(2) The river cross sections surveyed by DGWRD and the Study Team in 1987 and 1988 are used for design of river channel.

4.2 Improvement Reaches and Design Discharge

The Citarum river will be improved along the reaches from Curug Jompong to the uppermost site of the flood prone area to attain a full scale flood control.

The improvement of the tributaries, the Citarum (upstream), Citarik, Cikeruh and Cisangkuy Rivers will also be included in the Citarum River Improvement Project as a package, since flooding in those tributaries are caused by backwater of the Citarum River.

The existing river lengths to be improved are as follows:

Citarum River (main):	Curug Jompong to Sapan	:	40.2 km
Citarum River (upstream):	Upstream from Sapan	:	6.0 km
Citarik River		:	15.0 km
Cikeruh River		:	2.0 km
Cisangkuy River		:	8.5 km
	Total	:	71.7 km

The design discharge hydrograph at Dayeuh Kolot and design peak discharge distribution are shown in Fig. H.12.

4.3 Proposed River Alignment, Profile and Cross Section

4.3.1 Proposed River Alignment

(1) Cut-off Channel of Citarum Main River (Curug Jompong to Sapan)

1) Selection of Cut-off Channel Site

The Citarum River length existing between Curug Jompong and Sapan is 40.2 km and its bank slope is as gentle as 1/6,800. Cut-off channels are proposed for the river stretches with a large

meandering of the Citarum River to shorten the river course and to steepen the river gradient. Meanders where a cut-off rate of more than 50% is expected are selected for the cut-off channels. Eight (8) cut-off channels are proposed for the reaches presented in the table below between Curug Jompong (0 km) and Sapan (40.2 km) of the Citarum River. Location of the proposed cut-off channel sites is shown in Fig. H.13.

Proposed Reaches for Cut-off Channels of Citarum River

Name of Cut-off Channel	Existing Reaches of Proposed Cut-off
A	STA. 3.1 km - STA. 8.25 km (l = 5.15km)
B	STA. 9.1 km - STA. 11.0 km (l = 1.3 km)
C	STA. 17.5 km - STA. 21.65 km (l = 4.15km)
D	STA. 26.0 km - STA. 27.27 km (l = 1.27km)
E	STA. 29.25 km - STA. 30.56 km (l = 1.31km)
F	STA. 33.25 km - STA. 34.44 km (l = 1.19km)
G	STA. 35.3 km - STA. 36.25 km (l = 0.95km)
H	STA. 37.35 km - STA. 39.85 km (l = 2.45km)

2) Proposed Cut-off Channel Route

Two (2) or three (3) alternative routes for the proposed cut-off channel site are prepared as shown in Fig. H.14 to Fig. H.17. The proposed cut-off routes are selected based on the comparison of the following items:

- Improvement length and its cut-off rate
- Required excavation volume
- Required land acquisition area
- Number of house resettlements
- Structures to be newly constructed
- New available land produced by cut-off channel (existing river portion)

The comparison of alternative cut-off routes and proposed one are shown in Fig. H.14 to Fig. H.17.

The river length between Curug Jompong and Sapan will be reduced from 40.2 km to 31.2 km by the proposed cut-off channels listed below:

Name of Cut-off Channel	Route	Proposed Route	
		Length (km)	Cut-off Rate
A	A-3	2.02	0.61
B	B-3	0.30	0.65
C	C-2	1.35	0.59
D	D-2	0.48	0.62
E	E-3	0.54	0.49
F	F-3	0.48	0.52
G	G-2	0.50	0.47
H	H-2	1.31	0.47

3) Evaluation of Cut-off Channel A

The proposed cut-off channel A is located at the upstream of Nanjung which is the lowest reaches of the Citarum River (3.1 km - 8.25 km). The proposed cut-off length is 1.80 km which is the longest among the eight (8) proposed cut-off channels.

The ground elevation along the proposed cut-off routes varies from EL. 659 m to EL. 663.5 m. The proposed river bed elevation is approx. EL. 648.1 m and the required depth of excavation varies from 10.9 m to 15.5 m. The cut-off channel A will require a high construction cost.

In this section, the following two (2) alternative river improvement plans are discussed in order to confirm the adequacy of the proposed cut-off channel A.

Alternative I (without cut-off channel A)
River improvement along the existing Citarum River between 1 km and 8.25 km (river improvement length: 7.25 km)

Alternative II (with cut-off channel A)
River improvement by cut-off channel A
(river improvement length: 4.1 km)

Location of the two (2) alternatives are illustrated in Fig. H.18.

(a) Design Discharge

The design discharges of the two (2) alternative plans are the same with 510 m^3/s for 20-year frequency flood.

(b) Design River Profile and Cross Section

The design river bed slopes of both alternatives are the same with 1/5,500 as shown in Fig. H.19. The design river cross sections of these two (2) alternative plans are shown in Fig. H.18.

(c) Construction Works and Costs

The required construction works and costs of both alternatives are shown in Table H.9.

(d) Conclusion

The cut-off channel A is recommended based on the following facts and considerations.

- Alternative I requires a higher construction cost than Alternative II.
- Alternative I requires an additional dredging for the downstream stretches following the cut-off part (1.0 - 3.0 km) to maintain the same flood water level as Alternative II at the uppermost site of the cut-off portion (8.25 km site).
- According to the hydraulic characteristics of the existing Citarum River channel analyzed in Supporting Report C, the width to depth ratio of the river stretches between 3 km and 9 km is 15 ~ 20, while the ratio of the other stretches mostly fall within 8 - 10.

It implies that this part of the river course is unstable and susceptible to sediment deposit. From the above facts, it is considered that Alternative I will require frequent maintenance dredgings in the future.

(2) Cut-off Channel of Tributaries

1) Citarum (upstream) and Cikeruh Rivers

No cut-off channels are proposed. The existing river courses will be widened. The improvement lengths of both rivers are as follows.

Citarum River (upstream) : 6.0 km (Sapan to uppermost site of the flood prone area)

Cikeruh River : 2.0 km (Sapan to uppermost site of the flood prone area)

2) Citarik River

Three (3) cut-off channels including realignment of the junction with the Citarum River are proposed for the reaches presented in the table below.

Proposed Reaches for Cut-off Channels of Citarik River

Name of Cut-off Channel	Existing Reaches of Proposed Cut-off
I	STA. 0 km - STA. 0.45 km (0.45 km)
J	STA. 11.5 km - STA. 11.8 km (0.30 km)
K	STA. 13.05 km - STA. 13.2 km (0.15 km)

The river improvement length will be reduced from 15.0 km to 14.8 km by the proposed cut-off channels.

3) Cisangkuy River

Three (3) cut-off channels are proposed for the reaches presented in the table below.

Proposed Reaches for Cut-off Channels of Cisangkuy River

Name of Cut-off Channel	Existing Reaches of Proposed Cut-off
L	STA. 0.5 km - STA. 1.22 km (0.72 km)
M	STA. 1.88 km - STA. 2.23 km (0.35 km)
N	STA. 5.45 km - STA. 6.28 km (0.83 km)

The river improvement length will be reduced from 8.5 km to 7.4 km by the proposed cut-off channels.

(3) River Improvement Length

The river improvement length of the Citarum, Citarik, Cikeruh and Cisangkuy Rivers are as follows (See Fig. H.20).

Citarum River
- Main Stream : 31.2 km (Curug Jompong - Sapan)
- Upstream : 6.0 km (Sapan - uppermost site of flood area)

Citarik River : 14.8 km (Sapan - uppermost site of flood area)

Cikeruh River : 2.0 km (Sapan - uppermost site of flood area)

Cisangkuy River : 7.4 km (Dayeuh Kolot - uppermost site of flood area)

4.3.2 Proposed River Profile

(1) Design Flood Water and River Bed Slope

The design flood water slope of the Citarum Main River (Curug Jompong to Sapan) is determined to be 1/5,500, considering the proposed cut-off channels and the target flood water levels at Curug Jompong (EL. 654.5 m), Dayeuh Kolot (EL. 658.1) and Sapan (EL. 660.1).

The design flood water slope is also determined to be 1/3,600 for the Citarum Upstream River (upstream stretches from Sapan), 1/4,500 and 1/1,100 for the Citarik River, 1/4,500 for the Cikeruh River and 1/2,800 for the Cisangkuy River, tracing the slopes of their existing river banks.

The design river bed slope is fixed in parallel with the design flood water level to keep a uniform flow condition.

The proposed river profiles of the Citarum, Citarik, Cikeruh and Cisangkuy Rivers are shown in Fig. H.21 to Fig. H.24.

(2) Hydraulic Effect of Fall at Curug Jompong

At Curug Jompong, there is a water fall with a head of eight (8) meters. In flood time, a critical water depth appears at Curug Jompong and the flood water profile forms a draw down curve with a steep slope in the immediate upstream of Curug Jompong due to the hydraulic effect of the fall.

The flood water, profiles of a 20-year flood were calculated for the reaches between Curug Jompong (0 km) and River Station at 5.0 km distance under the following conditions.

- River alignment, profile and cross section: present condition
- Roughness coefficient

  Case 1: 0.04 (present river condition)

  Case 2: 0.035 (river condition after bank clearing and grubbing)
- Flood discharge: 20-year flood

The calculated flood profiles are shown in Fig. H.25.

In the present condition (case 1), the flood water level is lower than the proposed design flood water level in the downstream of Nanjung Bridge. If a small river improvement such as bank

clearing and grubbing is executed in this reaches (case 2), the flood water level will become lower than that of case 1.

Hence, approximately 1.0 km stretch upstream of Curug Jompong will not require any major river improvements.

4.3.3 Proposed River Cross Section

The design river cross sections are proposed based on the following considerations.

(1) For Citarum River (Main)

1) Double section will be applied in principle to maintain stability of the river course and bed.

2) River width will be set less than 100 m to minimize the required land acquisition and house resettlement.

3) Lowering of the river bed is limited because soft rocks and stiff soils are underlying the existing river bed throughout the downstream stretches of Dayeuh Kolot.

4) Ratio of the proposed river width to depth will be set within 8 to 12, based on the facts that the existing river width to depth ratio falls within the range of 8 to 12 in the stable stretches of river bed.

5) Frequent floods will be discharged by low-water channel of the proposed double cross section. The discharge capacity of the low-water channel will be almost equivalent to that of the existing channel. Target sectional area is approximately 100 m^2 at Sapan and 170 m^2 at the confluence of the Ciwidey River.

6) For the downstream reaches of the confluence of the Ciwidey River, cross section of single type will be applied. Application

of double type is not economical because there are hilly lands of soft rock or stiff soil close to both river banks.

(2) For Tributaries

1) Double section will be applied in principle, same as the Citarum River (main). However, for the Cisangkuy and the uppermost reaches of the Citarik River, a single section is adopted. This is because their river-bed slopes are steep enough to counter the sedimentation problem.

2) River width will be set to minimize the required land acquisition and house resettlement.

3) For the middle and uppermost reaches of the Citarik River, river cross sections including the dikes for the irrigation works will be considered.

The proposed cross sections of the Citarum River (main) and its tributaries are illustrated in Fig. H.26.

River-bed stability of the proposed cross sections of the Citarum River (main) are evaluated by the hydraulic case study as shown in Table H.10.

According to the study results, the values of tractive force of the proposed river cross sections ($U*^2$) are larger than that of critical tractive force of the river bed materials ($U*c^2$) and are almost the same as that of the existing river ($U*e^2$).

This means that the proposed river channels of the Citarum River (main) are considered to be relatively in a stable condition and will be free from serious sedimentation and scouring problems.

4.4 Proposed River Structure

Proposed major river structures related with the channel improvement works consist of a bank protection, bridge, irrigation weir and ground sill.

Bank protection will be provided along the steep concave banks of meander between Curug Jompong and Sapan of the Citarum River, consisting of contiguous housing, roads, and public facilities, for preventing bank erosion. For structural details refer Supporting Report I.

Bridge improvement works consist of a new bridge construction and strengthening the sub-structure of the existing one. For structural details also refer Supporting Report I.

Existing two (2) irrigation weirs located along the Citarik River will be required to be reconstructed similar to the existing ones because of a large scale channel improvement.

One (1) ground sill will be provided at the middle stream of the Citarik River in order to adjust the river bed slope of up and down-streams.

Location of the proposed major structures is shown in Fig. H.27.

4.5 Construction Works

Major improvement works, of the Citarum (main), Citarum (upstream), Citarik, Cikeruh and Cisangkuy Rivers, are river dredging including cut-off channels. Small dikes will be constructed for the upper parts of the Citarik River. The construction works of the long-term plan are summarized below.

- River dredging	:	$9{,}409 \times 10^3$ m^3
- River bank clearing and grubbing	:	1.0 km
- Dike construction	:	12.90 km
- Bank protection	:	6.1 km
- Bridge improvement	:	16 places

- Ground sill	:	1 place
- Irrigation weir	:	2 places
- Maintenance/Connection Rd.	:	97.3 km
- Land acquisition	:	165.7 ha
- House resettlement	:	254 houses

Breakdown of the construction works is shown in Table H.11.

5. Flood Plain Management (Non-structural Measure)

Flood plain management is planned to supplement the flood control by structural measures. The possible measures are:

- Land-use regulation including relief to house damage by non-structural measures
- Flood forecasting and warning system

Flood risk map is an essential information required for flood plain management.

5.1 Flood Risk Map

The 1986 flood inundated an area of 7,249 ha and caused damages to 27,310 houses. Number of the affected desas reached 50. (Refer to Supporting Report E)

Some low-lying areas along the Citarum and Citarik Rivers will still sustain flood damages even after completion of the proposed long-term river improvement project. Such flood risk areas are identified for the following two (2) conditions.

(1) Affected by a 20-year flood after completion of the proposed long-term plan

(2) Affected by a 50-year flood after completion of the proposed long-term plan

The estimated flood risk areas for the above conditions are as follows:

Condition (1) : 900 ha
Condition (2) : 1260 ha

The flood risk maps with depth contours for the above two (2) conditions are shown in Figs. H.28 and H.29.

5.2 Target Area of Flood Plain Management

Flood plain management will be performed for the flood risk area of a 50-year flood (1,260 ha).

5.3 Land-use Regulation

Future urban development of the Bandung Metropolitan Area may create sprawl housing development in the flood plain of the Citarum River. The sprawl development will increase the flood damage potential of the area.

A proper land-use regulation by the Government is required to curb the increase of the flood damage potential. The conceivable land-use regulation includes:

- Restriction of housing development in critical areas.
- Guidance for flood-proof housing development.

The following non-structural measures will be required to relieve the existing houses in the critical areas.

- Land filling of house yard
- Raising of house floor
- Construction of flood walls surrounding house

5.4 Flood Forecasting and Warning System

The existing flood forecasting and warning system, established mainly for the purpose of the operation of the Sagling Dam, will be improved to facilitate the evacuation of residents living in the critical flood prone areas.

The system will be improved so that it will have dual functions facilitating the flood plain management of the Upper Citarum Basin as well as the operation of the Sagling Dam.

6. Project Cost of Long-Term Plan

6.1 Unit Construction Cost

The unit construction costs by work items are estimated on a unit cost basis consisting of unit prices of materials, labor, equipment and cost for land acquisition and resettlement compensation. These unit prices at November 1987 are estimated based on the data prepared by the DPUP, West Java Province and the data collected from the agencies concerned.

6.2 Project Cost

The long-term plan consists of the structural and non-structural measures. The project cost are composed on the following items:

A. Direct cost : (1) Civil work cost
(2) Flood warning system cost

B. Indirect cost : (1) Land acquisition and house resettlement cost
(2) Administration and engineering service cost

C. Contingency : (1) Physical contingency

Civil work, flood warning system, and land acquisition and house resettlement compensation costs are estimated based on the unit price.

Administration and engineering costs are assumed at 15% of the total cost of civil work, flood warning system, and land acquisition and house resettlement compensation. Physical contingency cost is assumed at 10% of the sum of the above cost. Price escalation is not considered.

The construction cost of the long-term plan is summarized below.

Project Cost of Long-Term Plan

Item	Cost (Million Rp.)
A. Direct Cost	85,778
(1) Civil Work	(84,513)
(2) Flood Warning System	(1,265)
B. Indirect Cost	23,855
(1) Land Acquisition/Compensation	(9,555)
(2) Administration/Engineering	(14,300)
C. Physical Contingency	10,963
Total	120,596

Breakdown of the project costs of long-term plan are shown in Table H.12 to Table H.14.

7. Economic Evaluation

7.1 Economic Cost

Economic construction cost for the long-term plans is estimated considering deduction of any transfer payment such as tax and duty from local currency portion of the construction cost. The economic construction cost for the long-term plan is estimated at Rp. 117,591 million as shown in Table H.15.

The construction period is assumed to be ten years, and in each year the same amount of construction cost will be incurred untill the completion of the project.

Thus, annual construction cost for the long-term plan amounts to Rp. 11,759 million. The operation and maintenance (O/M) costs of the project are assumed to be 0.5% of the cost of civil works, hence it is estimated at Rp. 427 million, as shown in Table H.19.

7.2 Economic Benefit

The amount of flood damages estimated for various frequency floods under the existing socio-economic condition without project and with the proposed long-term project are shown in Table H.16 and Table H.17. The expected flood damage reduction by the project for various frequency floods are shown in Table H.18.

The average annual flood damage is estimated to be:

- Rp. 16,136 million for without project
- Rp. 130 million for with project

Economic benefit, expected flood damage reduction, of the long-term project is estimated to be Rp. 16,006 million per annum.

Partial benefits up to completion of construction works is assumed to accrue from the fourth year after the commencement of the construction and to increase linearly up to the matured benefit in the eleventh year, i.e., the year of the completion of the whole works. The flow of these benefit is shown in Table H.19.

7.3 Economic Internal Rate of Return (EIRR)

Based on the economic cost and benefit mentioned before, internal rate of return for the proposed long-term plan is calculated under the condition that the project life is assumed at 50 years after completion of the construction works.

Estimated EIRR, B/C and net present value (NPV) in the case discounted at a rate of 10% per annum are 11.6%, 1.18 and Rp. 13,092 million respectively as shown in Table H.19.

Table H.1 COST COMPARISON OF IMPROVEMENT METHOD ALTERNATIVES

(1987 price)

	Unit	Quantity	Unit Cost (Rp.)	Amount (Rp.x10^9)
I. Dike Method				
1) River Improvement Cost				
(a) Citarum (Main)				
Dike	10^3 m3	1,025	5,600	5.74
Land Acquisition	m2	697,500	5,000	3.49
Dredging	10^3 m3	1,100	3,600	3.96
Sub-total				13.19
(b) Major Tributaries				
Dike	10^3 m3	1,160	5,600	6.50
Land Acquisition	m2	627,000	5,000	3.14
Dredging	10^3 m3	1,200	3,600	4.32
Sub-total				13.96
(c) Small Tributaries				
Dike	10^3 m3	1,790	5,600	10.02
Land Acquisition	m2	1,405,000	5,000	7.03
Dredging	10^3 m3	1,900	3,600	6.84
Sub-total				23.89
(d) Miscellaneous ((a) to (c)) x 10%	L.S.			5.10
(e) Other Cost ((a) to (d)) x 30%				16.84
(f) Total ((a) to (e))				72.98
2) Pump Drainage Improvement Cost *1				
(a) Pump Drainage Area	km2	137	1 x 10^9	137.00
3) Grand Total				209.98
II. Dredging Method (Refer to Table H.11 to H16)				
1) Citarum (main)				80.34
2) Major Tributaries				13.73
3) Other Cost				24.93
4) Total				119.00

Note: *1 Pump capacity = 1.0 m3/sec/km2

Table H.2 DESIGN DISCHARGE OF RIVERS IN INDONESIA

No.	Name of River	Province	Catchment Area (km2)	Design Flood (m3/s)	Return Period (Year)
1	Sungai Cimanuk	West Java	3,006	1,440	25
2	Kali Serang	Central Java	937	900	25
3	Sungai Citanduy	West Java	3,680	1,900	25
4	Sungai Ular	North Sumatra	1,080	800	30
5	Kali Pemali	Central Java	1,228	1,300	25
6	Sungai Cipanas	West Java	220	385	25
7	Bengawan Solo	Central/East Java	3,320	2,000	40
8	Kalo Madiun	East Java	2,400	2,300	40
9	Sungai Wanpu	North Sumatra	3,840	1,320	20
10	Sungai Arakundo	Aceh	5,495	2,100	50
11	Krung Aceh	Aceh	1,775	1,960	50
12	Kali Brantas	East Java	10,000	1,500	50
13	Sungai Bah Bolon	North Sumatra	2,776	1,200	20
14	Sungai Walanae	South Sulawesi	3,190	2,900	20
15	Sungai Bila	South Sulawesi	1,368	1,900	20
16	Sungai Jeneberang	South Sulawesi	729	3,700	50

Table H.3 COST COMPARISON OF DESIGN FLOOD ALTERNATIVES

Name of River	Cost (Million Rp.) (1987 price) Alternative I	Altenative II
I. Civil Works		
(a) Citarum River (Main)	73,236	87,349
(b) Citarum River (Up-stream)	1,615	1,615
(c) Citarik River	5,721	5,721
(d) Cikeruh River	932	932
(e) Cisangkuy River	3,011	3,011
Sub-total	84,515	98,628
II. Land Acquisition / Compensation		
(a) Citarum River (Main)	7,100	8,660
(b) Citarum River (Up-stream)	335	335
(c) Citarik River	1,305	1,305
(d) Cikeruh River	200	200
(e) Cisangkuy River	615	615
Sub-total	9,555	11,115
III. Others		
(a) Administration / Engineering Cost	14,110	16,461
(b) Contingency	10,818	12,620
Sub-total	24,928	29,081
IV. Grand Total	118,996	138,824

Note: Breakdown of cost comparison is given in Table H.4.

