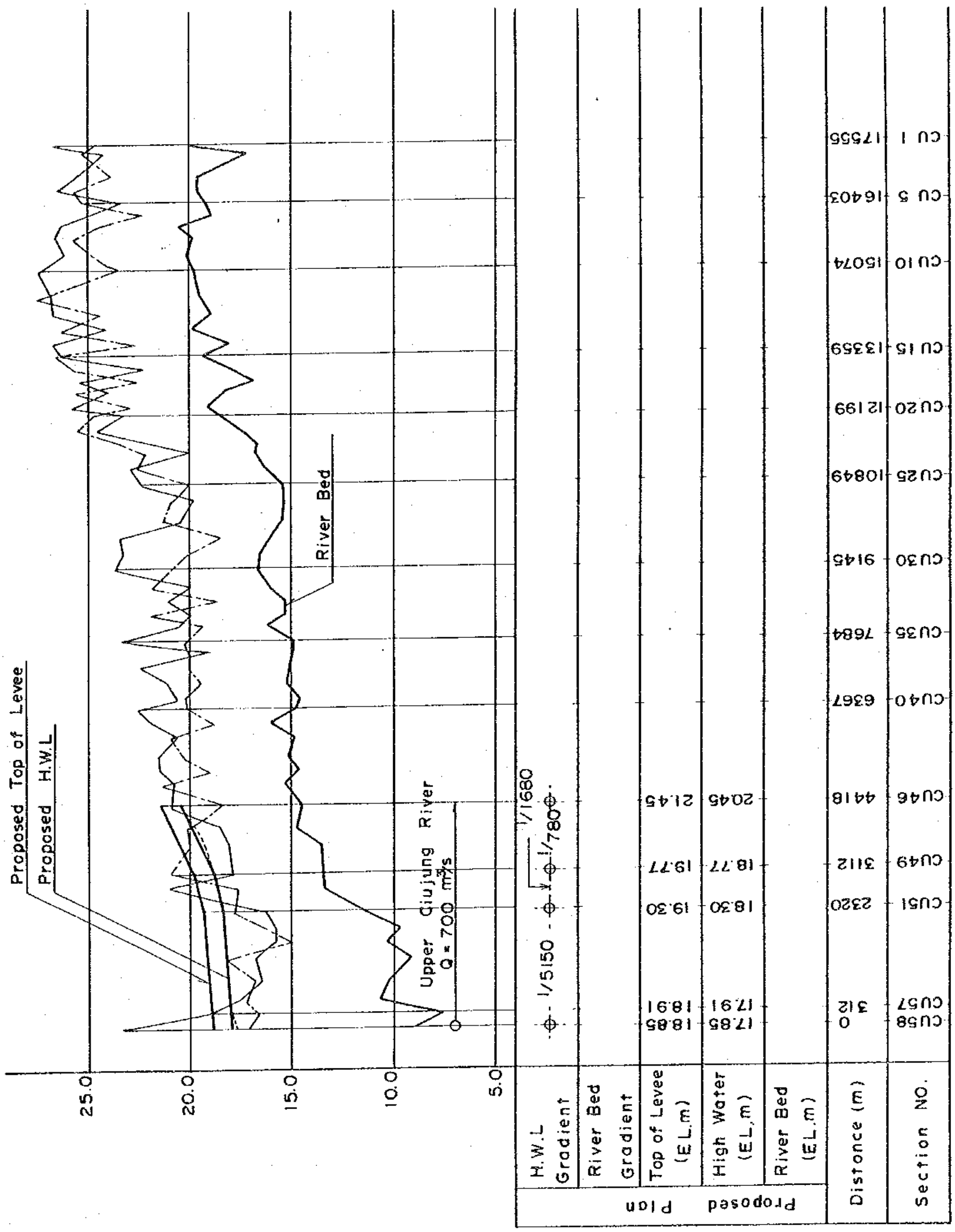
Fig. H-25(2)