Table H.4 BREAKDOWN OF COST COMPARISON OF DESIGN FLOOD ALTERNATIVES

(1987 price)

Item	Unit	Quantity		Unit Price (Rp.)	Total Cost (Million Rp.)	
		Alternative I	Alternative II		Alternative I	Alternative II
I.Main Civil Work						
A.Citarum River (main)						
(a) Preparation Work	L.S				4,932	5,882
(b) Dredging	10^3m3	7,900	9,684	6,522	51,524	63,159
(c) Bank Clearing/ Grubbing	m2	29,750	29,750	417	12	12
(d) Bank Protection	m	6,100	6,100	777,435	4,742	4,742
(e) Bridge						
-New Construction	m2(place)	2,112 (3)	2,313 (3)	1,213,658	2,562	2,807
-Strengthening	place	4	4	407,000,000	1,628	1,628
(f) Maintenance/ Connection Road	m	62,400	62,400	18,874	1,178	1,178
(g) Miscellaneous	L.S				6,658	7,941
Sub-tolal					73,234	87,349
B.Citarum River (Up-stream)						
(a) Preparation Work	L.S				109	109
(b) Dredging	10^3m3	219	219	3,516	770	770
(c) New Bridge Construction	m2 (place)	560 (2)	560 (2)	850,331	476	476
(d) Maintenance/ Connection Road	m	6,000	6,000	18,874	113	113
(e) Miscellaneous	L.S				147	147
Sub-tolal					1,615	1,615
C.Citarik River						
(a) Preparation Work	L.S				385	385
(b) Dredging	10^3m3	683	683	3,516	2,402	2,402
(c) Dike	m3(km)	54,043(12.6	54,043(12.6	5,672	307	307
(d) New Bridge Construction	m2 (place)	560 (2)	560 (2)	850,331	476	476
(e) Ground Sill	m(place)	7.5 (1)	7.5 (1)	18,000,000	135	135
(f) Irrigation Weir	m(place)	54 (2)	54 (2)	19,000,000	1,026	1,026
(g) Maintenance/ Connection Road	m	24,900	24,900	18,874	470	470
(h) Miscellaneous					520	520
Sub-tolal					5,721	5,721
D.Cikeruh River						
(a) Preparation Work	L.S				63	63
(b) Dredging	10^3m3	134	134	3,516	471	471
(c) New Bridge Construction	m2 (place)	280 (1)	280 (1)	850,331	238	238
(d) Maintenance/ Connection Road	m	4,000	4,000	18,874	75	75
(e) Miscellaneous	L.S				85	85
Sub-tolal					932	932

(Continued)

Item	Unit	Quantity		Unit Price (Rp.)	Total Cost (Million Rp.)	
		Alternative I	Alternative II		Alternative I	Alternative II
E.Cisangkuy River						
(a) Preparation Work	L.S				203	203
(b) Dredging	10^3m3	473	473	3,516	1,663	1,663
(c) New Bridge	m2	1,024	1,024	850,331	871	871
Construction	(place)	(4)	(4)			
(d) Miscellaneous	L.S				274	274
Sub-tolal					3,011	3,011
Total (A to E)					84,513	98,628
II.Land Acquisition/ Compensation						
A.Land Acquisition						
(a) Citarum River (Main)	10^3m3	1,226	1,479	5,000	6,130	7,395
(b) Citarum River (Up-stream)	10^3m3	59	59	5,000	295	295
(c) Citarik River	10^3m3	246	246	5,000	1,230	1,230
(d) Cikeruh River	10^3m3	32	32	5,000	160	160
(e) Cisangkuy River	10^3m3	94	94	5,000	470	470
Sub-total		1,657	1,910		8,285	9,550
B.House Resettlement						
(a) Citarum River (Main)	house	194	253	5,000,000	970	1,265
(b) Citarum River (Up-stream)	house	8	8	5,000,000	40	40
(c) Citarik River	house	15	15	5,000,000	75	75
(d) Cikeruh River	house	8	8	5,000,000	40	40
(e) Cisangkuy River	house	29	29	5,000,000	145	145
Sub-total		254	313		1,270	1,565
Total (A to B)					9,555	11,115
III.Others						
A. Administration/ Engineering Cost:(I+II)x15%	L.S				14,110	16,461
B. Contingency	L.S				10,818	12,620
Sub-total					24,928	29,081
IV.Grand Total					118,996	138,824

Table H.5 ECONOMIC EVALUATION OF DESIGN FLOOD ALTERNATIVES

Alternative I (20-year plan)

ESTIMATED FLOOD REDUCTION BENEFIT BY ASSET ITEM
FOR ALTERNATIVE I

(Unit : Million Rupiahs)

Asset Item	Recurrence Interval						
	1986 Flood	2-Years	5-Years	10-Years	20-Years	50-Years	100-Years
Houses	5,936.1	7,383.8	11,751.2	16,409.1	19,645.0	22,656.8	24,192.4
Industry	1,506.5	1,709.1	2,040.1	2,221.5	2,322.2	2,418.4	2,430.5
Paddy	4,249.6	4,395.0	4,597.0	4,634.4	4,582.5	4,432.2	4,131.1
Fishpond	18.2	18.2	18.2	18.2	18.2	18.2	18.2
Infrastructure	1,488.3	1,818.6	2,758.3	3,726.1	4,393.4	4,015.0	5,324.6
Indirect Damage	659.9	766.2	1,058.2	1,350.5	1,548.1	1,727.0	1,804.8
Total	13,857.6	16,090.9	22,223.0	28,359.8	32,509.4	36,267.7	37,901.6
Average Annual Damage							16,005.8

ANNUAL FLOW OF ECONOMIC COST AND BENEFIT
FOR ALTERNATIVE I OF LONG-TERM PLAN

(Unit : Million Rupiahs)

No.	Year	Economic Cost			Economic Benefit	Difference
		Construction	O/M Cost	Total		
1	1990	11,834	0	11,834	0	-11,834
2	1991	11,834	0	11,834	0	-11,834
3	1992	11,834	0	11,834	0	-11,834
4	1993	11,834	52	11,886	2,001	-9,885
5	1994	11,834	104	11,938	4,001	-7,937
6	1995	11,834	156	11,990	6,002	-5,988
7	1996	11,834	208	12,042	8,003	-4,039
8	1997	11,834	260	12,094	10,004	-2,090
9	1998	11,834	312	12,146	12,004	-142
10	1999	11,834	364	12,198	14,005	1,807
11	2000	0	416	416	16,006	15,590
12	2001	0	416	416	16,006	15,590
13	2002	0	416	416	16,006	15,590
14	2003	0	416	416	16,006	15,590
15	2004	0	416	416	16,006	15,590
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
59	2048	0	416	416	16,006	15,590
60	2049	0	416	416	16,006	15,590

EIRR : 11.6%

Alternative II (50-year plan)

ESTIMATED FLOOD REDUCTION BENEFIT BY ASSET ITEM
FOR ALTERNATIVE II

(Unit : Million Rupiahs)

Asset Item	Recurrence Interval						
	1986 Flood	2-Years	5-Years	10-Years	20-Years	50-Years	100-Years
Houses	5,941.3	7,390.0	11,772.5	16,442.0	19,717.4	22,778.4	24,445.9
Industry	1,507.6	1,712.5	2,045.7	2,237.9	2,348.1	2,471.0	2,494.9
Paddy	4,253.9	4,399.7	4,610.0	4,651.0	4,640.6	4,589.3	4,419.9
Fishpond	18.2	18.2	18.2	18.2	18.2	18.2	18.2
Infrastructure	1,489.8	1820.5	2,763.6	3,736.0	4,413.1	5,049.9	5,388.2
Indirect Damage	660.5	767.0	1,060.5	1,354.3	1,556.9	1,745.3	1,838.4
Total	13,871.3	16,107.9	22,270.5	28,439.5	32,694.3	36,652.1	38,605.4
Average Annual Damage							16,047.3

ANNUAL FLOW OF ECONOMIC COST AND BENEFIT
FOR ALTERNATIVE II OF LONG-TERM PLAN

(Unit : Million Rupiahs)

No.	Year	Economic Cost			Economic Benefit	Difference
		Construction	O/M Cost	Total		
1	1990	13,535	0	13,535	0	-13,535
2	1991	13,535	0	13,535	0	-13,535
3	1992	13,535	0	13,535	0	-13,535
4	1993	13,535	60	13,595	2,006	-11,590
5	1994	13,535	120	13,656	4,012	-9,644
6	1995	13,535	180	13,716	6,018	-7,698
7	1996	13,535	240	13,776	8,024	-5,752
8	1997	13,535	300	13,836	10,030	-3,806
9	1998	13,535	361	13,896	12,035	-1,860
10	1999	13,535	421	13,956	14,041	85
11	2000	0	481	481	16,047	15,567
12	2001	0	481	481	16,047	15,567
13	2002	0	481	481	16,047	15,567
14	2003	0	481	481	16,047	15,567
15	2004	0	481	481	16,047	15,567
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
59	2048	0	481	481	16,047	15,567
60	2049	0	481	481	16,047	15,567

EIRR : 10.2%

Table H.6 DESIGN DISCHARGE DISTRIBUTION OF CISANGKUY DIVERSION ALTERNATIVES (20-Year Frequency Flood)

Unit: m3/s

Alternative	Citarum River			Cisangkuy River		Cisangkuy Diversion
	Downstream from Margahayu	Margahayu to Dayeuh Kolot	Upstream from Dayeuh Kolot	Downstream from Inlet Site	Upstream from Inlet Site	
I	510	490	390	170	140	-
II	510	425	390	40	140	140

Table H.7 MAIN FEATURES OF CISANGKUY DIVERSION ALTERNATIVES

Alternative	Item	Citarum River	Cisangkuy River	Cisangkuy Diversion
I	Improvement Length (km)	8.15	8.5	-
	Design Discharge Q (m3/s)	490	170	-
	River Bed Slope	1/5,500	1/2,800	-
	River Cross Section (m)	Double Sectin Type Refer to Fig H.8	Single Section Type Refer to Fig H.8	-
II	Improvement Length (km)	8.15	-	3.1
	Design Discharge Q (m3/s)	4.25	-	140
	River Bed Slope	1/5,500	-	1/2,800
	River Cross Section (m)	Double Sectin Type Refer to Fig H.8	-	Single Section Type Refer to Fig H.8

Table H.8 COST COMPARISON OF CISANGKUY DIVERSION ALTERNATIVES

(1987 price)

Item	Quantity			Price (Rp.)	Total Cost (Million Rp.)	
	Unit	Alternative I	Alternative II		Alternative I	Alternative II
I. Citarum River						
A. Main Civil Work						
(a) Dredging						
-Common Soil	x10^3m3	846	705	3,516	2,974.5	2,478.8
-Stiff Soil	x10^3m3	665	554	6,849	4,554.6	3,794.3
-Soft Rock	x10^3m3	553	460	16,720	9,246.2	7,691.2
Sub Total					16,775.3	13,964.3
(b) Road Bridge	m2	672	632		815.6	767.0
	place	(1)	(1)	1,213,658		
(c) Maintenance & Connection Road	m	16,600	16,600	18,874	313.3	313.3
(d) Miscellaneous	L.s.				1,790.4	1,504.5
Sub-total					19,694.6	16,549.1
B. Land Acquisition/ Compensation						
(a) Land Acquisition	x10^3m2	281	253	5,000	1,405.0	1,265.0
(b) House Resettlement	nos	137	124	5,000,000	685.0	620.0
Sub-total					2,090.0	1,885.0
C. Total					21,784.6	18,434.1
II. Cisangkuy River						
A. Main Civil Work						
(a) Dredging	x10^3m3	473	-	3,516	1,663.1	-
(b) Road Bridge	m2	1,024	-	5,660,000	724.5	-
	(place)	(4)		773,488	792.1	
(C) Miscellaneous	L.s.		-		245.5	-
Sub-total					2,700.7	
B. Land Acquisition/ Compensation						
(a) Land Acquisition	x10^3m2	94	-	5,000	470.0	-
(b) House Resettlement	nos	29	-	5,000,000	145.0	-
Sub-total					615.0	-
C. Total					3,315.7	

(Continued)

Item	Quantity			Price (Rp.)	Total Cost (Million Rp.)	
	Unit	Alternative I	Alternative II		Alternative I	Alternative II
III. Cisangkuy Diversion						
A. Main Civil Work						
(a) Dredging	x10^3m3	-	663	7,170	-	4,753.7
(b) Road Bridge	m2	-	1,424	773,488	-	1,101.4
	(place)	-	(5)			
(c) Water Conveyance	m2	-	365	906,000	-	330.7
	(place)	-	(2)			
(d) Ground Sill	m	-	45	19,000,000	-	855.0
	(place)		(3)			
(e) Sluice	place	-	1	20,000,000	-	20.0
(f) Maintenance & Connection Road	m	-	6,200	18,874	-	117.0
(g) Miscellaneous	L.s.	-			-	717.8
Sub-total						7,895.6
B. Land Acquisition/ Compensation						
(a) Land Acquisition	x10^3m2	-	111	5,000	-	555.0
(b) House Resettlement	nos	-	-	5,000,000	-	-
Sub-total						555.0
C. Total						8,450.6
IV. Grand Total					25,100.3	26,884.7

Table H.9 COST COMPARISON OF CUT-OFF "A" ALTERNATIVES

(1987 price)

Item	Quantity			Price (Rp.)	Total Cost (Million Rp.)	
	Unit	Alternative I	Alternative II		Alternative I	Alternative II
I. Existing River						
A. Main Civil Work						
(a) Dredging						
-Common Soil	x10^3m3	328	111	3,516	1,153.2	390.3
-Stiff Soil	x10^3m3	694	66	6,849	4,753.2	452.0
-Soft Rock	x10^3m3	674	335	16,720	11,269.3	5,601.2
Sub Total					17,175.7	6,443.5
(b) Maintenance & Connection Road	m	14,500	5,300	18,874	273.7	100.0
(c) Miscellaneous	L.s.				1,744.9	654.4
Sub-total					19,194.3	7,197.9
B. Land Acquisition/ Compensation						
(a) Land Acquisition	x10^3m2	188	68	5,000	940.0	340.0
(b) House Resettlement	house	-	-	5,000,000	-	-
Sub-total					940.0	340.0
C. Total					20,134.3	7,537.9
II. Cut-off Channel						
A. Main Civil Work						
(a) Dredging						
-Common Soil	x10^3m3	-	252	3,616	-	911.2
-Stiff Soil	x10^3m3	-	802	3,931	-	3,152.7
-Soft Rock	x10^3m3	-	262	7,817	-	2,048.1
Sub Total					-	6,112.0
(b) Road Bridge	m2 (place)	-	1,440 (2)	1,213,658	-	1,747.7
(c) Maintenance & Connection Road	m	-	2,500	18,874	-	47.2
(d) Miscellaneous	L.s.				-	790.7
Sub-total					-	8,697.6
B. Land Acquisition/ Compensation						
(a) Land Acquisition	x10^3m2	-	131	5,000	-	655.0
(b) House Resettlement	house	-	-	5,000,000	-	-
Sub-total					-	655.0
C. Total					-	9,352.6
III. Grand Total					20,134.3	16,890.5

Table H.10 CASE STUDY OF TRACTIVE FORCE OF THE CITARUM RIVER

Location	Pameuntrsan (Nanjung - Ciwidey)	Dayeuh Kolot (Ciwidey - Cisangkuy)	Haurhapit (Cisangkuy - Sapan)	Bojongrangkas (Sapan - Majalaya)
d (cm)	1.68	0.052	0.037	0.101
U*c^2 (cm/s)^2	136	3.04	2.71	5.56
Toc (gr/cm2)	0.138	3.10*10^-3	2.77*10^-3	5.67*10^-3
Ie.Lg (gr/cm3)	1.0*1/5500	1.0*1/5500	1.0*1/5500	1.0*1/5500
R (cm)	700	400	400	400
To (gr/cm2)	127*10^-3	72.7*10^-3	72.7*10^-3	72.7*10^-3
U*^2 (cm/s)^2	125	71.3	71.3	71.3
Existing U*e^2	86	79.3	76.4	72.0
To	0.088	0.081	0.078	0.073

To = Lg R Ie
U* = $\sqrt{To/L}$
Toc = LU*c^2
U*^2 = Toc/L
IWAGAKI Formula ;
d≥0.303cm ; U*c^2=80.9d
0.118≤d≤0.303 ; U*c^2=134.6d^31/22
0.0565≤d≤0.118 ; U*c^2=55d
0.0065≤d≤0.0565 ; U*c^2=8.41d^11/32
d≤0.0065 ; U*c^2=226d

Where, To = tractive force (gr/cm2)
L = density of water (1/980gr.s2/cm4)
g = acceralation of gravity (980cm/s3)
R = Hydraulic radius (cm)
Ie = energy gradient (1/5500)
U* = friction velocity (cm/s)
U*c= critical friction velocity (cm/s)
d = grain size (cm)

Table H.11 CONSTRUCTION WORKS OF PROPOSED LONG-TERM PLAN OF CITARUM RIVER IMPROVEMENT

Item	Unit	Citatrum R. (Main)	Citatrum R. (Upstream)	Citarik River	Cikeruh River	Cisangkuy River	Total
I Civil Work							
A Existing River							
(a) Dredging							
(1) Common Soil	10^3m3	2,701	219	683	134	387	4,124
(2) Stiff Soil	10^3m3	1,123	-	-	-	-	1,123
(3) Soft Rock	10^3m3	1,322	-	-	-	-	1,322
(b) Bank Clearing / Grubbing	m2	29,750	-	-	-	-	29,750
(c) Dike	m3	-	-	54,043	-	-	54,043
(d) Bank Protection	m	6,100	-	-	-	-	6,100
(e) Bridge							
New Construction	m2(place)	-	560 (2)	560 (2)	280 (1)	1,024 (4)	2,424 (9)
Improvement	place	4	-	-	-	-	4
(f) Ground Sill	m(place)	-	-	7.5 (1)	-	-	7.5 (1)
(g) Irrigation Weir	m(place)	-	-	54 (2)	-	-	54 (2)
(h) Maintenancel Connection Road		10,300	-	-	-	-	10,300
B Cut-off Channel							
(a) Dredging							
(1) Common Soil	10^3m3	1,101	-	-	-	86	1,187
(2) Stiff Soil	10^3m2	1,205	-	-	-	-	1,205
(3) Soft Rock	10^3m2	448	-	-	-	-	448
(b) Now Bridge Construction	m2 (place)	2,112 3	- -	- -	- -	- -	2,112 3
(c) Maintenance / Connection Road	m	52,100	6,000	24,900	4,000	-	87,000
II Land Acquisition Compensation							
A Land Acquisition							
(a) Existing River	10^3m2	874	59	246	32	71	1,282
(b) Cut-off Channel	10^3m2	352	-	-	-	23	375
B House Resettlement							
(a) Existing River	house	114	8	15	8	29	174
(b) Cut-off Channel	house	80	-	-	-	-	80
III Warning System Equipment	set	1	-	-	-	-	1

Table H.12 BREAKDOWN IN PROJECT COST OF LONG-TERM PLAN

(1987 price)

Item	Local Currency L/C (Rp 10^6)	Foreign Currency F/C (us$ 10^3)	Equivalent Total (Rp 10^6)
A. Structual Measures			
I Civil Work			
(1) Citarum River (Main)	11,754.5	37,148.0	73,234.3
(2) Citarum River (Up-Stream)	315.0	785.5	1,615.1
(3) Citarik River	1,192.5	2,735.9	5,720.6
(4) Cikeruh River	179.1	455.3	932.4
(5) Cisangkuy River	511.5	1,510.1	3,010.6
Sub-Total	13,952.6	42,634.8	84,513.0
II Land Acquisition / Compensation			
(1) Citarim River (Main)	7,100.0	-	7,100.0
(2) Citarum River (Up-Stream)	335.0	-	335.0
(3) Citarik River	1,305.0	-	1,305.0
(4) Cikeruh River	200.0	-	200.0
(5) Cisangkuy River	615.0	-	615.0
Sub-Total	9,555.0	-	9,555.0
III Total	23,507.6	42,634.8	94,068.0
IV Administration/Engineering (III) * 15%	3,526.1	6,395.2	14,110.2
V Contingency (III + IV) * 10%	2,703.4	4,903.0	10,817.8
VI Structual Total	29,737.1	53,933.0	118,996.0
B. Non Structual Measures (Flood Warning System)			
I Equipment Installation and Accessaries	252.4	612.0	1,265.2
II Administration/Engineering (III) * 15%	37.9	91.8	189.8
III Contingency (III + IV) * 10%	29.0	70.4	145.5
IV Non Structual Total	319.3	774.2	1,600.5
C. Grand Total	30,056.4	54,707.2	120,596.5

Note: Excharge rate US$ 1.00 = Rp.1655 = ¥135

Table H.13 BREAKDOWN OF CIVIL WORK COST OF LONG-TERM PLAN

(1987 price)

Item	Quantity		Local Currency (Rp.)		Foreign Currency (US$)		Equivalent Total (Rp. 10^6)
	Unit	Amount	Unit Cost	Amount (10^6)	Unit Cost	Amount (10^3)	
I Citarum (main) River							
A Existing River							
(a) Preparatory Work				533.9		1,932.8	3,732.7
(b) Dredging							
(1) Common Soil	10^3 m3	2,701	422	1,139.8	1.87	5,050.9	9,499.0
(2) Stiff Soil	10^3 m3	1,123	754	846.7	3.68	4,132.6	7,686.2
(3) Soft Rock	10^3 m3	1,322	1,480	1,956.6	9.21	12,175.6	22,107.2
(c) Bank Clearing/Grubbing	m2	29,750	135	4.0	0.17	5.1	12.4
(d) Bank Protection	m	6,100	340,680	2,078.1	263.90	1,609.8	4,742.3
(e) Bridge Improvement Strengthening (Gabion)	place	4	61,050,000	244.2	209,033.00	836.1	1,627.9
(f) Maintenance/Connection Rd.	m	52,100	7,752	403.9	6.72	350.1	983.3
(g) Miscellaneous	L.s.			720.7		2,609.3	5,039.1
Sub-total				7,927.9		28,702.3	55,430.1
B Cut-off Channel							
(a) Preparatory Work				257.7		568.7	1,198.9
(b) Dredging							
(1) Common Soil	10^3 m3	1,101	768	845.6	1.73	1,904.7	3,997.9
(2) Stiff Soil	10^3 m3	1,205	829	998.9	1.87	2,253.4	4,728.3
(3) Soft Rock	10^3 m3	448	1,464	655.9	3.84	1,720.3	3,503.0
(c) New Bridge Construction	m2 (place)	2,112 (3)	303,415	640.8	550.00	1,161.6	2,563.2
(d) Maintenance/Connection Rd.	m	10,300	7,752	79.8	6.72	69.2	194.3
(e) Miscellaneous	L.s.			347.9		767.8	1,618.6
Sub-total				3,826.6		8,445.7	17,804.2
C Total				11,754.5		37,148.0	73,234.3

(continued)

Item	Quantity		Local Currency (Rp.)		Foreign Currency (US$)		Equivalent Total (Rp. 10^6)
	Unit	Amount	Unit Cost	Amount (10^6)	Unit Cost	Amount (10^3)	
II Citarum (upstream) River							
(a) Preparatory Work				21.2		52.9	108.8
(b) Dredging	10^3 m3	219	422	92.4	1.87	409.5	770.1
(c) New Bridge Construction	m2 (place)	560 (2)	225,552	126.3	377.51	211.4	476.2
(h) Maintenance/Connection Rd.	m	6,000	7,752	46.5	6.72	40.3	113.2
(i) Miscellaneous	L.s.			28.6		71.4	146.8
Sub-total				315.0		785.5	1,615.1
III Citarik River							
(a) Preparatory Work				80.3		184.2	385.2
(b) Dredging	10^3 m3	683	422	288.2	1.87	1,277.2	2,402.0
(c) Dike	m3	54,043	889	48.0	2.89	156.2	306.5
(d) New Bridge Construction	m2 (place)	560 (2)	225,552	126.3	377.51	211.4	476.2
(e) Ground Sill	m (place)	7.5 (1)	5,400,000	40.5	7,595.00	57.0	134.8
(f) Irrigation Weir	m (place)	54 (2)	5,700,000	307.8	8,036.00	433.9	1,025.9
(g) Maintenance/Connection Rd.	m	24,900	7,752	193.0	6.72	167.3	469.9
(h) Miscellaneous	L.s.			108.4		248.7	520.1
Sub-total				1,192.5		2,735.9	5,720.6
IV Cikeruh River							
(a) Preparatory Work				12.1		30.7	62.8
(b) Dredging	10^3 m3	134	422	56.5	1.87	250.6	471.2
(c) New Bridge Construction	m2 (place)	280 (1)	225,552	63.2	377.51	105.7	238.1
(d) Maintenance/Connection Rd.	m	4,000	7,752	31.0	6.72	26.9	75.5
(e) Miscellaneous	L.s.			16.3		41.4	84.8
Sub-total				179.1		455.3	932.4