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Longitudinal Profile of
Upper Ciujung River (Case-2)

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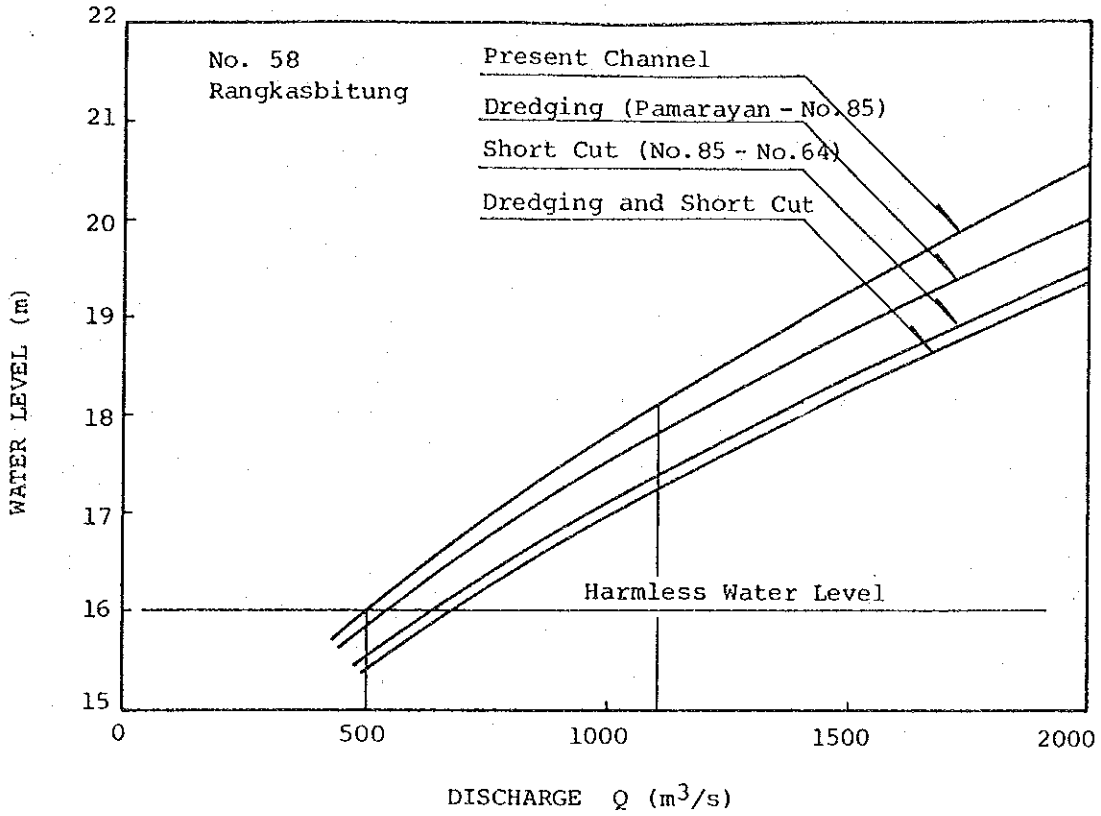

EFFECT OF UNDER DISCHARGE 1100 m³/s

ITEM	WATER LEVEL EL (m)	DRAW DOWN (m)
PRESENT CONDITION	18.08	---
ONLY DREDGING AT PAMARAYAN TO NO.85	17.76	0.32
ONLY SHORT CUT (NO.85~64)	17.36	0.72
DREDGING AND SHORT CUT	17.18	0.90

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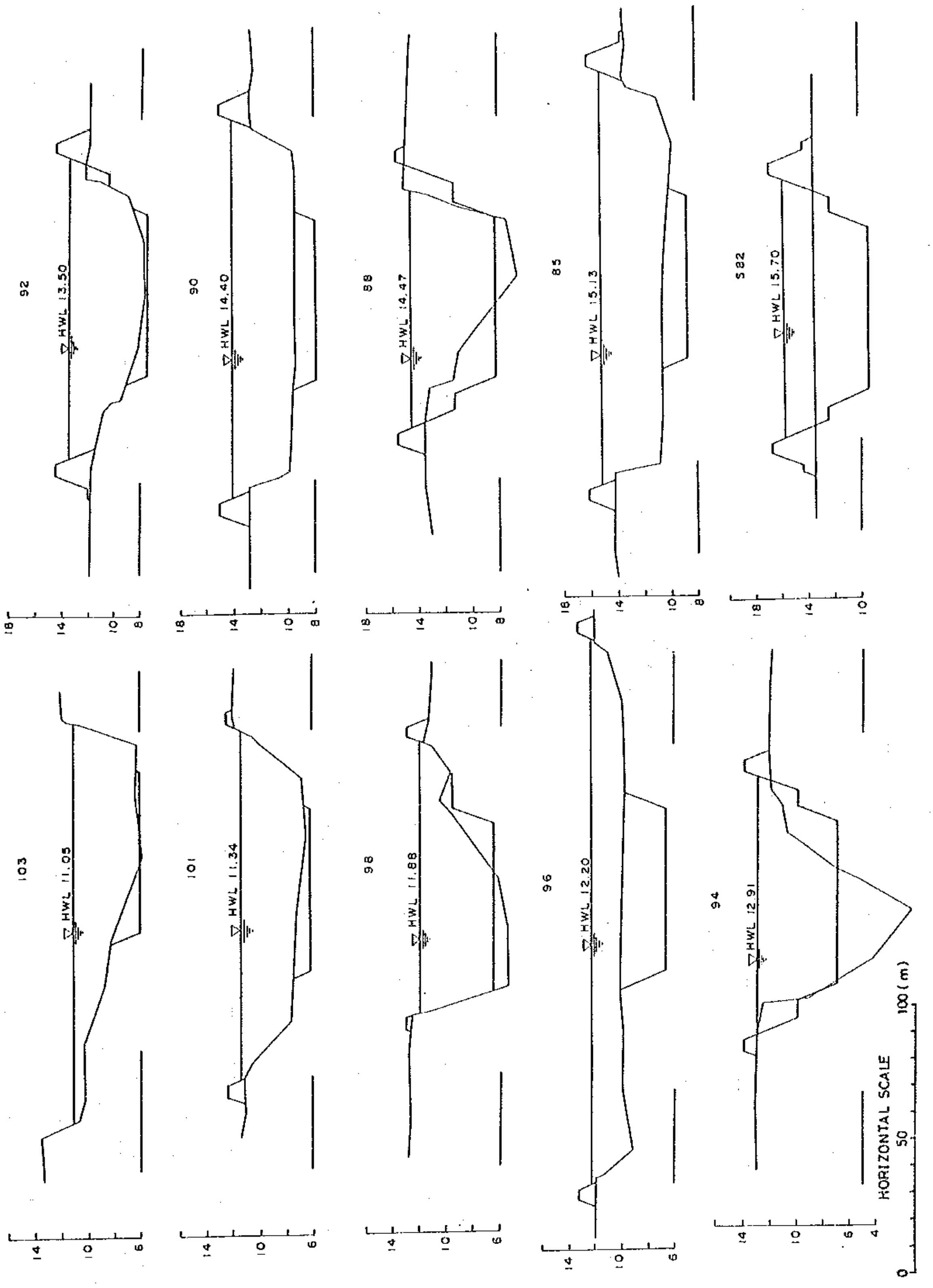
FEASIBILITY STUDY ON KARIAN
MULTIPURPOSE DAM CONSTRUCTION PROJECT

Effect of Dredging and Short Cut on Water Level at Kangaksbitung

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. H-27(1)



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Cross Section of Ciujung River
(Case-2)