(continued)

Item	Quantity		Local Currency (Rp.)		Foreign Currency (US$)		Equivalent Total (Rp. 10^6)
	Unit	Amount	Unit Cost	Amount (10^6)	Unit Cost	Amount (10^3)	
V Cisangkuy River							
A Existing River							
(a) Preparatory Work				31.5		88.8	178.5
(b) Dredging	10^3 m3	387	422	163.3	1.87	723.7	1,361.0
(c) New Bridge Construction	m2 (place)	1,024 (4)	225,552	231.0	377.51	386.6	871.8
(d) Miscellaneous	L.s.			42.6		119.9	241.0
Sub-total				468.4		1,319.0	2,651.3
B Cut-off Channel							
(a) Preparatory Work				2.9		12.9	24.2
(b) Dredging		86	422	36.3	1.87	160.8	302.4
(c) Miscellaneous				3.9		17.4	32.7
Sub-total				43.1		191.1	359.3
C Total				511.5		1,510.1	3,010.6
VI Grand Total				13,952.6		42,634.8	84,513.0

Table H.14 BREAKDOWN OF LAND ACQUISITION/COMPENSATION COST OF LONG-TERM PLAN

(1987 price)

Item	Quantity		Local Currency (Rp.)		Foreign Currency (US$)		Equivalent Total (Rp. 10^6)
	Unit	Amount	Unit Cost	Amount (10^6)	Unit Cost	Amount (10^3)	
I Citarum (main) River							
A Land Acquisition							
(a) Existing River	10^3 m2	874	5,000	4,370.0			4,370.0
(b) Cut-off Channel	10^3 m2	352	5,000	1,760.0			1,760.0
B House Resettlement							
(a) Existing River	house	114	5,000,000	570.0			570.0
(b) Cut-off Channel	house	80	5,000,000	400.0			400.0
C Total				7,100.0			7,100.0
II Citarum (upstream) River							
A Land Acquisition	10^2 m2	59	5,000	295.0			295.0
B House Resettlement	house	8	5,000,000	40.0			40.0
C Total				335.0			335.0
III Citarik River							
A Land Acquisition	10^3 m2	246	5,000	1,230.0			1,230.0
B House Resettlement	house	15	5,000,000	75.0			75.0
C Total				1,305.0			1,305.0
IV Cikeruh River							
A Land Acquisition	10^3 m2	32	5,000	160.0			160.0
B House Resettlement	house	8	5,000,000	40.0			40.0
C Total				200.0			200.0

(continued)

Item	Quantity		Local Currency (Rp.)		Foreign Currency (US$)		Equivalent Total (Rp. 10^6)
	Unit	Amount	Unit Cost	Amount (10^6)	Unit Cost	Amount (10^3)	
V Cisangkuy River							
A Land Acquisition							
(a) Existing River	10^3 m2	71	5,000	355.0			355.0
(b) Cut-off Channel	10^3 m2	23	5,000	115.0			155.0
B House Resettlement							
(a) Existing River	house	29	5,000,000	145.0			145.0
(b) Cut-off Channel	house	-	-	-			-
C Total				615.0			615.0
VI Grand Total				9,555.0			9,555.0

Table H.15 ECONOMIC COST FOR PROPOSED OVERALL FLOOD CONTROL PLAN

(1987 price)

Item	Loacal Currency			Foreign Currency		Economic Cost
	Construction Cost (Million Rp.)	Tax (Million Rp.)	Economic Cost (Million Rp.)	Construction Cost (10^3 US$)	Equivalant (Million Rp.)	(Million Rp.)
Structural Measure	29,737.1	2,973.7	26,763.4	53,933.0	89,259.1	116,022.5
Non-structural Measure	319.3	31.9	287.4	774.2	1,281.3	1,568.7
Total	30,056.4	3,005.6	27,050.8	54,707.2	90,540.4	117,591.2

Note:1.Rate of Tax is assumed 10% of construction cost of local currency.
2.US$ 1 = Rp.1,655

Table H.16 ESTIMATED FLOOD DAMAGE AND AVERAGE ANNUAL DAMAGE POTENTIAL UNDER WITHOUT-PROJECT CONDITION AT 1987 ECONOMIC PRICE

(Unit : Million Rupiahs)

Asset Item	Recurrence Iterval						
	1986 Flood	2-Years	5-Years	10-Years	20-Years	50-Years	100-Years
Houses	5,946.8	7,401.0	11,821.2	16,545.0	19,910.1	23,111.1	25,010.7
Industry	1,510.6	1,717.7	2,068.0	2,274.4	2,422.6	2,595.1	2,704.8
Paddy	4,258.6	4,408.5	4,633.0	4,695.9	4,717.0	4,741.8	4,751.7
Fishpond	18.2	18.2	18.2	18.2	18.2	18.2	18.2
Infrastructure	1,491.5	1,823.7	2,777.8	3,763.9	4,466.5	6,141.2	5,543.1
Indirect Damage	661.3	768.5	1,065.9	1,364.9	1,576.7	1,780.4	1,901.4
Total	13,887.0	16,137.6	22,384.2	28,662.2	33,111.2	37,387.8	39,929.9
Average Annual Damage							16,135.5

Table H.17 ESTIMATED FLOOD DAMAGE AFTER COMPLETION OF THE LONG-TERM PLAN

(Unit : Million Rupiahs)

Asset Item	Recurrence Iterval						
	1986 Flood	2-Years	5-Years	10-Years	20-Years	50-Years	100-Years
Houses	10.7	17.2	70.0	135.9	265.1	454.3	818.3
Industry	5.1	8.6	27.9	52.9	100.4	176.7	274.3
Paddy	9.0	13.5	36.0	61.5	134.5	309.6	620.6
Fishpond	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Infrastructure	3.2	5.2	19.6	37.8	73.1	126.2	218.5
Indirect Damage	1.4	2.2	7.7	14.4	28.7	53.3	96.6
Total	29.4	46.7	161.2	302.5	601.8	1,120.1	2,028.3
Average Annual Damage							129.8

Table H.18 ESTIMATED FLOOD REDUCTION BENEFIT BY ASSET ITEM OF LONG-TERM PLAN

(Unit : Million Rupiahs)

Asset Item	Recurrence Iterval						
	1986 Flood	2-Years	5-Years	10-Years	20-Years	50-Years	100-Years
Houses	5,936.1	7,383.8	11,751.2	16,409.1	19,645.0	22,656.8	24,192.4
Industry	1,505.5	1,709.1	2,040.1	2,221.5	2,322.2	2,418.4	2,430.5
Paddy	4,249.6	4,395.0	4,597.0	4,634.4	4,582.5	4,432.2	4,131.1
Fishpond	18.2	18.2	18.2	18.2	18.2	18.2	18.2
Infrastructure	1,488.3	1,818.6	2,758.3	3,726.1	4,393.4	4,015.0	5,324.6
Indirect Damage	659.9	766.2	1,058.2	1,350.5	1,548.1	1,727.0	1,804.8
Total	13,857.6	16,090.9	22,223.0	28,359.8	32,509.4	36,267.7	37,901.6
Average Annual Damage							16,005.8

Table H.19 ANNUAL FLOW OF ECONOMIC COST AND BENEFIT OF LONG-TERM PLAN

(Unit : Million Rupiahs)

No.	Year	Economic Cost			Economic Benefit	Difference
		Construction	O/M Cost	Total		
1	1990	11,759	0	11,759	0	-11,759
2	1991	11,759	0	11,759	0	-11,759
3	1992	11,759	0	11,759	0	-11,759
4	1993	11,759	53	11,812	2,001	-9,811
5	1994	11,759	107	11,866	4,001	-7,865
6	1995	11,759	160	11,919	6,002	-5,917
7	1996	11,759	214	11,973	8,003	-3,970
8	1997	11,759	267	12,026	10,004	-2,022
9	1998	11,759	320	12,079	12,004	-75
10	1999	11,759	374	12,133	14,005	1,872
11	2000	0	427	427	16,006	15,579
12	2001	0	427	427	16,006	15,579
13	2002	0	427	427	16,006	15,579
14	2003	0	427	427	16,006	15,579
15	2004	0	427	427	16,006	15,579
-	-	"	"	"	"	"
-	-	"	"	"	"	"
-	-	"	"	"	"	"
-	-	"	"	"	"	"
59	2048	0	427	427	16,006	15,579
60	2049	0	427	427	16,006	15,579

EIRR : 11.6%
B/C : 1.18
NPV : Rp 13,092 million

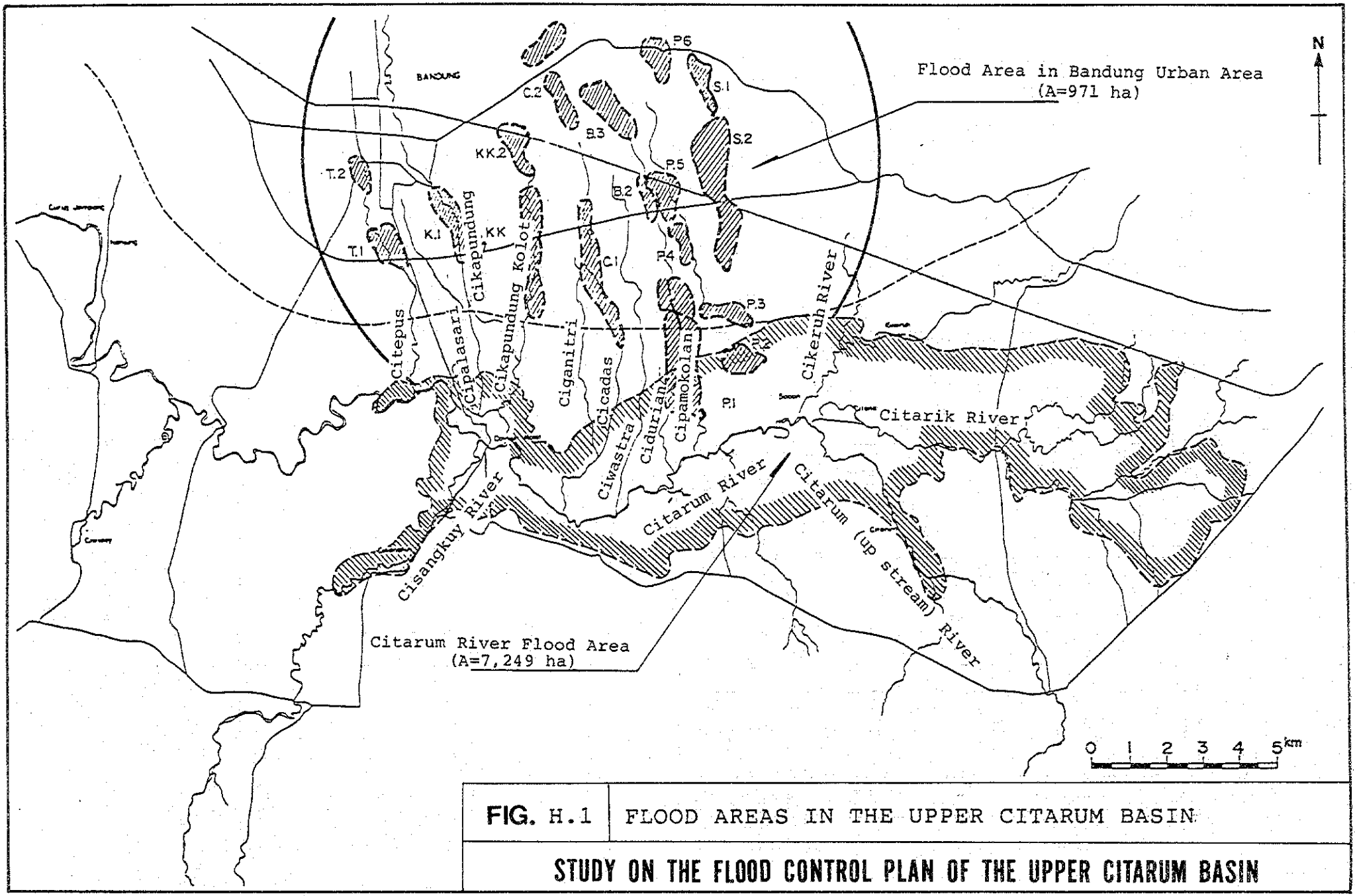
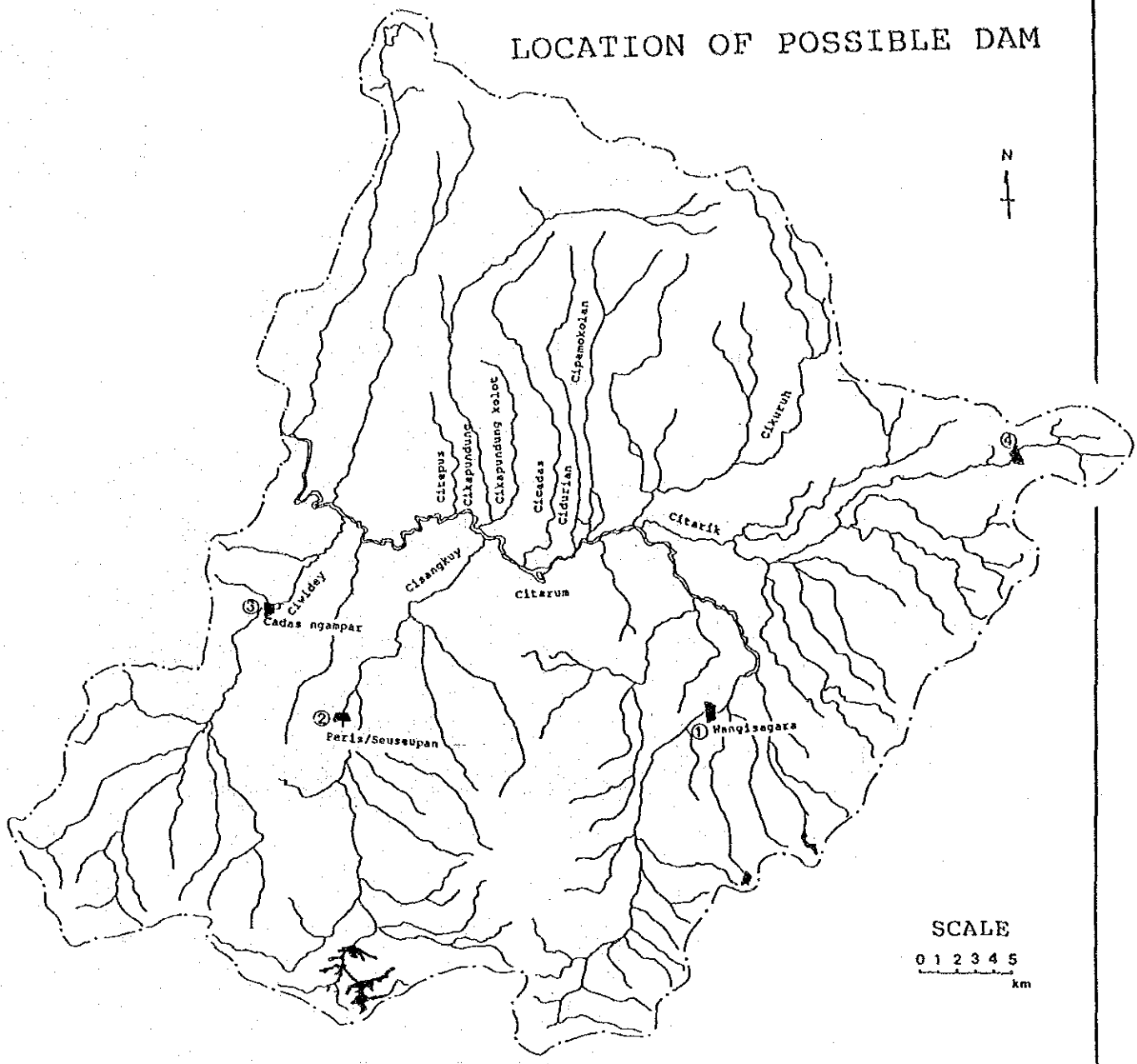


FIG. H.1 FLOOD AREAS IN THE UPPER CITARUM BASIN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



MAIN FEATURES OF POSSIBLE DAMS

	Name of Dam	River	Catchment Area (km2)	Gross Storage Volume (10^3 m3)	Effective Storage Volume (10^3 m3)	Dam Height (m)
1	Wangi Sagara	Citarum	97.5	730	592	18.5
2	Seuseupan / Peris	Cisangkuy	157.2	440	270	19.0
3	Cadas Ngampar	Ciwidey	183.1	630	513	22.0
4	-------	Citarik	13.66	1500		50.0

Source: Bina Program (1986; Raya Consult),
West Java Province Public Work Service (1985, PT Seconria Java)

FIG. H.2 LOCATION AND MAIN FEATURES OF POSSIBLE DAM

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

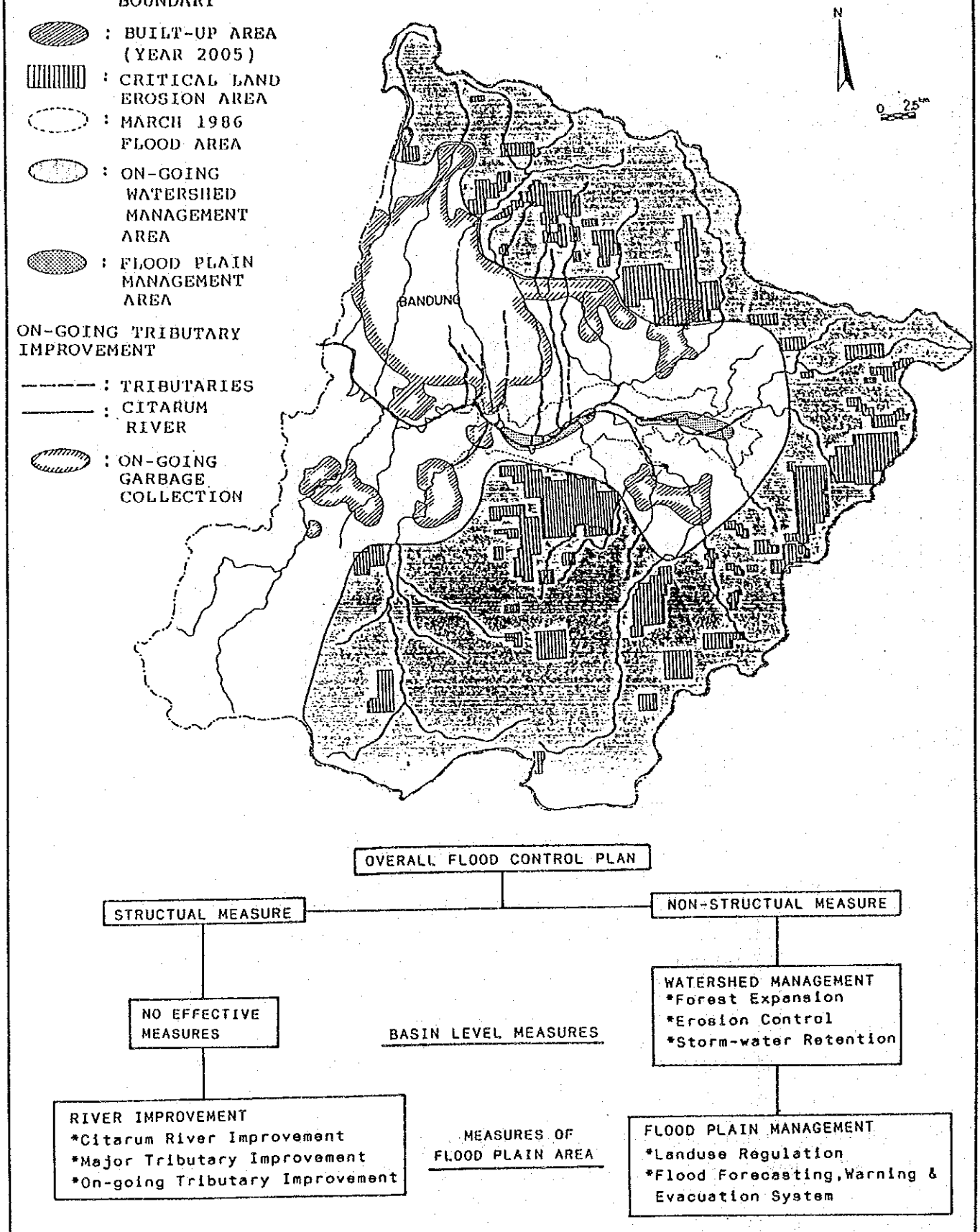
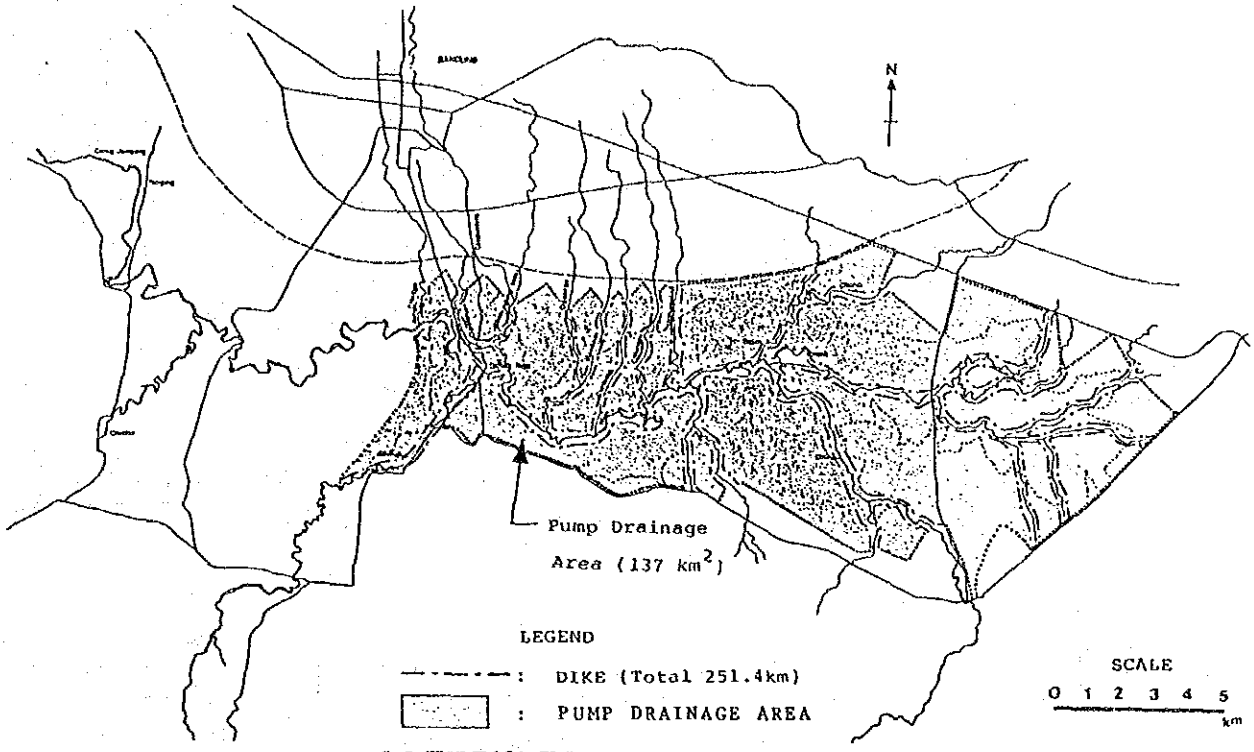


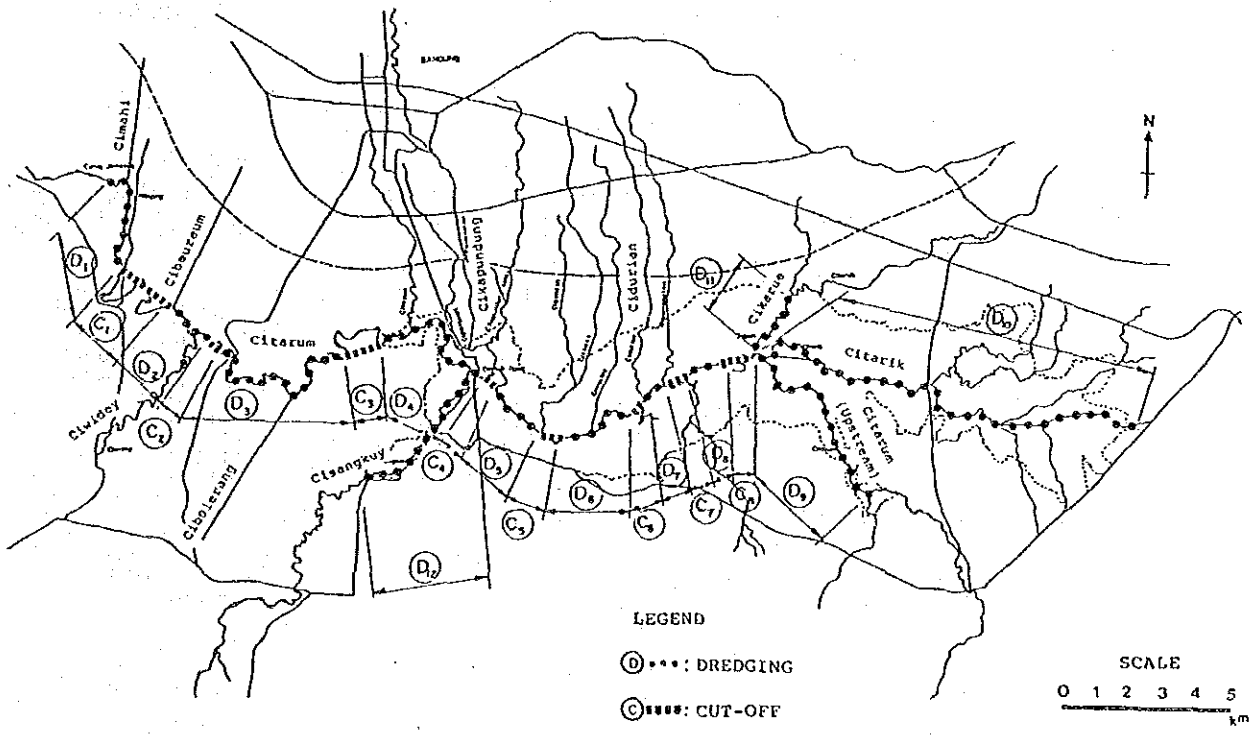
FIG. H.3 COMPONENT OF PROPOSED OVERALL FLOOD CONTROL PLAN OF UPPER CITARUM RIVER BASIN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



ALTERNATIVE I : DIKE METHOD

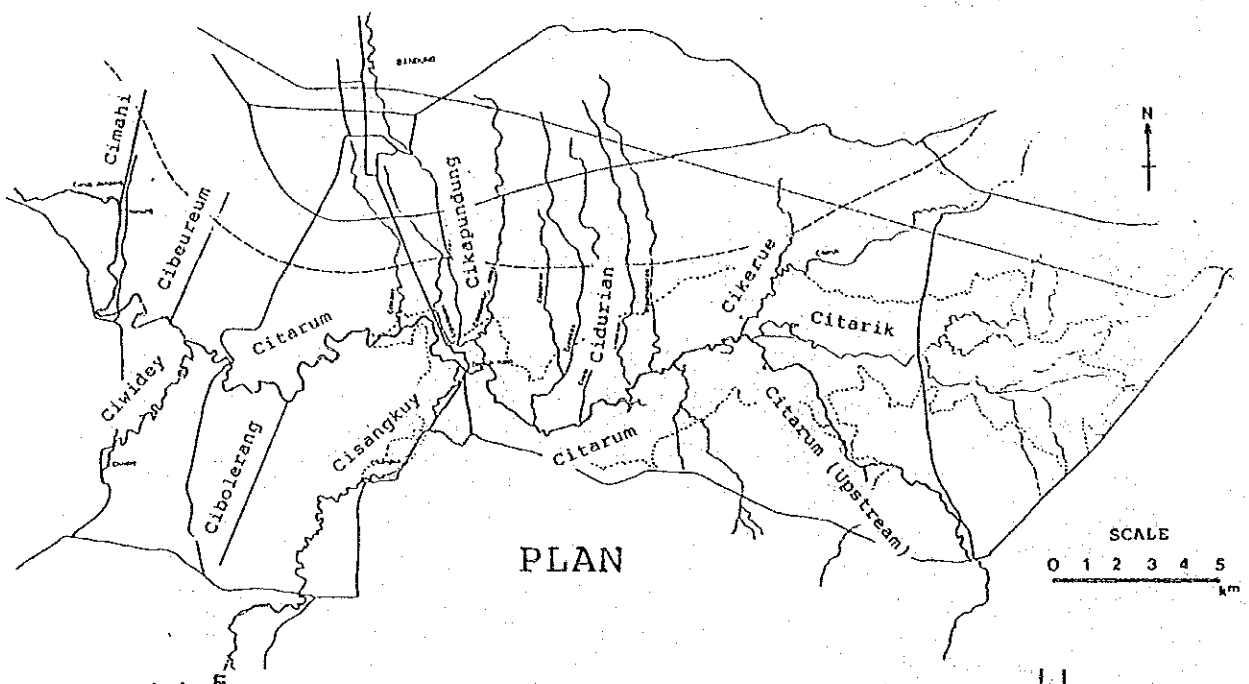


ALTERNATIVE II : DREDGING METHOD

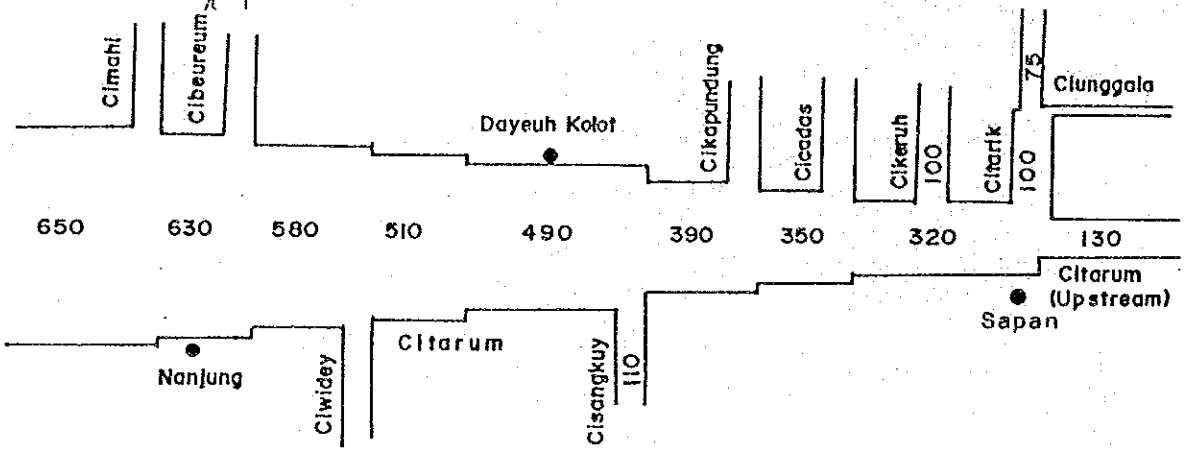
FIG. H.4	ALTERNATIVE SCHEME OF RIVER IMPROVEMENT METHOD

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

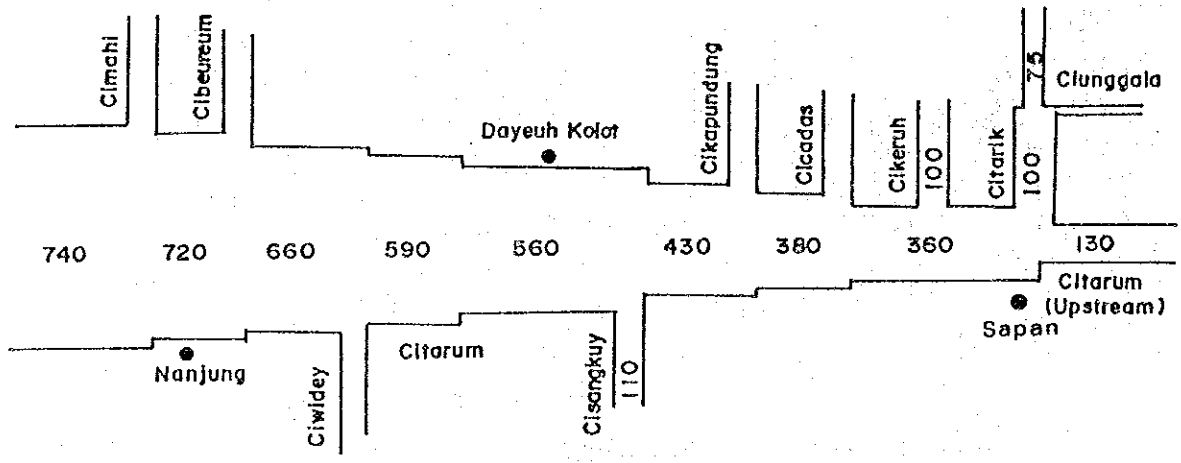
JICA



PLAN



ALTERNATIVE I (Citarum River : 20-Year Frequency Flood Discharge
Tributaries : 20-Year Frequency Flood Discharge)



ALTERNATIVE II (Citarum River : 50-Year Frequency Flood Discharge
Tributaries : 20-Year Frequency Flood Discharge)

FIG. H.5 DESIGN DISCHARGE DISTRIBUTION OF DESIGN FLOOD FREQUENCY ALTERNATIVES

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

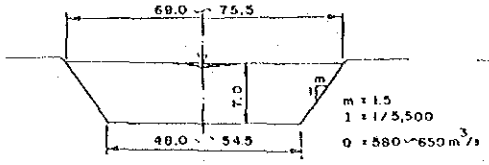
ALTERNATIVE I

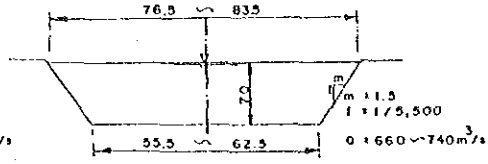
ALTERNATIVE II

SECTION

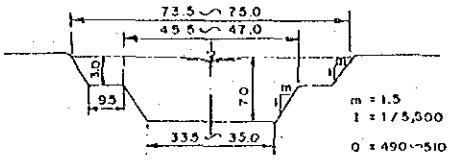
CITARUM RIVER

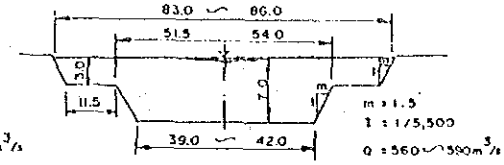
CURUG JOMPONG (0.00 Km)
TO
CIWIDEY (5.90 Km)



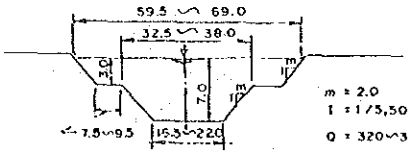


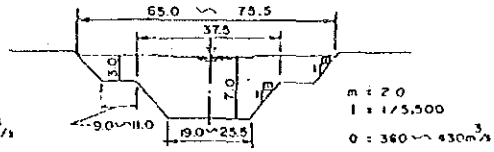
CIWIDEY (5.90 Km)
TO
CISANGKUY (20.00 Km)





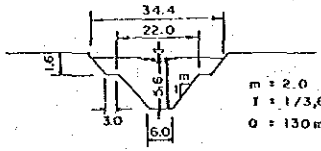
CISANGKUY (20.00 Km)
TO
CITARIK (31.10 Km)





CITARUM (UPSTREAM) RIVER

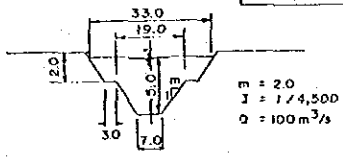
CITARIK (31.10 Km)
TO
BOJONG RANGKAS (35.20 Km)



SAME AS ALTERNATIVE I

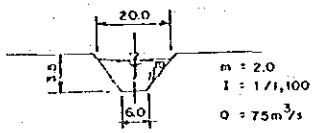
CITARIK RIVER

CITARUM (0.00 Km)
TO
CIUNGGALA (10.00 Km)



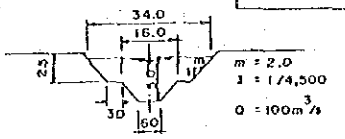
SAME AS ALTERNATIVE I

CIUNGGALA (10.00 Km)
TO
CIBODAS (15.00 Km)



CIKERUH RIVER

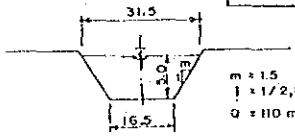
CITARUM (0.00 Km)
TO
CIPANJALU (2.00 Km)



SAME AS ALTERNATIVE I

CISANGKUY RIVER

CITARUM (0.00 Km)
TO
RANCAENGANG (8.50 Km)



SAME AS ALTERNATIVE I

FIG. H.6 DESIGN RIVER CROSS SECTIONS OF DESIGN FLOOD FREQUENCY ALTERNATIVES

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

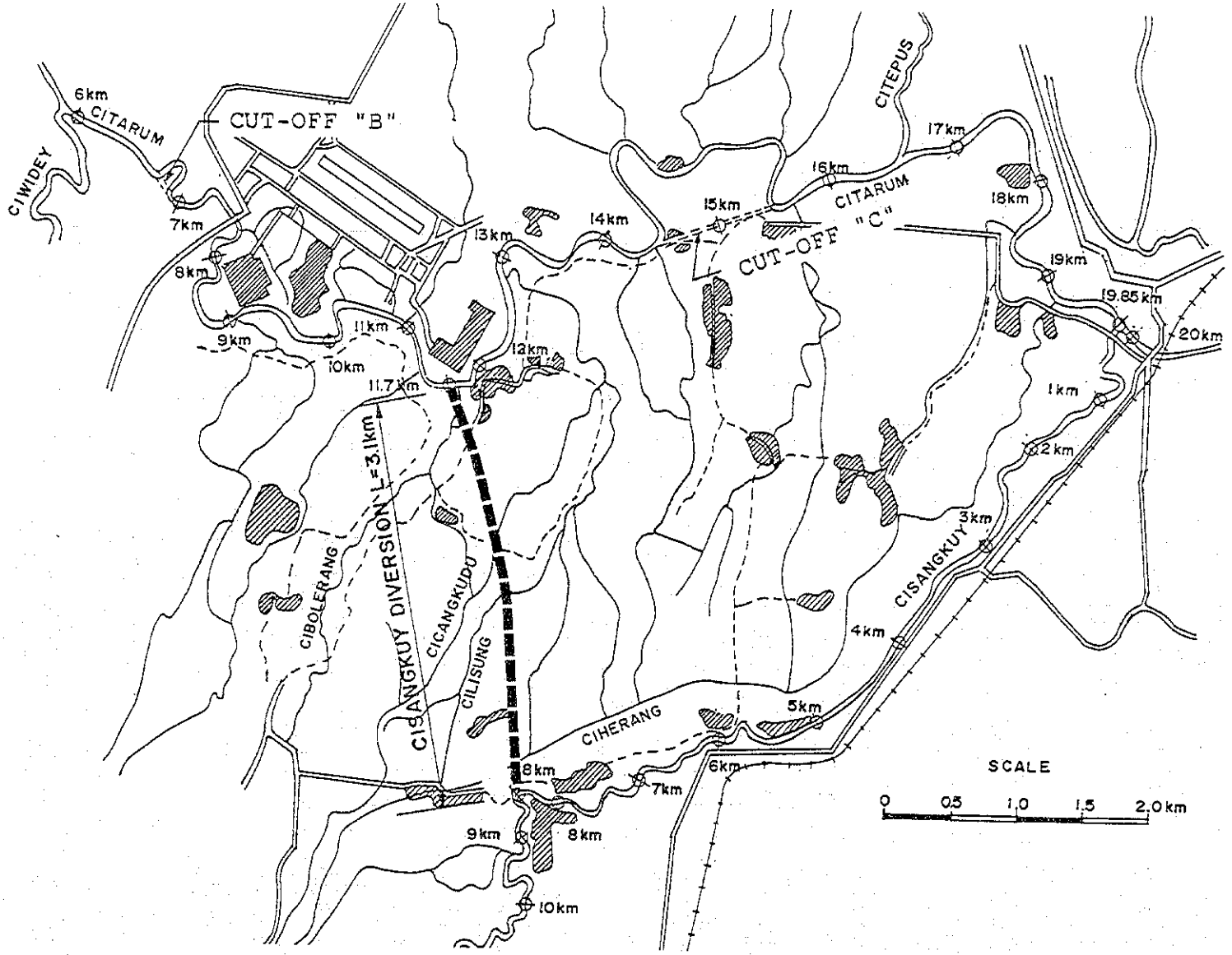
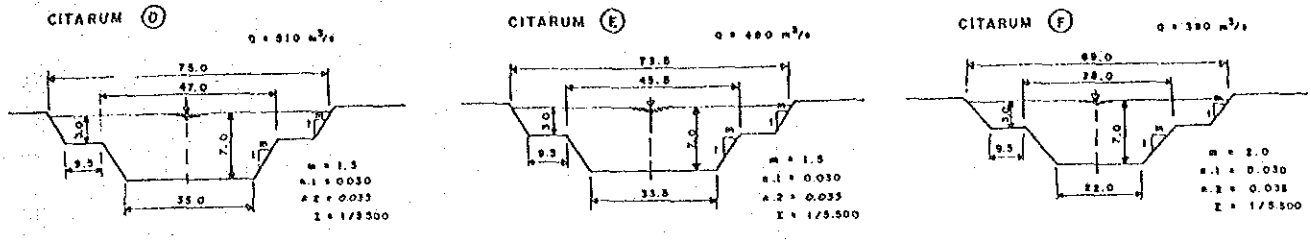


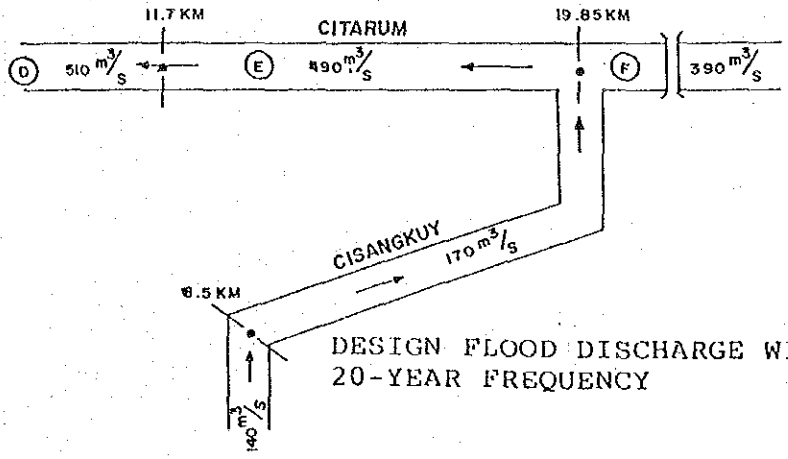
FIG. H.7 LOCATION OF PROPOSED CISANGKUY DIVERSION

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

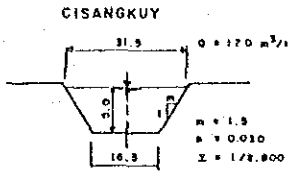
JICA



DESIGN CROSS SECTION OF CITARUM RIVER

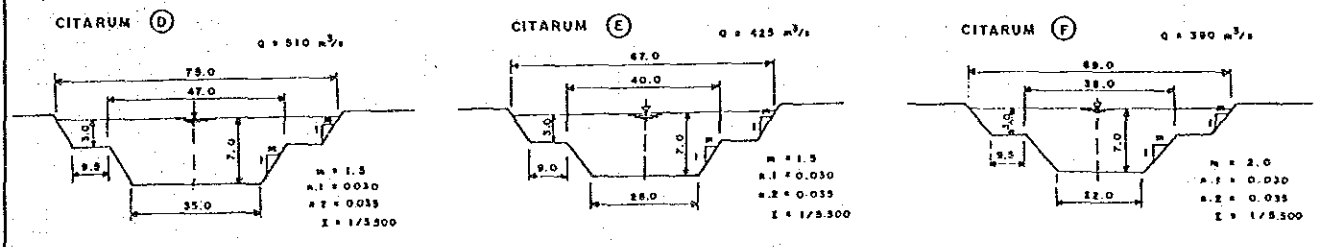


DESIGN FLOOD DISCHARGE WITH 20-YEAR FREQUENCY

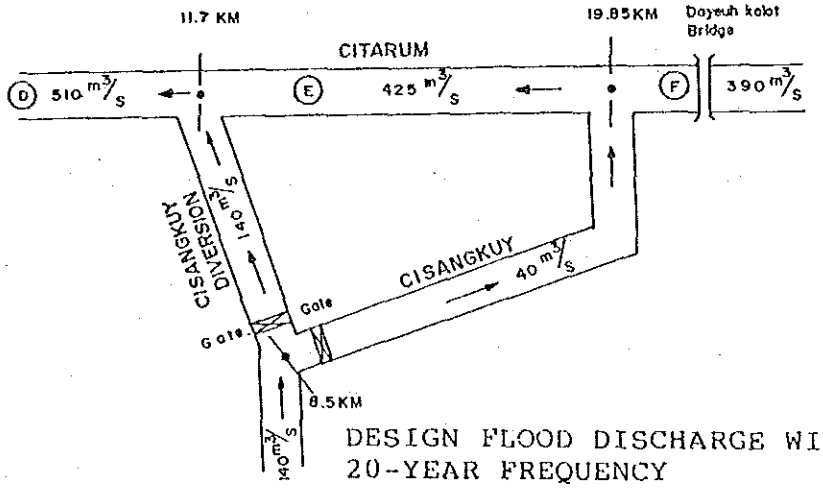


DESIGN CROSS SECTION OF CISANGKUY RIVER

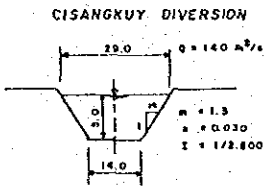
ALTERNATIVE I (WITHOUT CISANGKUY DIVERSION)