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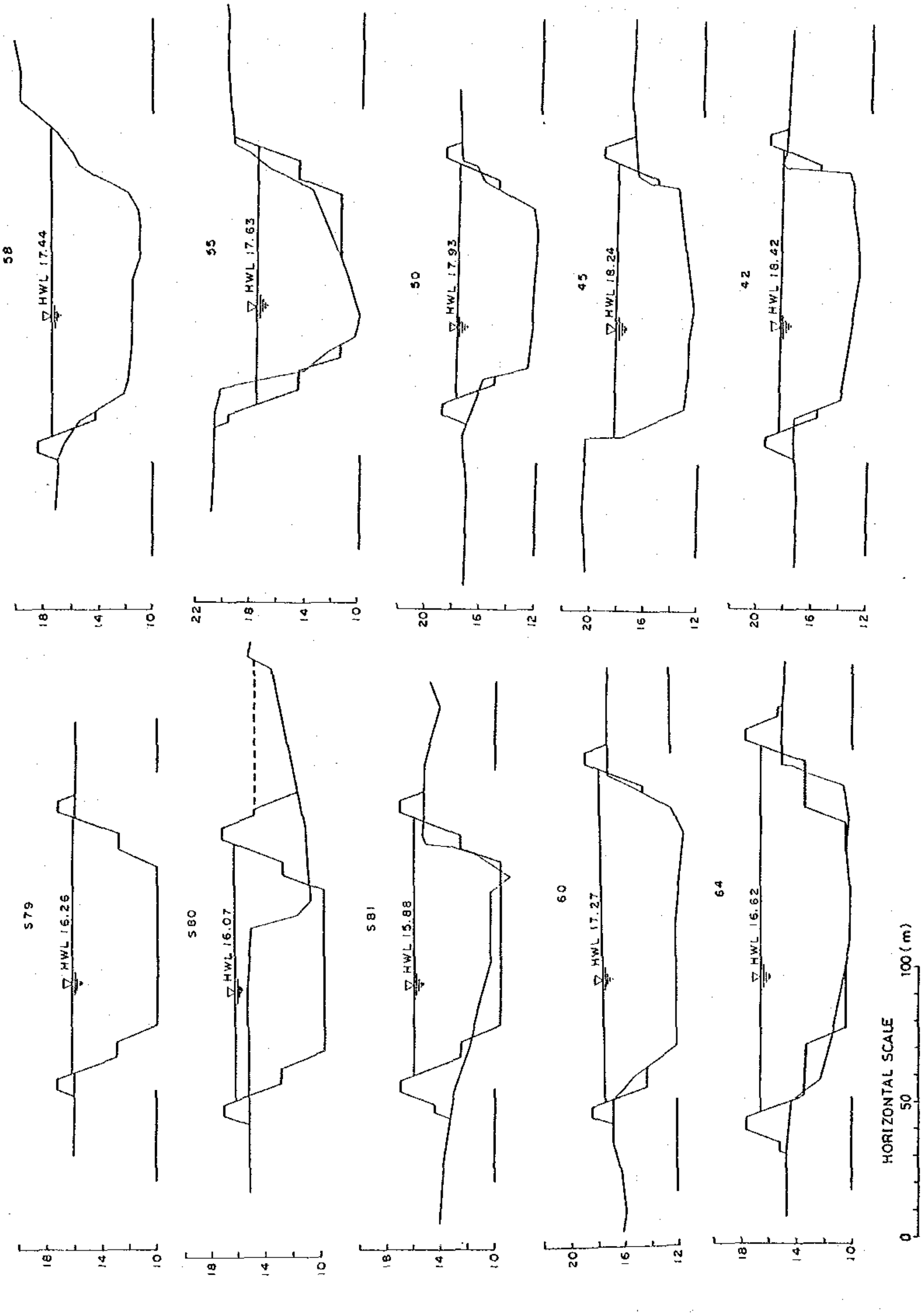
Fig. H-27(2)



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Cross Section of Ciujung and Ciberang River (Case-2)