DESIGN CROSS SECTION OF CITARUM RIVER



DESIGN FLOOD DISCHARGE WITH 20-YEAR FREQUENCY



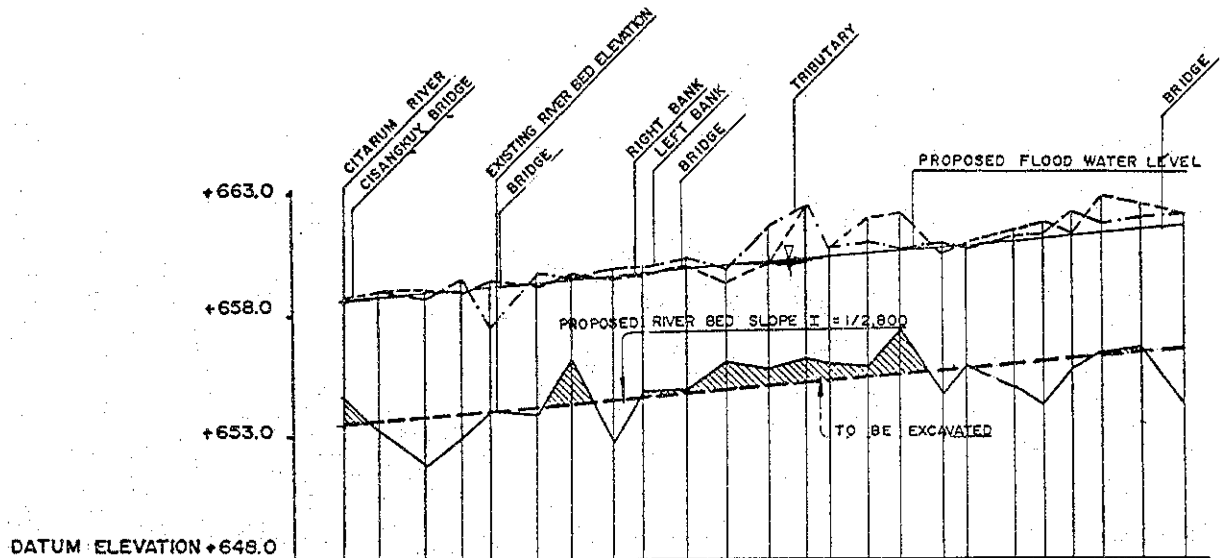
DESIGN CROSS SECTION OF CISANGKUY DIVERSION)

ALTERNATIVE II (WITH CISANGKUY DIVERSION)

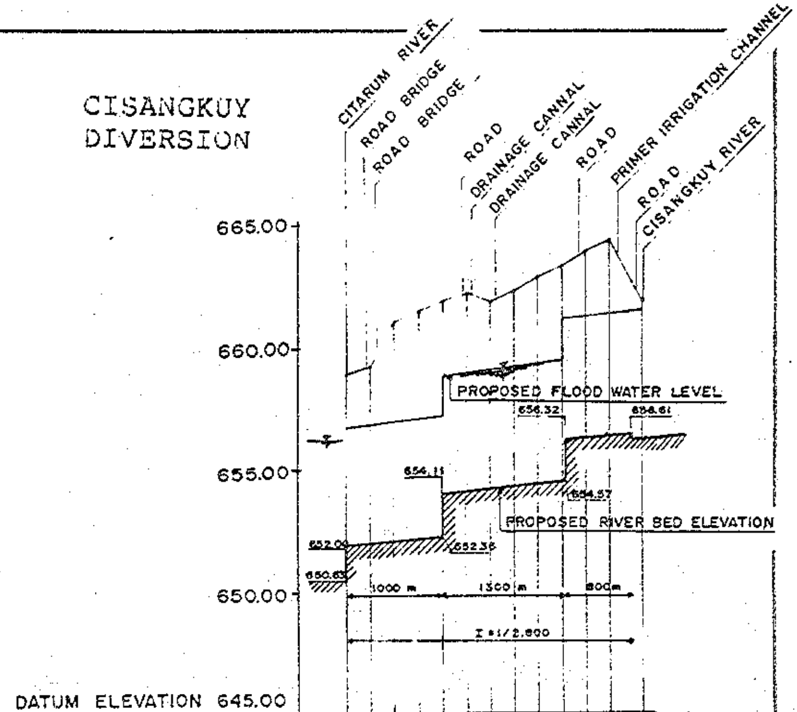
FIG. H.8 PROPOSED DESIGN DISCHARGE/RIVER CROSS SECTION OF CISANGKUY DIVERSION ALTERNATIVE

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



		BM17	17	18	24	32	41	50	59	65	73	82	88	93	BM18	S/10	S/29	S/32	S/40	S/55	S/62	S/71	S/78	S/90	S/101
PROPOSED	BANK ELEVATION (M)	658.47	658.97	658.67	658.67	657.63	659.17	659.62	659.47	659.58	659.94	659.38	660.01	662.52	661.12	661.11	660.72	660.54	660.80	661.31	661.44	661.40	661.83	662.06	662.23
	FLOOD WATER LEVEL (M)	658.50	658.63	658.79	658.96	659.04	659.21	659.34	659.50	659.61	659.77	659.91	660.07	660.21	660.30	660.45	660.57	660.73	660.82	661.00	661.11	661.21	661.32	661.48	661.68
	RIVER BED ELEVATION (M)	653.50	653.63	653.79	653.96	654.04	654.21	654.34	654.50	654.61	654.77	654.91	655.07	655.21	655.30	655.45	655.57	655.73	655.82	656.00	656.11	656.21	656.32	656.48	656.68
EXISTING	LEFT BANK ELEVATION (M)	658.64	658.99	659.01	659.43	659.45	659.17	659.49	659.47	659.56	659.94	659.36	660.01	662.52	661.12	662.19	662.25	660.54	661.10	661.58	661.90	661.40	662.92	662.62	662.24
	RIGHT BANK ELEVATION (M)	658.47	658.97	658.67	658.87	657.33	658.71	659.32	659.85	659.98	660.23	658.61	661.56	662.57	661.21	661.11	660.72	661.05	660.80	661.31	661.44	662.26	661.83	663.06	663.23
	RIVER BED ELEVATION (M)	654.61	653.26	651.72	652.99	654.15	655.93	656.10	652.72	654.82	654.98	656.13	655.76	656.18	656.04	658.95	657.42	654.65	655.89	655.17	654.54	653.87	658.82	658.72	654.83
COMULATIVE DISTANCE(KM)		0.00	0.33	0.82	1.20	1.50	2.00	2.35	2.80	3.10	3.55	3.95	4.40	4.80	5.05	5.45	5.80	6.25	6.50	7.00	7.30	7.60	7.90	8.30	8.75
SECTION DISTANCE (KM)		0.00	0.33	0.47	0.38	0.30	0.50	0.35	0.45	0.30	0.45	0.40	0.45	0.40	0.25	0.40	0.35	0.45	0.25	0.50	0.30	0.30	0.30	0.40	0.45
SECTION NAME		BM17	17	18	24	32	41	50	59	65	73	82	88	93	BM18	S/10	S/29	S/32	S/40	S/55	S/62	S/71	S/78	S/90	S/101



		CPSC00	R.6	R.10	SD47	SD42	SD37	SD32	SD29	CP300	SD19	SD14	SD10	TBCS01
PROPOSED	BANK ELEVATION (M)													
	FLOOD WATER LEVEL (M)													
	RIVER BED ELEVATION (M)	652.00	652.08	652.18	652.27	652.36	654.20	654.29	654.38	654.47	654.57	656.39	656.48	656.61
EXISTING	GROUND LEVEL (M)	659.00	659.70	661.10	661.80	662.00	662.25	662.00	662.40	663.10	663.40	664.00	664.80	662.00
	RIVER BED ELEVATION (M)													
CUMULATIVE DISTANCE (M)		0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.10
SECTION DISTANCE (M)		0.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.35
SECTION NAME		CPSC00	R.6	R.10	SD47	SD42	SD37	SD32	SD29	CP300	SD19	SD14	SD10	TBCS01

FIG. H.9 PROPOSED RIVER PROFILES OF CISANGKUY RIVER AND CISANGKUY DIVERSION

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

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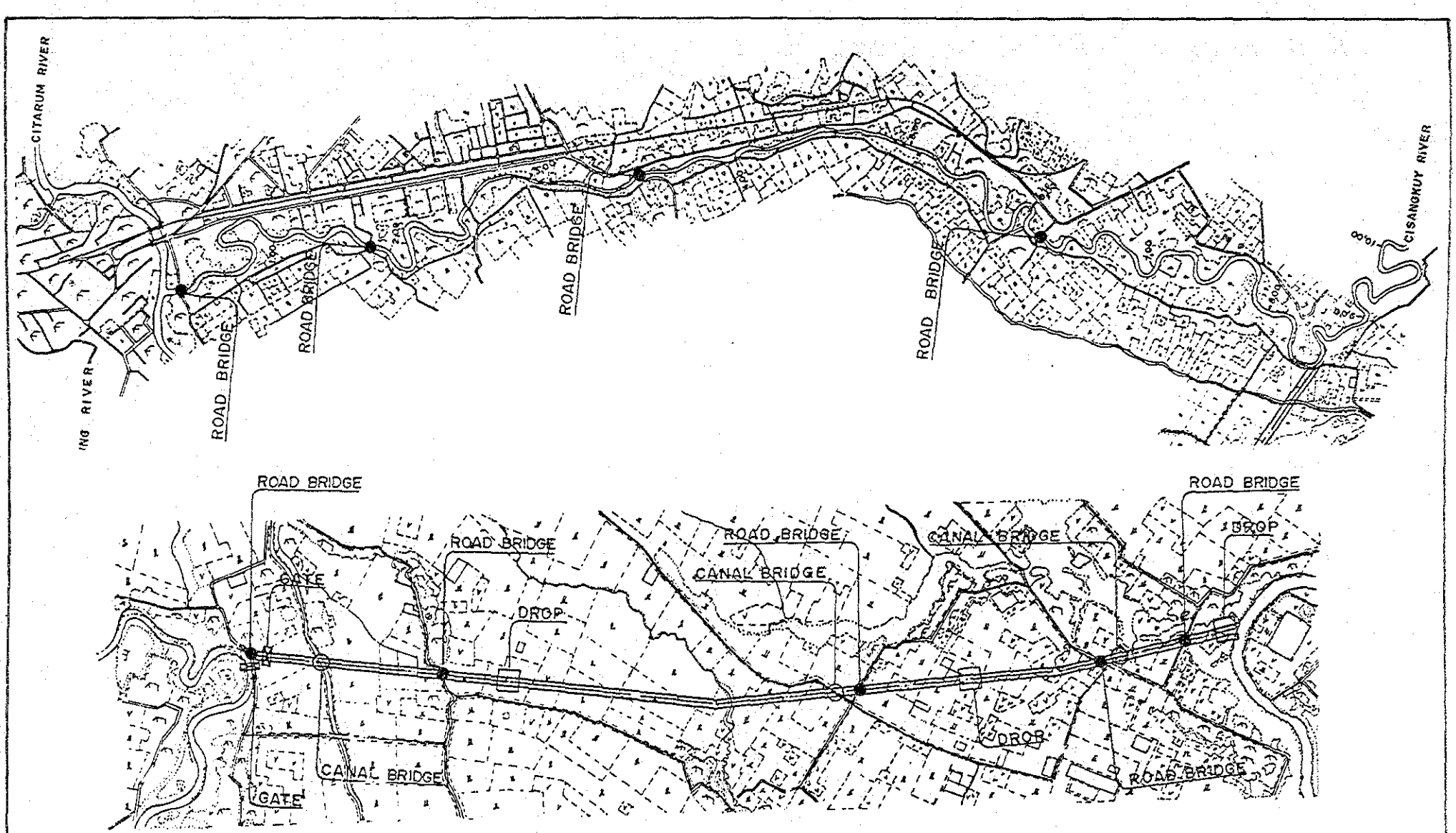


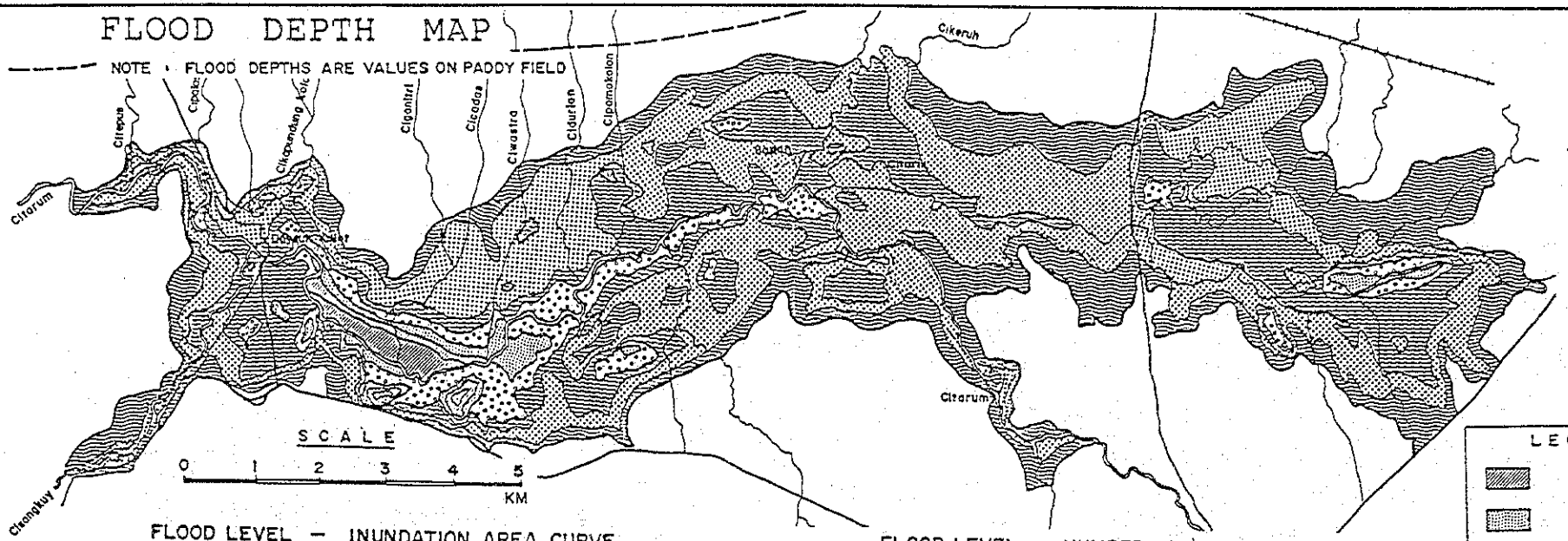
FIG.H.10 LOCATION OF PROPOSED MAJOR STRUCTURES OF CISANGKUY RIVER AND CISANGKUY DIVERSION

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

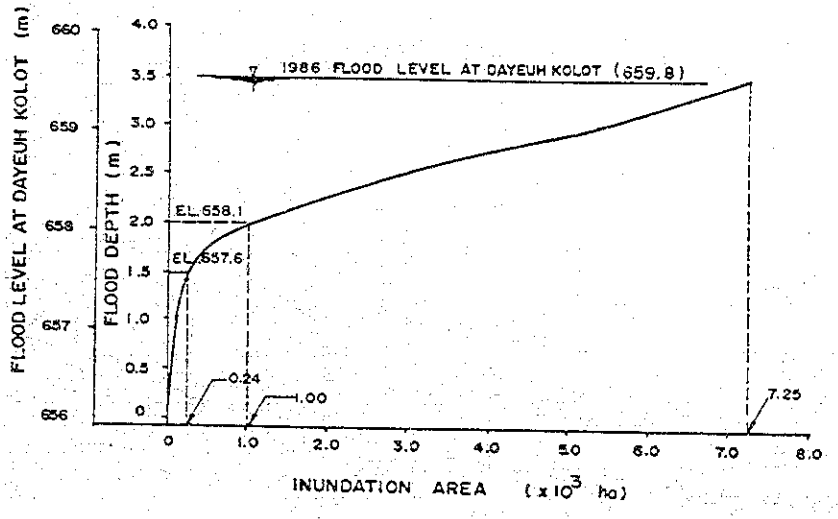
JICA

FLOOD DEPTH MAP

NOTE : FLOOD DEPTHS ARE VALUES ON PADDY FIELD



FLOOD LEVEL — INUNDATION AREA CURVE



FLOOD LEVEL — NUMBER OF FLOOD PRONE HOUSE

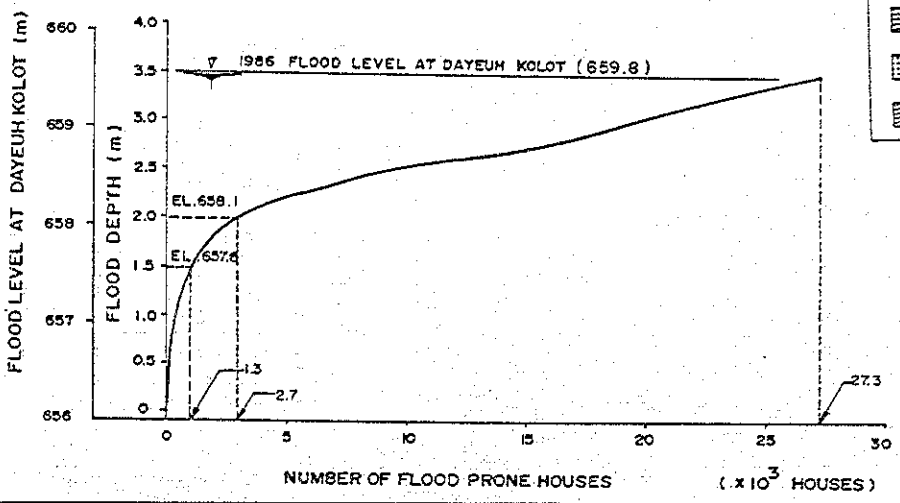
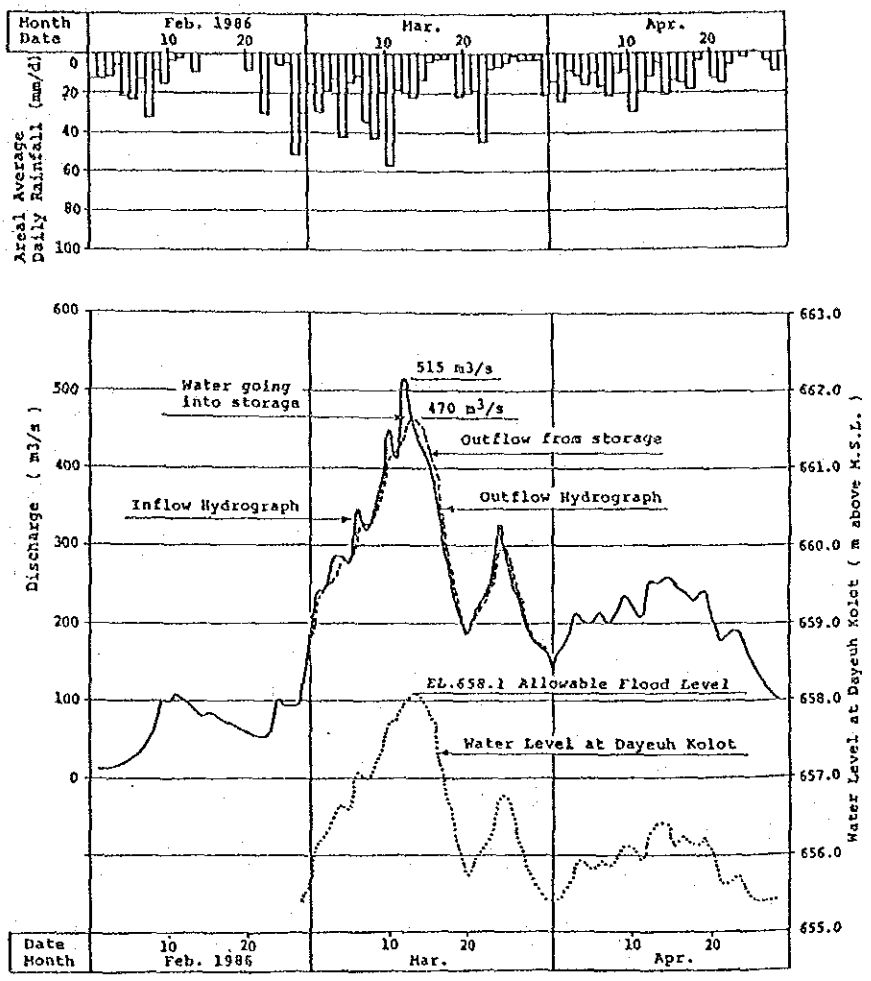


FIG. H.11 FLOOD LEVEL - INUNDATION AREA AND FLOOD PRONE HOUSE CURVES

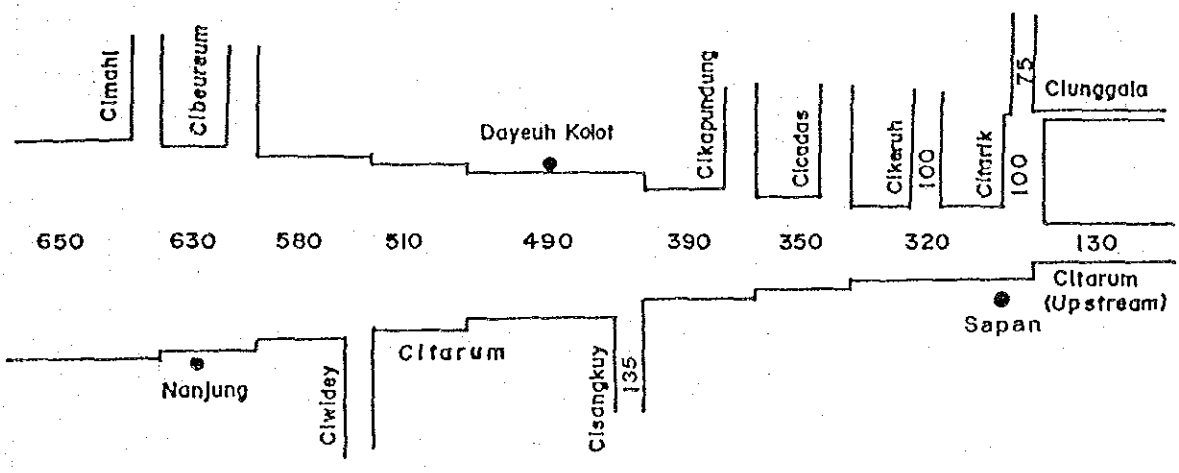
STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



20-Year Frequency

DESIGN DISCHAREGE HYDROGRAPH AT DAYEUH KOLOT

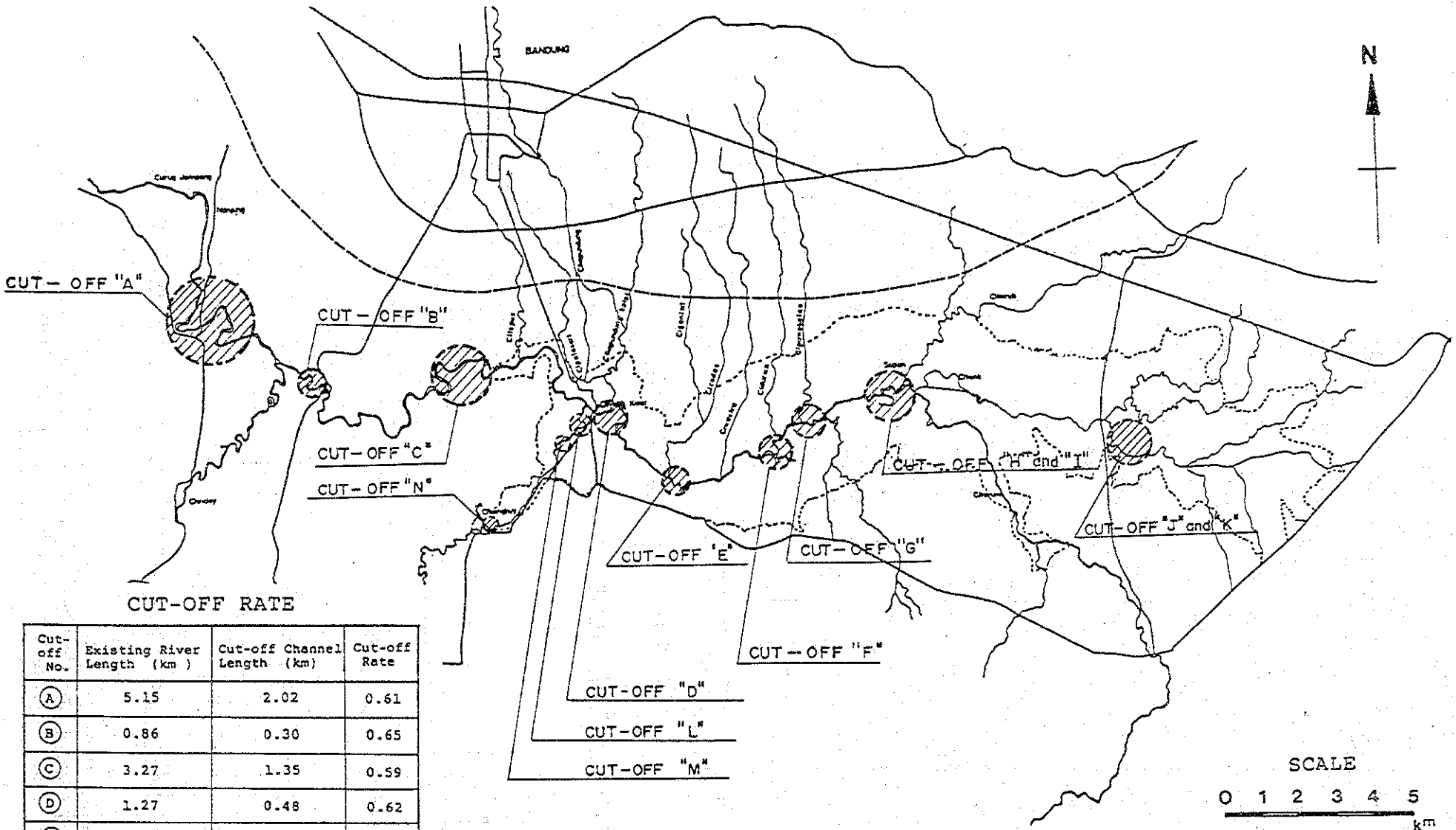


DESIGN PEAK DISCHARGE DISTRIBUTION

FIG. H.12 DESIGN DISCHARGE HYDROGRAPH AT DAYEUH KOLOT AND PEAK DISCHARGE DISTRIBUTION OF PROPOSED LONG-TERM PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



CUT-OFF RATE

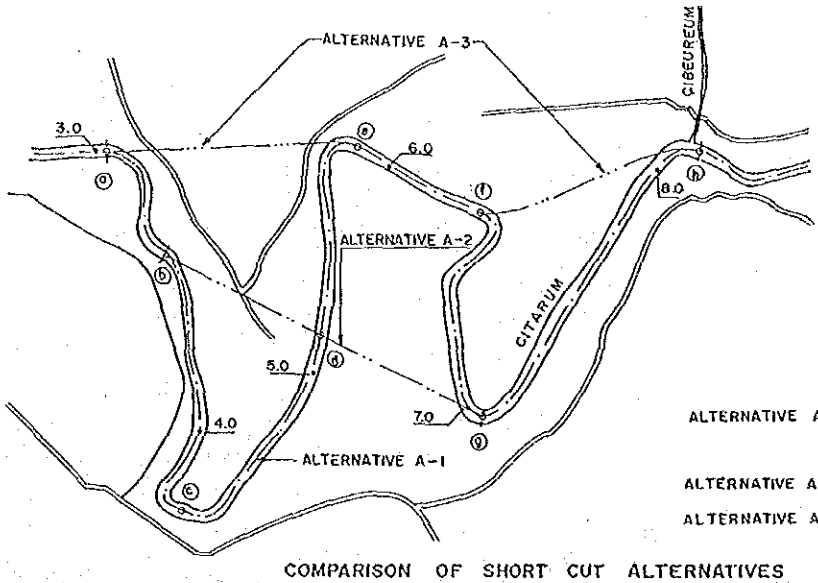
Cut-off No.	Existing River Length (km)	Cut-off Channel Length (km)	Cut-off Rate
(A)	5.15	2.02	0.61
(B)	0.86	0.30	0.65
(C)	3.27	1.35	0.59
(D)	1.27	0.48	0.62
(E)	1.05	0.54	0.49
(F)	0.99	0.48	0.52
(G)	0.95	0.50	0.47
(H)	2.45	1.31	0.47

FIG. H.13 LOCATION OF PROPOSED CUT-OFF CHANNELS OF LONG-TERM RIVER IMPROVEMENT PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

CUT-OFF CHANNEL A



ALTERNATIVE A－1 : ⓐ, ⓑ, ⓒ, ⓓ ⓔ, ⓕ, ⓖ, ⓗ

ALTERNATIVE A－2 : ⓐ, ⓑ, ⓓ, ⓖ, ⓗ

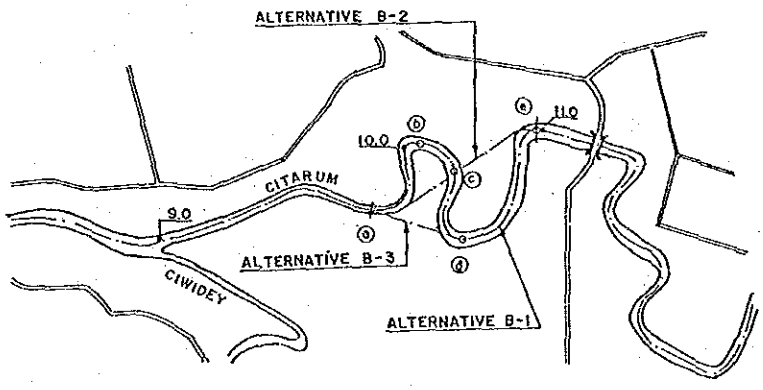
ALTERNATIVE A－3 : ⓐ, ⓔ, ⓕ, ⓗ

COMPARISON OF SHORT CUT ALTERNATIVES

ALTERNATIVE	LENGTH OF RIVER IMPROVEMENT (km)			RATE OF SHORT CUT	REQUIRED EXCAVATION VOLUME ($\times 10^3 m^3$)	NUMBER OF HOUSE TO BE REMOVED	REQUIRED LAND AQUISITION ($\times 10^3 m^2$)	NEWLY PRODUCED AREA (OLD RIVER) ($\times 10^3 m^2$)	STRUCTURE TO BE CONSTRUCTED	
	EXISTING RIVER	NEW RIVER	TOTAL						BRIDGE	ROAD (m)
A. 1	5.15	——	5.15	0.00	1.200	——	187	——	——	——
A. 2	1.55	1.15	2.70	0.48	2.272	33	175	209	1	——
A. 3	0.45	1.57	2.02	0.61	1.700	——	178	273	2	500

Note : Alternative A-3 is recommended.

CUT-OFF CHANNEL B



ALTERNATIVE B－1 : ⓐ ⓑ ⓒ ⓓ ⓔ

ALTERNATIVE B－2 : ⓐ ⓒ ⓔ

ALTERNATIVE B－3 : ⓐ ⓓ ⓔ

COMPARISON OF SHORT CUT ALTERNATIVES

ALTERNATIVE	LENGTH OF RIVER IMPROVEMENT (km)			RATE OF SHORT CUT	REQUIRED EXCAVATION VOLUME ($\times 10^3 m^3$)	NUMBER OF HOUSE TO BE REMOVED	REQUIRED LAND AQUISITION ($\times 10^3 m^2$)	NEWLY PRODUCED AREA (OLD RIVER) ($\times 10^3 m^2$)	STRUCTURE TO BE CONSTRUCTED	
	EXISTING RIVER	NEW RIVER	TOTAL						BRIDGE	ROAD (m)
B. 1	1.30	——	1.30	0.00	198	——	31	——	——	——
B. 2	——	0.61	0.61	0.53	236	——	46	44	——	——
B. 3	0.44	0.30	0.74	0.43	186	——	33	24	——	——

Note : Alternative B-3 is recommended.

FIG. H.14 COMPARISON OF CUT-OFF CHANNEL ROUTE ALTERNATIVES (1)

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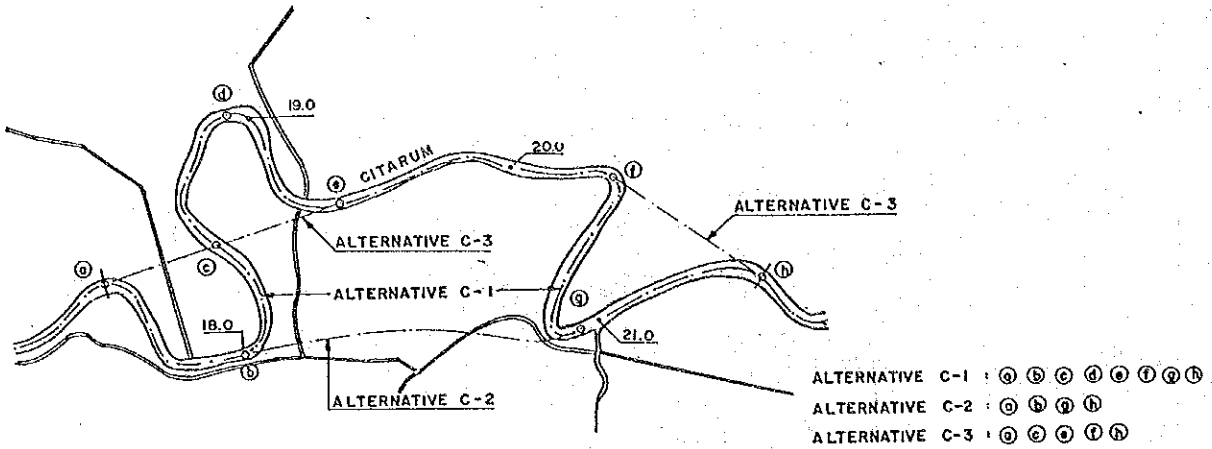
CUT -OFF CHANNEL C

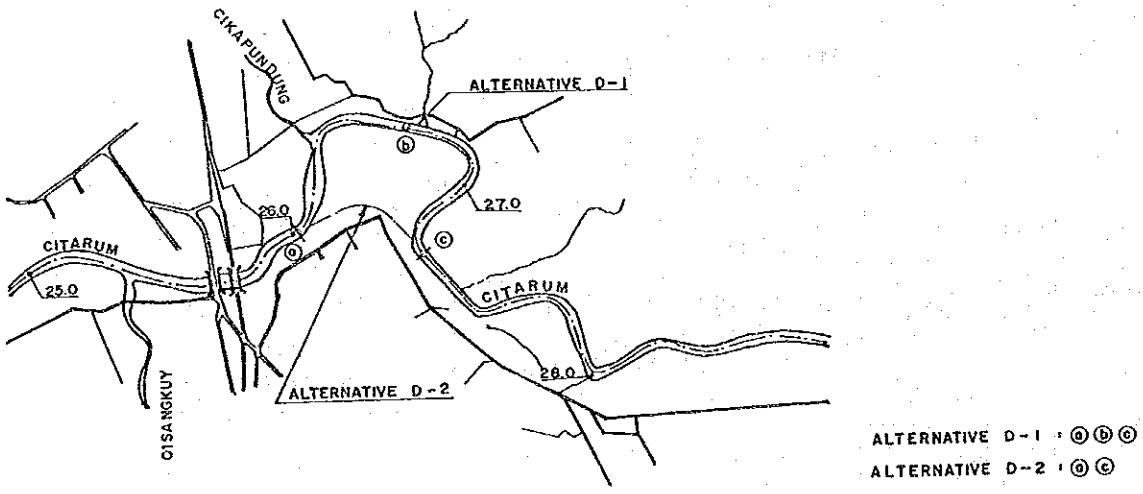


COMPARISON OF SHORT CUT ALTERNATIVES

ALTERNATIVE	LENGTH OF RIVER IMPROVEMENT (km)			RATE OF SHORT CUT	REQUIRED EXCAVATION VOLUME ($\times 10^3 m^3$)	NUMBER OF HOUSE TO BE REMOVED	REQUIRED LAND AQUISITION ($\times 10^3 m^2$)	NEWLY PRODUCED AREA (OLD RIVER) ($\times 10^3 m^2$)	STRUCTURE TO BE CONSTRUCTED	
	EXISTING RIVER	NEW RIVER	TOTAL						BRIDGE	ROAD (m)
C. 1	4.15	—	4.15	0.00	581	—	129	—	—	—
C. 2	1.20	1.05	2.25	0.46	548	25	114	110	1	300
C. 3	0.88	1.35	2.23	0.46	611	8	125	116	2	—

Note : Alternative C-2 is recommended.

CUT-OFF CHANNEL D



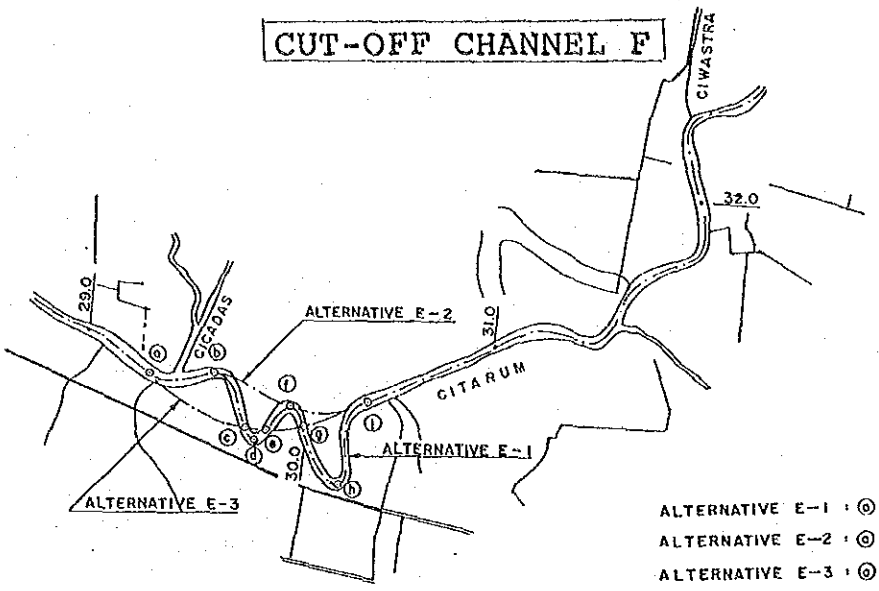
COMPARISON OF SHORT CUT ALTERNATIVES

ALTERNATIVE	LENGTH OF RIVER IMPROVEMENT (km)			RATE OF SHORT CUT	REQUIRED EXCAVATION VOLUME ($\times 10^3 m^3$)	NUMBER OF HOUSE TO BE REMOVED	REQUIRED LAND AQUISITION ($\times 10^3 m^2$)	NEWLY PRODUCED AREA (OLD RIVER) ($\times 10^3 m^2$)	STRUCTURE TO BE CONSTRUCTED	
	EXISTING RIVER	NEW RIVER	TOTAL						BRIDGE	ROAD (m)
D. 1	1.27	—	1.27	0.00	488	—	36	—	—	—
D. 2	—	0.48	0.48	0.62	73	5	35	47	—	—

Note : Alternative D-2 is recommended.

FIG. H.15 COMPARISON OF CUT-OFF CHANNEL ROUTE ALTERNATIVES (2)

CUT-OFF CHANNEL F



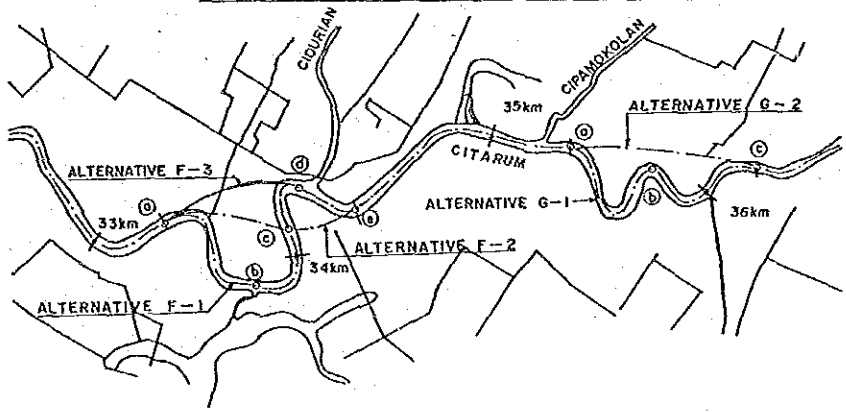
ALTERNATIVE E-1 : ⓐⓑⓒⓓⓔⓕⓖⓗⓘ
ALTERNATIVE E-2 : ⓐⓑⓕⓘ
ALTERNATIVE E-3 : ⓐⓒⓔⓖⓘ

COMPARISON OF SHORT CUT ALTERNATIVES

ALTERNATIVE	LENGTH OF RIVER IMPROVEMENT (km)			RATE OF SHORT CUT	REQUIRED EXCAVATION VOLUME ($\times 10^3 m^3$)	NUMBER OF HOUSE TO BE REMOVED	REQUIRED LAND AQUISITION ($\times 10^3 m^2$)	NEWLY PRODUCED AREA (OLD RIVER) ($\times 10^3 m^2$)	STRUCTURE TO BE CONSTRUCTED	
	EXISTING RIVER	NEW RIVER	TOTAL						BRIDGE	ROAD (m)
E.1	1.31	—	1.31	0.00	228	—	47	—	—	—
E.2	0.22	0.54	0.76	0.42	114	—	47	25.5	—	—
E.3	—	0.78	0.78	0.40	119	—	56	28.5	—	—

Note : Alternative E-2 is recommended.

CUT-OFF CHANNELS F AND G



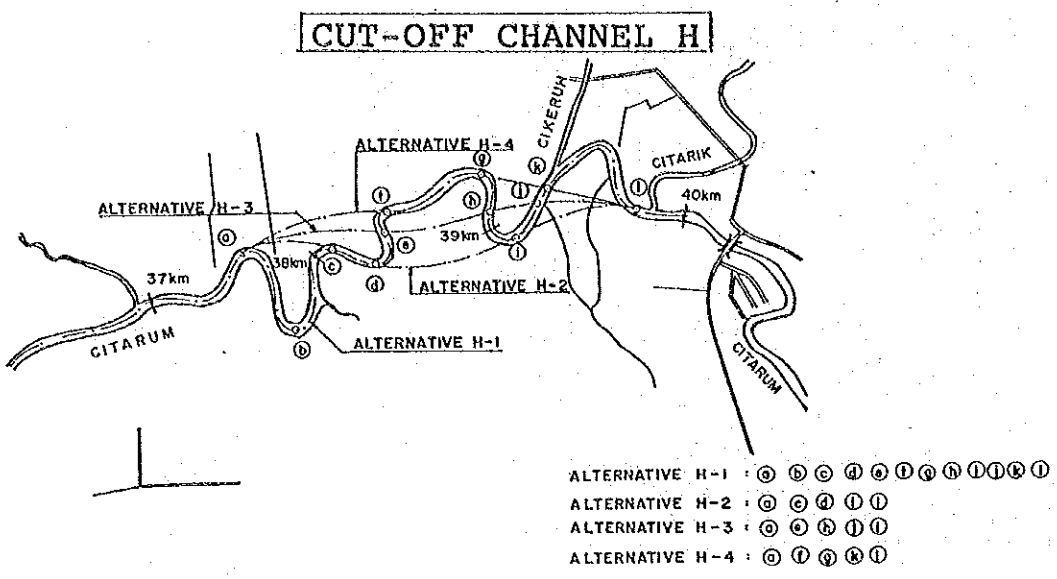
ALTERNATIVE F-1 : ⓐ, ⓑ, ⓒ, ⓓ, ⓔ
ALTERNATIVE F-2 : ⓐ, ⓒ, ⓔ
ALTERNATIVE F-3 : ⓐ, ⓓ, ⓔ
ALTERNATIVE G-1 : ⓐ, ⓑ, ⓒ
ALTERNATIVE G-2 : ⓐ, ⓒ

COMPARISON OF SHORT CUT ALTERNATIVES

ALTERNATIVE	LENGTH OF RIVER IMPROVEMENT (km)			RATE OF SHORT CUT	REQUIRED EXCAVATION VOLUME ($\times 10^3 m^3$)	NUMBER OF HOUSE TO BE REMOVED	REQUIRED LAND AQUISITION ($\times 10^3 m^2$)	NEWLY PRODUCED AREA (OLD RIVER) ($\times 10^3 m^2$)	STRUCTURE TO BE CONSTRUCTED	
	EXISTING RIVER	NEW RIVER	TOTAL						BRIDGE	ROAD (m)
F.1	1.19	—	1.19	0.00	121	—	29	—	—	—
F.2	—	0.65	0.65	0.45	99	1	46	18	—	—
F.3	0.20	0.48	0.68	0.43	95	7	39	15	—	—
G.1	0.95	—	0.95	0.00	73	1	20	—	—	—
G.2	—	0.60	0.60	0.37	86	3	42	22.5	2	—

Note : Alternative F-3 and G-2 are recommended.