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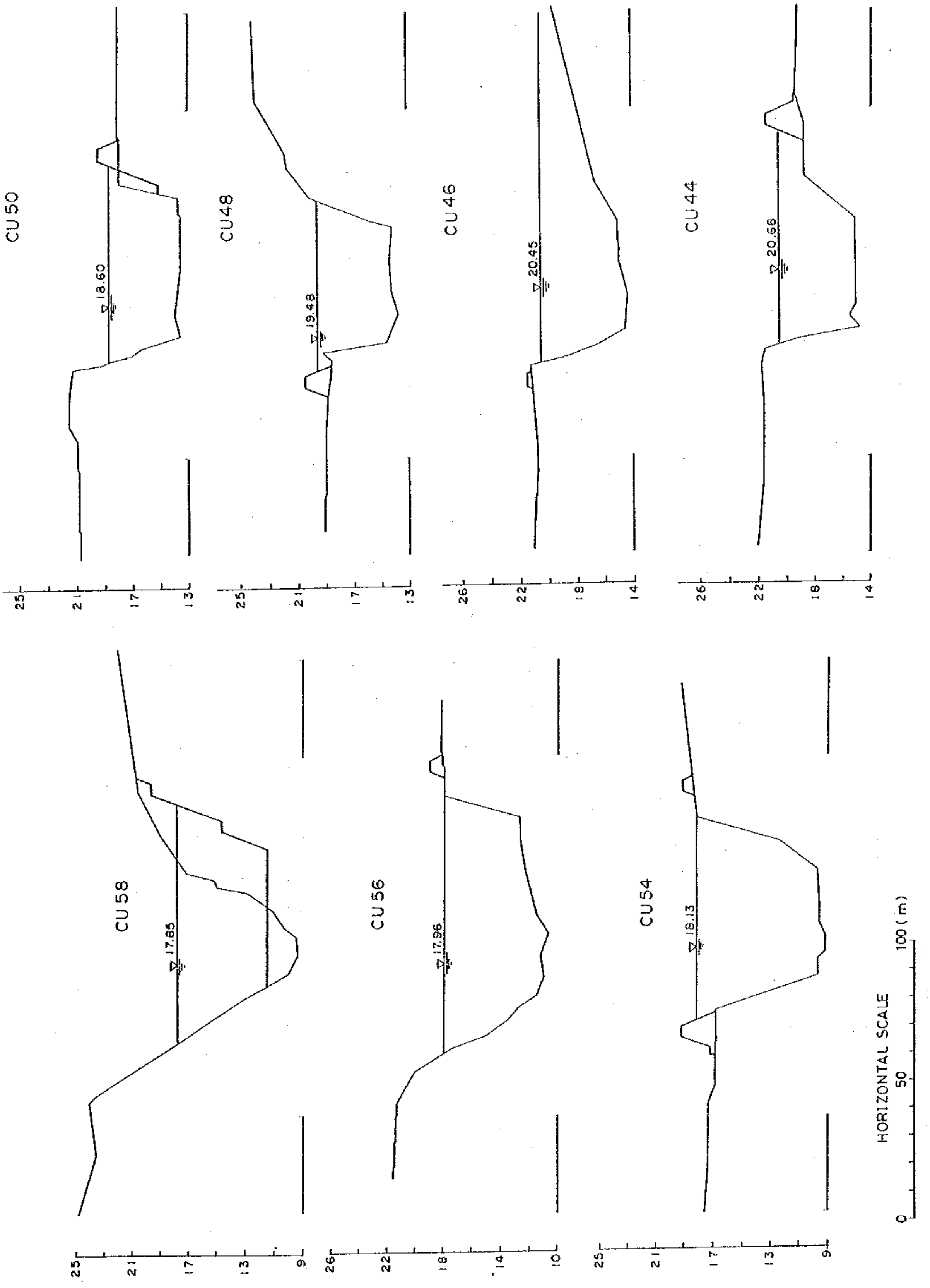
Fig. 27(3)



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MULTIPURPOSE DAM CONSTRUCTION PROJECT