FIG. H.16 COMPARISON OF CUT-OFF CHANNEL ROUTE ALTERNATIVES (3)



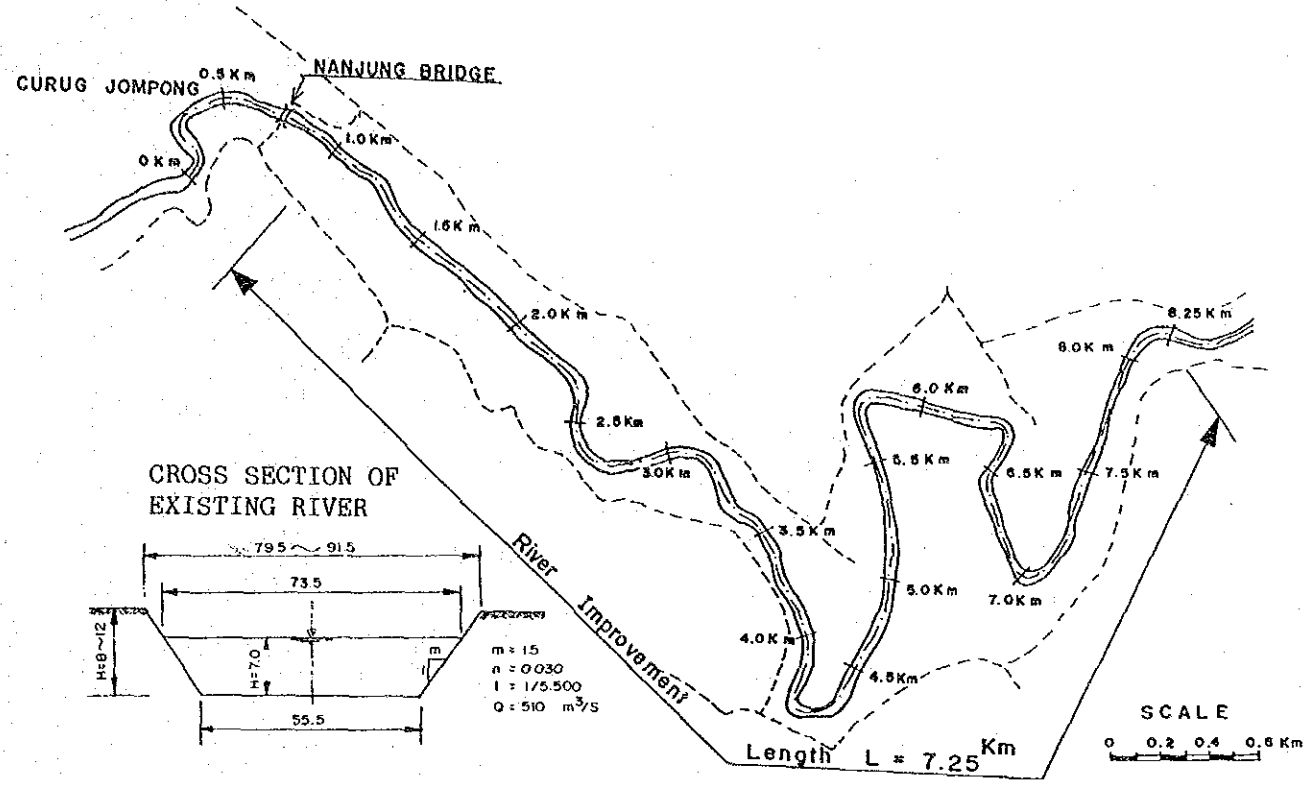
COMPARISON OF SHORT CUT ALTERNATIVES

ALTERNATIVE	LENGTH OF RIVER IMPROVEMENT (km)			RATE OF SHORT CUT	REQUIRED EXCAVATION VOLUME ($\times 10^3 m^3$)	NUMBER OF HOUSE TO BE REMOVED	REQUIRED LAND AQUISITION ($\times 10^3 m^2$)	NEWLY PRODUCED AREA (OLD RIVER) ($\times 10^3 m^2$)	STRUCTURE TO BE CONSTRUCTED	
	EXISTING RIVER	NEW RIVER	TOTAL						BRIDGE	ROAD (m)
H. 1	2.45	—	2.45	0.00	189	—	52	—	—	—
H. 2	0.14	1.17	1.31	0.47	167	15	84	48	2	400
H. 3	—	1.30	1.30	0.47	185	46	90	52.5	3	1500
H. 4	0.33	1.11	1.44	0.41	186	25	85	48.5	3	1000

Note : Alternative H-2 is recommended.

FIG. H. 17 COMPARISON OF CUT-OFF CHANNEL ROUTE ALTERNATIVES (4)

ALTERNATIVE I (WITHOUT CUT OFF "A")



ALTERNATIVE II (WITH CUT OFF "A")

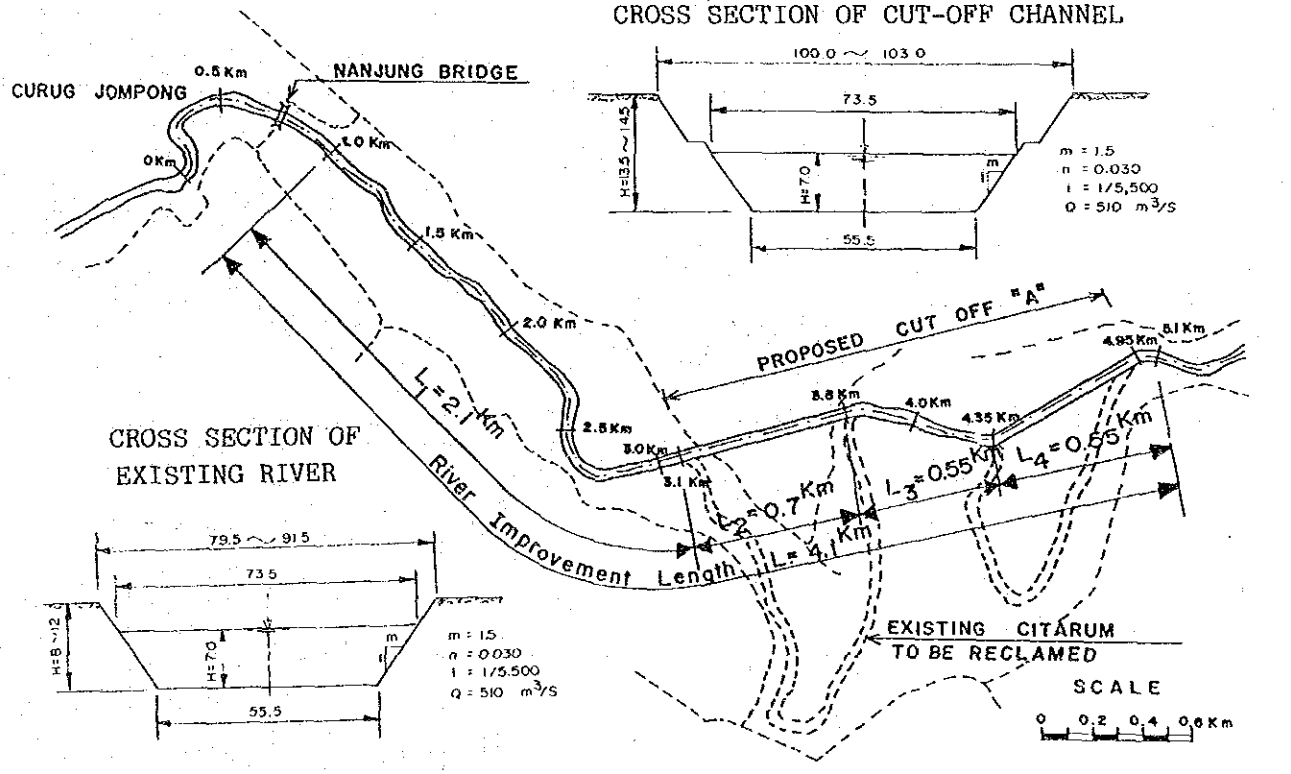


FIG. H.18 LOCATION OF CUT-OFF CHANNEL-A ALTERNATIVE AND DESIGN RIVER CROSS SECTIONS

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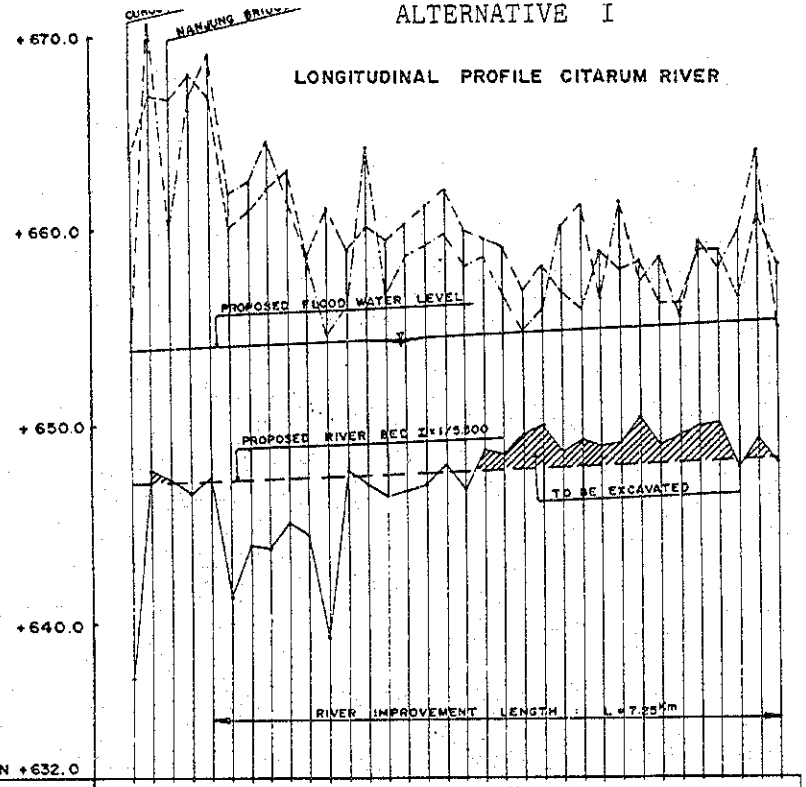
ALTERNATIVE I

LONGITUDINAL PROFILE CITARUM RIVER

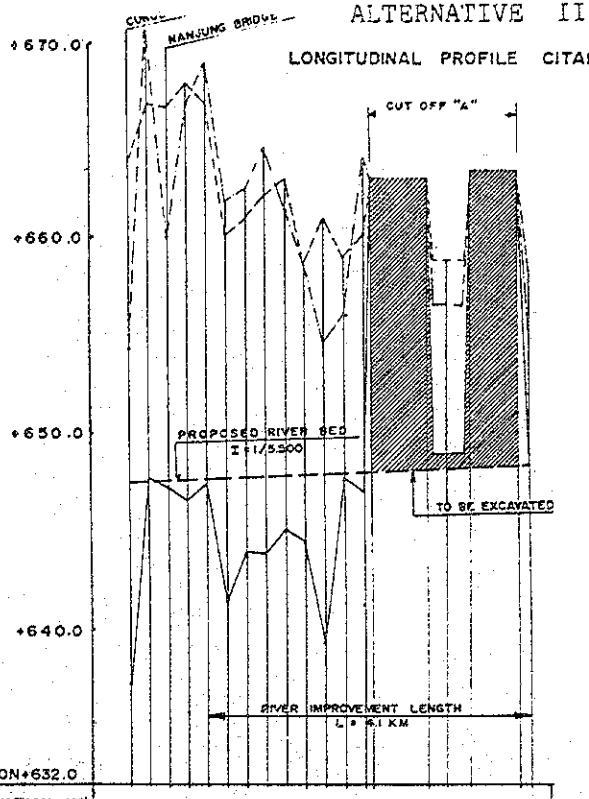


DATUM ELEVATION +632.0

PROPOSED	BANK ELEVATION (M)	
	FLOOD WATER LEVEL(M)	
	RIVER BED ELEVATION (M)	
EXISTING	LEFT BANK ELEVATION (M)	
	RIGHT BANK ELEVATION (M)	
	RIVER BED ELEVATION (M)	
CUMULATIVE DISTANCE (KM)		
SECTION DISTANCE (KM)		
SECTION NAME		

ALTERNATIVE II

LONGITUDINAL PROFILE CITARUM RIVER



DATUM ELEVATION +632.0

PROPOSED	BANK ELEVATION (M)	
	FLOOD WATER LEVEL(M)	
	RIVER BED ELEVATION (M)	
EXISTING	LEFT BANK ELEVATION (M)	
	RIGHT BANK ELEVATION (M)	
	RIVER BED ELEVATION (M)	
CUMULATIVE DISTANCE(KM)		
SECTION DISTANCE (KM)		
SECTION NAME		

FIG. H.19 PROPOSED RIVER PROFILES OF CUT-OFF CHANNEL-A ALTERNATIVES

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

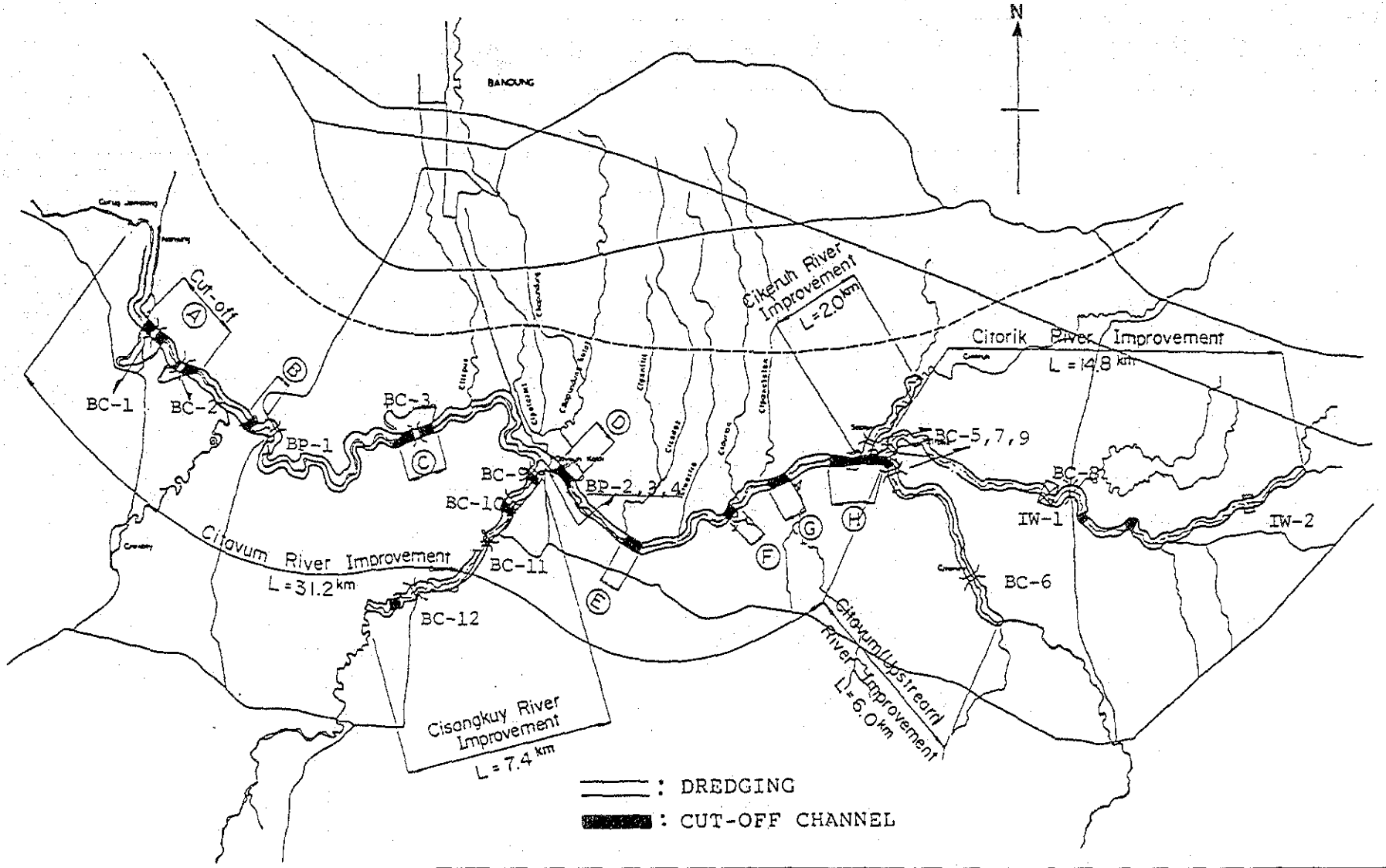
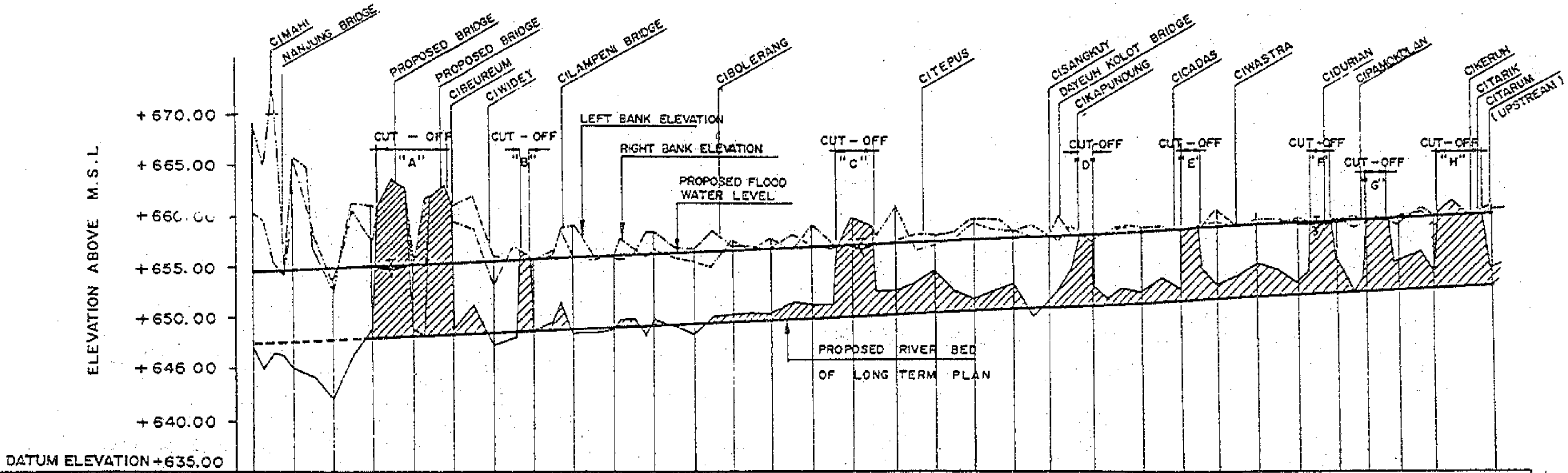


FIG. H.20 PROPOSED IMPROVEMENT REACHES FOR LONG-TERM PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



		0.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00
RIVER BED SLOPE		I = 1/5,500 (0.00018)							
PROPOSED	BANK ELEVATION (M)	SAME AS EXISTING BANK ELEVATION							
PROPOSED	FLOOD WATER LEVEL (M)	654.50	654.68	654.86	655.03	655.23	655.44	655.59	655.77
PROPOSED	RIVER BED ELEVATION (M)	647.25	646.06	641.93	648.03	648.23	648.44	648.59	648.77
EXISTING	LEFT BANK ELEVATION (M)	660.35	665.61	653.16	657.19	654.22	659.45	655.17	655.66
EXISTING	RIGHT BANK ELEVATION (M)	659.01	665.92	652.53	661.10	655.02	661.06	656.34	655.72
EXISTING	RIVER BED ELEVATION (M)	647.25	646.06	641.93	648.96	648.76	648.60	647.24	648.66
CUMULATIVE DISTANCE (KM)		0.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00
SECTION DISTANCE (KM)		0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SECTION NAME		0.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00

		8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00
PROPOSED	FLOOD WATER LEVEL (M)	655.95	656.14	656.32	656.50	656.68	656.86	657.05	657.23
PROPOSED	RIVER BED ELEVATION (M)	648.95	649.14	649.32	649.50	649.68	649.86	650.05	650.23
EXISTING	LEFT BANK ELEVATION (M)	659.18	655.92	656.55	656.98	657.37	657.12	657.31	660.26
EXISTING	RIGHT BANK ELEVATION (M)	655.81	656.20	656.80	655.55	657.84	658.14	659.48	
EXISTING	RIVER BED ELEVATION (M)	648.42	648.93	649.90	648.39	650.40	650.51	651.29	
CUMULATIVE DISTANCE (KM)		8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00
SECTION DISTANCE (KM)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.10
SECTION NAME		8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00

		16.10	17.10	18.10	19.10	20.00	21.10	22.35	23.35
PROPOSED	FLOOD WATER LEVEL (M)	657.43	657.61	657.79	657.97	658.14	658.34	658.56	658.73
PROPOSED	RIVER BED ELEVATION (M)	650.43	650.61	650.79	650.97	651.14	651.34	651.56	651.73
EXISTING	LEFT BANK ELEVATION (M)	657.87	658.49	660.23	658.90	658.54	658.78	658.68	658.83
EXISTING	RIGHT BANK ELEVATION (M)	661.45	657.48	659.60	658.89	658.58	657.93	659.34	658.90
EXISTING	RIVER BED ELEVATION (M)	652.80	653.91	652.12	653.66	651.65	655.65	652.86	653.14
CUMULATIVE DISTANCE (KM)		16.10	17.10	18.10	19.10	20.00	21.10	22.35	23.35
SECTION DISTANCE (KM)		1.00	1.00	1.00	1.00	0.90	1.10	1.25	1.00
SECTION NAME		16.10	17.10	18.10	19.10	20.00	21.10	22.35	23.35