Cross Section of Upper Ciujung River (Case-2)

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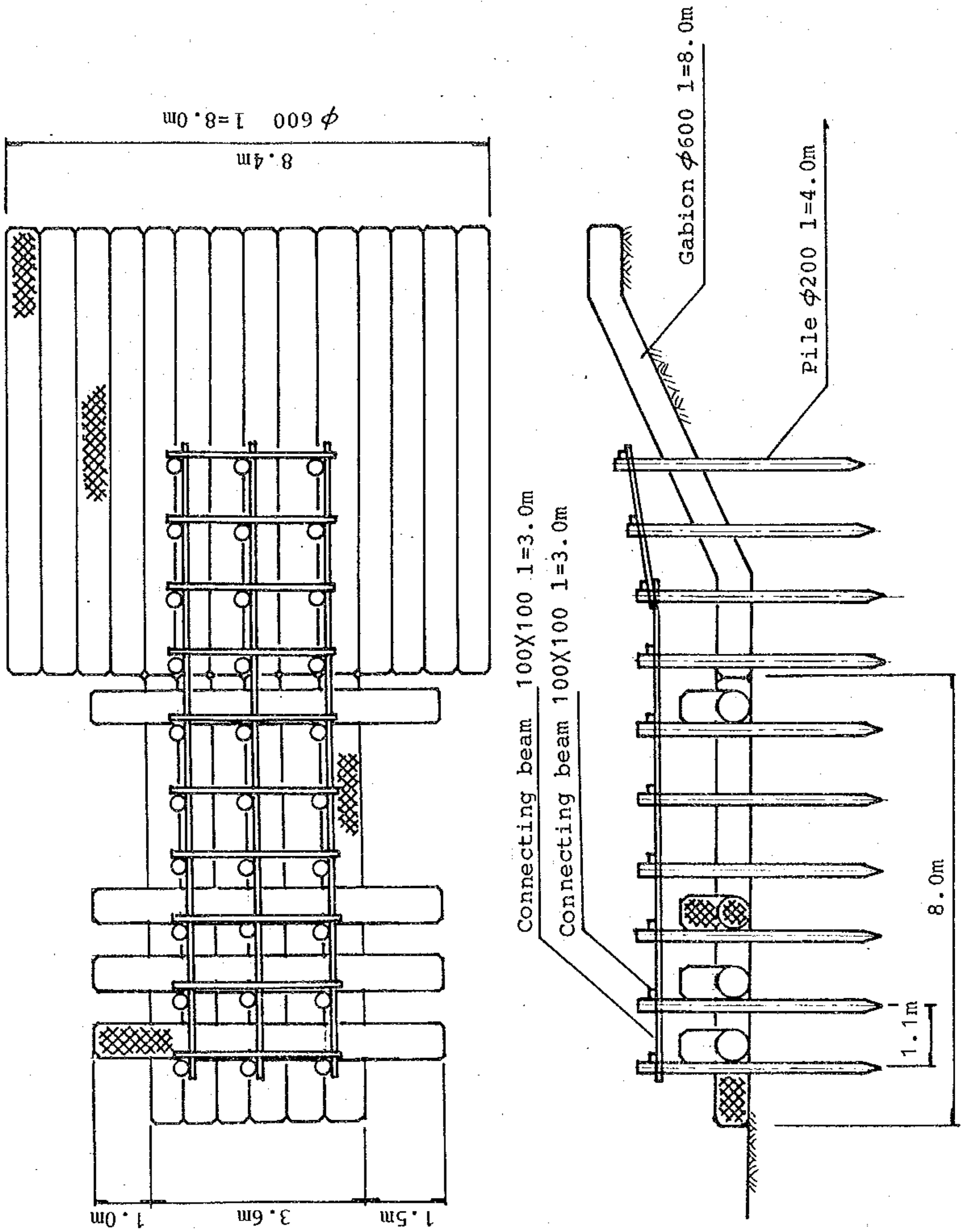
Fig. H-28



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