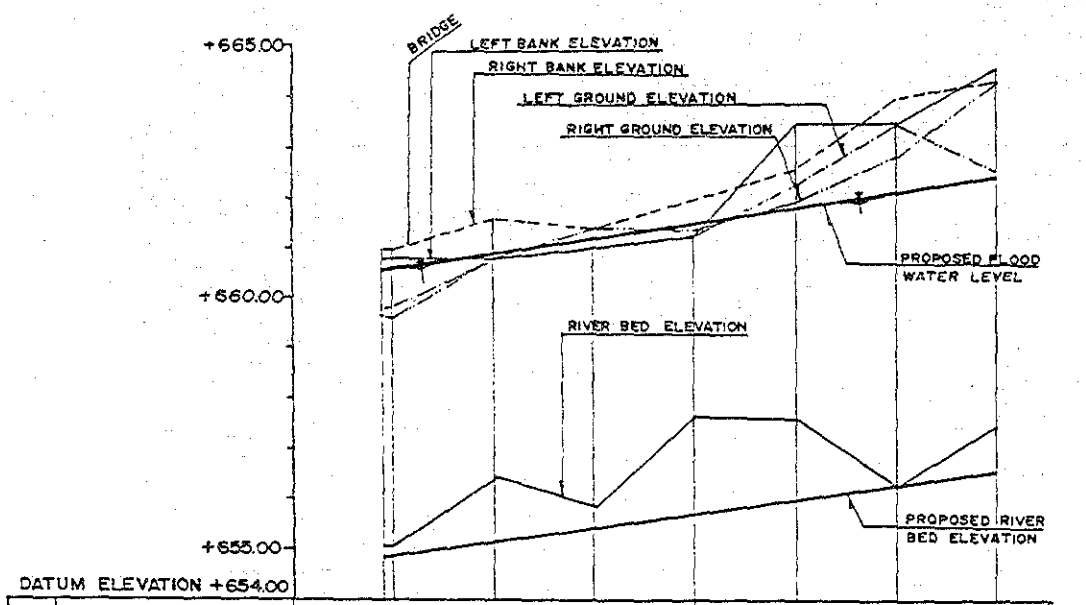
		24.25	25.25	26.25	27.25	28.00	28.80	29.70	31.20
PROPOSED	FLOOD WATER LEVEL (M)	658.91	659.09	659.27	659.45	659.59	659.74	659.90	660.17
PROPOSED	RIVER BED ELEVATION (M)	651.91	652.09	652.27	652.45	652.59	652.74	652.90	653.17
EXISTING	LEFT BANK ELEVATION (M)	658.86	659.50	658.84	659.68	659.59	659.33	660.12	660.80
EXISTING	RIGHT BANK ELEVATION (M)	659.04	659.79	659.65	659.87	659.37	660.00	659.04	661.16
EXISTING	RIVER BED ELEVATION (M)	653.55	653.41	653.67	653.90	654.00	655.53	654.72	654.95
CUMULATIVE DISTANCE (KM)		24.25	25.25	26.25	27.25	28.00	28.80	29.70	31.20
SECTION DISTANCE (KM)		0.90	1.00	1.00	[illegible]	0.75	0.80	0.90	1.50
SECTION NAME		24.25	25.25	26.25	27.25	28.00	28.80	29.70	31.20

FIG. H.21 LONG-TERM RIVER PROFILE OF CITARUM RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

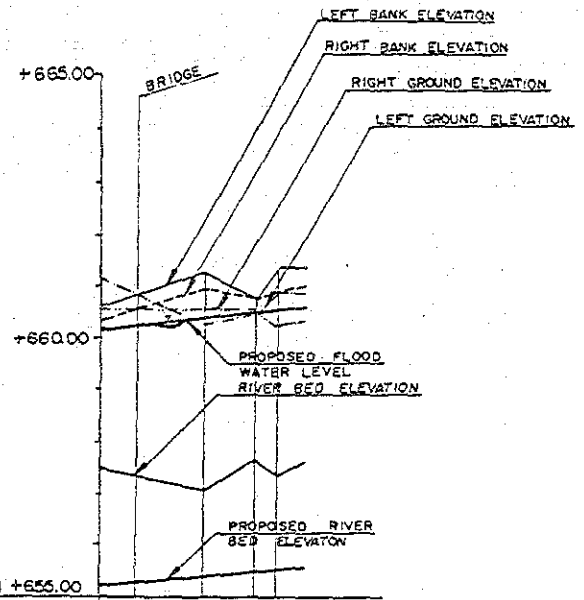
JICA

LONGITUDINAL PROFILE CIKERUH RIVER



DATUM ELEVATION +654.00

PROPOSED	BED SLOPE			1/3,600 (0.00028)				
	BANK ELEVATION (M)							
	FLOOD WATER LEVEL (M)	660.45 660.45	660.72	661.00	661.28	661.56	661.84	662.12
	RIVER BED ELEVATION (M)	654.45 654.45	658.12	659.40	659.68	659.96	659.24	658.82
EXISTING	LEFT BANK ELEVATION (M)	660.40 659.80	660.88 660.80	661.17 661.00	661.33 661.30	661.09	661.12 661.50	662.20 662.60
	RIGHT BANK ELEVATION (M)	660.19 659.60	661.01 660.80	661.20 661.40	661.95 661.90	662.28 662.28	662.84 662.90	663.34 664.30
	RIVER BED ELEVATION (M)	654.93	658.30	658.91	657.67	657.68	656.30	657.20
CUMULATIVE DISTANCE (KM)		31.10 31.20	32.20	33.20	34.20	35.20	36.20	37.20
SECTION DISTANCE (KM)		0.00 0.10	1.00	1.00	1.00	1.00	1.00	1.00
SECTION NAME		No.0 No.1	No.2	No.3	No.4	No.5	No.6	No.7



DATUM ELEVATION +655.00

PROPOSED	BED SLOPE		1/4,300 (0.00022)				
	BANK ELEVATION (M)						
	FLOOD WATER LEVEL (M)	660.17	660.25	660.30	660.00	660.03	660.41
	RIVER BED ELEVATION (M)	655.17	655.25	656.39	655.50	655.53	656.41
EXISTING	LEFT BANK ELEVATION (M)		660.80	661.24	660.85	661.21	
	RIGHT BANK ELEVATION (M)		660.80	660.86	660.87	660.59	
	RIVER BED ELEVATION (M)		657.30	657.13	657.69	657.39	
CUMULATIVE DISTANCE (KM)			0.35	1.00	1.50	1.70	2.00
SECTION DISTANCE (KM)			0.35	0.65	0.50	0.20	0.30
SECTION NAME			0.35	1.00	1.50	1.70	2.00

FIG. H.22 LONG-TERM RIVER PROFILES OF CITARUM (UPSTREAM) AND CIKERUH RIVERS

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

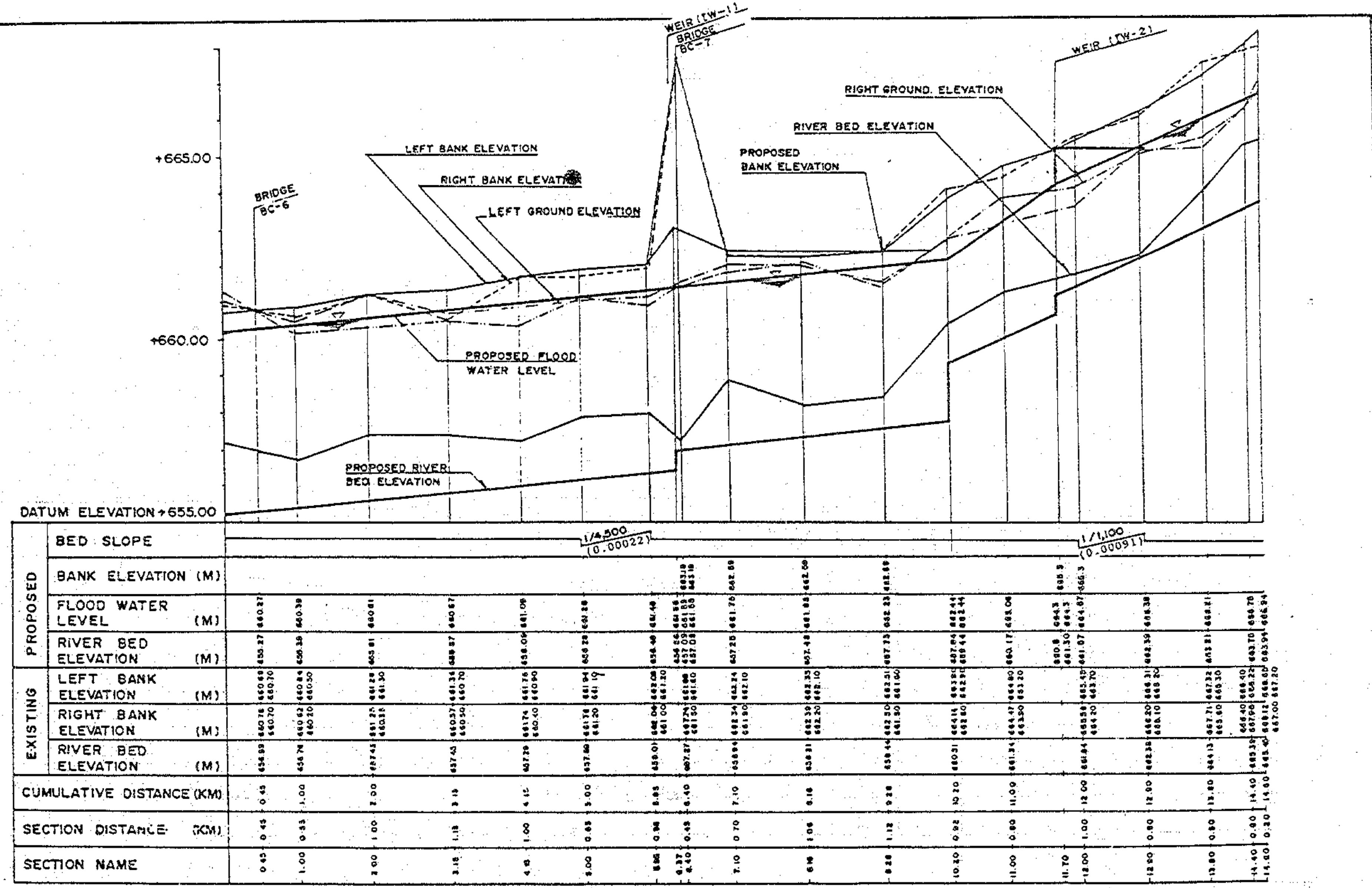
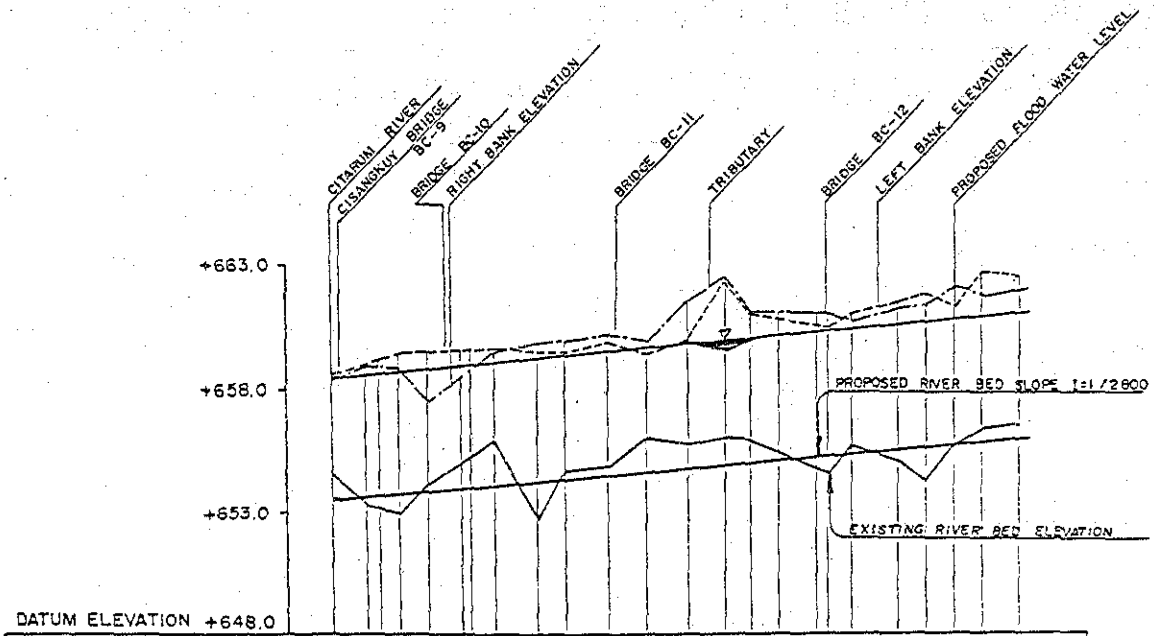


FIG. H.23 LONG-TERM RIVER PROFILE OF CITARIK RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

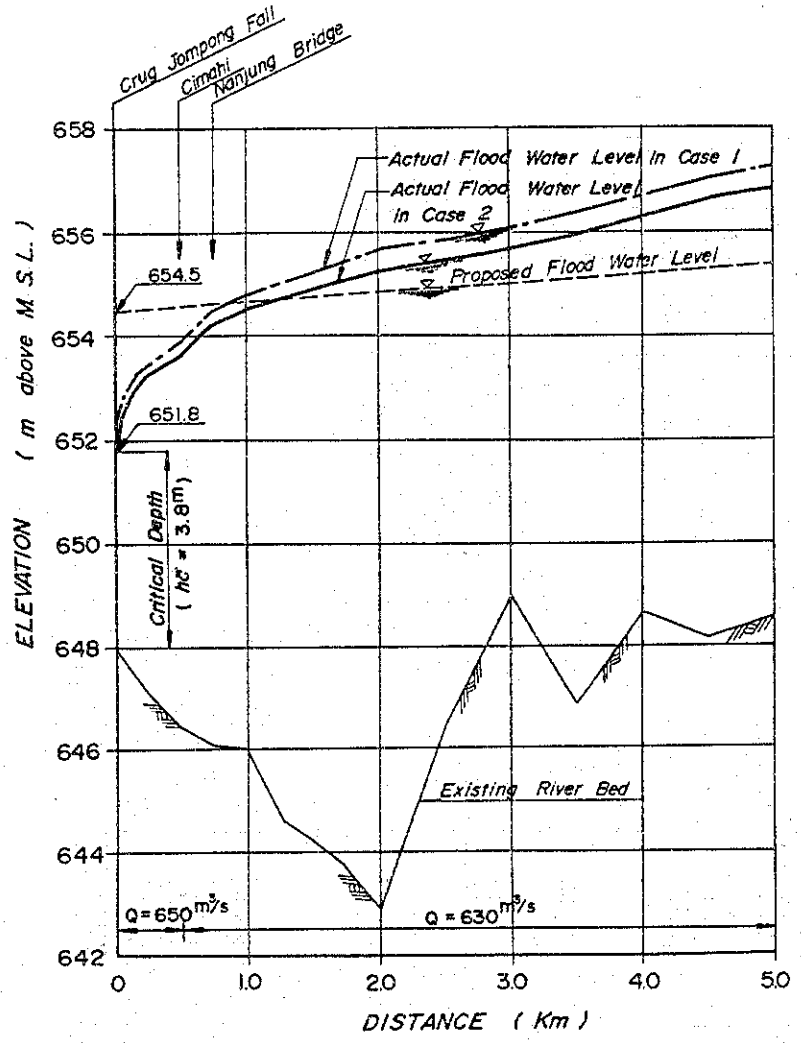


		1/2,800 (0.00036)																				
PROPOSED	BANK ELEVATION (M)	658.47	658.97	658.87	657.53		658.52	658.47	658.88	659.84	659.38	660.01	662.52	661.12		660.54	660.80	661.36	661.44	661.40	661.83	662.08
	FLOOD WATER LEVEL (M)	658.60	658.83 658.65	658.75	658.94	658.98 659.02	659.11	659.27	659.38	659.54	659.68	659.84	659.98	660.07	660.18	660.32 660.36	660.45	660.63	660.73	660.84	660.95	661.09 661.14
	RIVER BED ELEVATION (M)	653.50	653.63 653.69	653.78	653.86	653.96 654.02	654.11	654.27	654.38	654.54	654.68	654.84	654.98	655.07	655.18	655.32 655.36	655.45	655.65	655.73	655.84	655.95	656.09 656.14
EXISTING	LEFT BANK ELEVATION (M)	658.44	658.99	659.43	656.46		658.58	658.47	658.58	659.84	659.38	660.01	662.52	661.12		660.54	661.10	661.54	661.90	661.40	662.82	662.62
	RIGHT BANK ELEVATION (M)	658.47	658.97	658.87	657.53		658.62	658.68	659.99	660.26	659.91	661.84	662.87	661.21		661.05	660.80	661.31	661.44	662.28	661.83	662.04
	RIVER BED ELEVATION (M)	654.81	653.26	652.90	654.15		656.10	652.72	654.86	654.59	656.13	655.78	655.19	655.04		654.65	656.56	655.17	654.54	656.87	658.32	656.72
COMULATIVE DISTANCE (KM)		0.00	0.35 0.50	0.70	1.00	1.33 1.45	1.70	2.15	2.45	2.90	3.30	3.75	4.15	4.40	4.70	5.10 5.20	5.45	5.95	6.25	6.55	6.85	7.25 7.40
SECTION DISTANCE (KM)		0.00	0.35 0.15	0.20	0.30	0.33 0.12	0.25	0.45	0.30	0.45	0.40	0.45	0.40	0.25	0.30	0.40 0.10	0.25	0.60	0.30	0.60	0.30	0.40 0.15
SECTION NAME		BM17	17	28	32		50	55	65	73	82	89	96	BM18		5/32	5/40	5/63	5/68	5/71	5/78	5/90

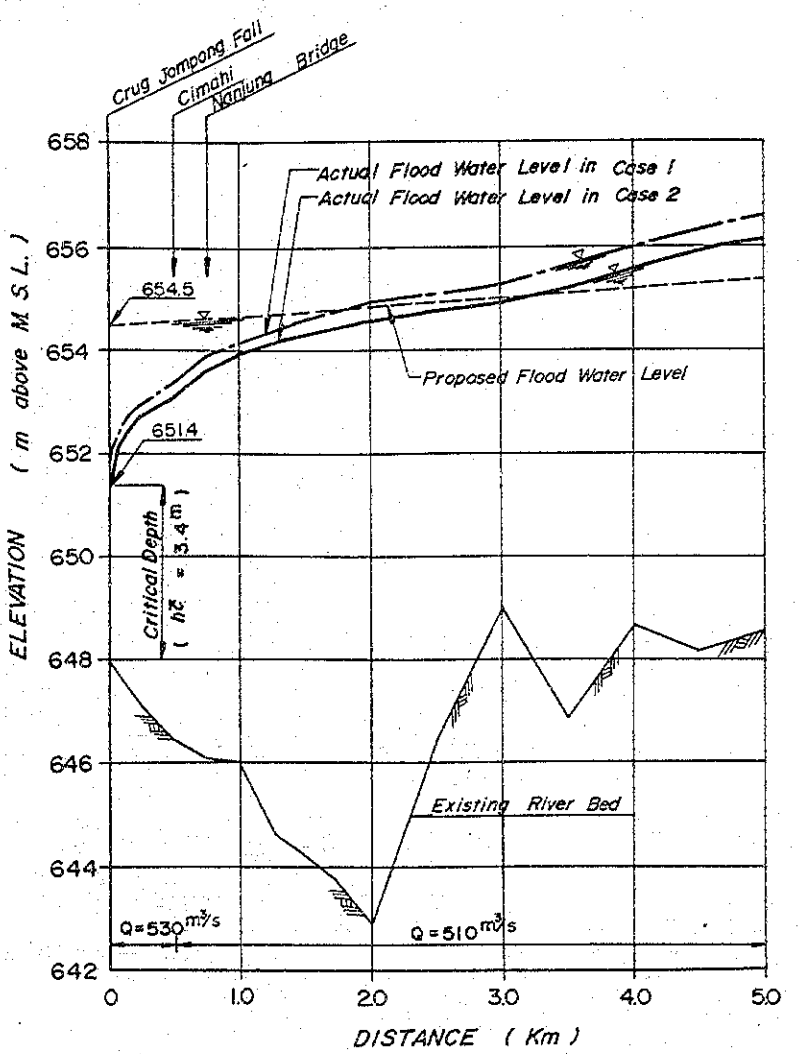
FIG. H.24 LONG-TERM RIVER PROFILE OF CISANGKUY RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



20-year Frequency Flood



5-year Frequency Flood

FIG. H.25 HYDRAULIC EFFECT OF CURUG JOMPONG FALL

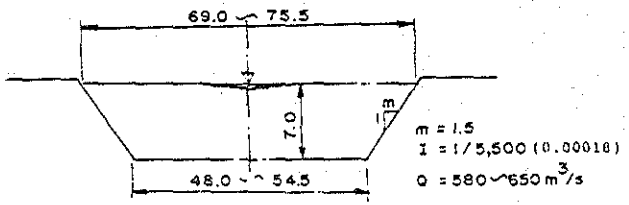
STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

CITARUM RIVER

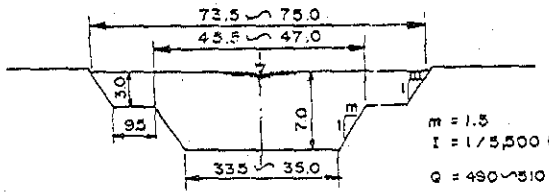
SECTION

NANJUNG (1.00 Km)
TO
CIWIDEY (5.90 Km)



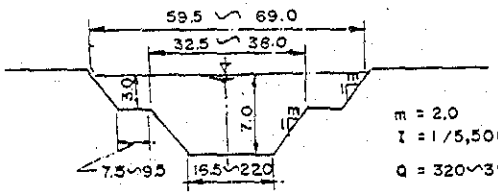
m = 1.5
I = 1/5,500 (0.00018)
Q = 580 ~ 650 m³/s

CIWIDEY (5.90 Km)
TO
CISANGKUY (20.00 Km)



m = 1.5
I = 1/5,500 (0.00018)
Q = 490 ~ 510 m³/s

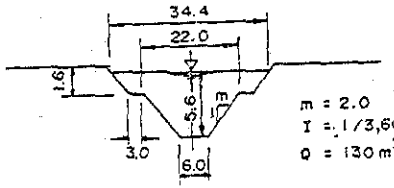
CISANGKUY (20.00 Km)
TO
CITARIK (31.10 Km)



m = 2.0
I = 1/5,500 (0.00018)
Q = 320 ~ 390 m³/s

CITARUM (UPSTREAM) RIVER

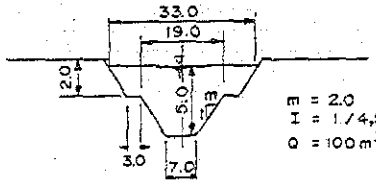
CITARIK (31.10 Km)
TO
BOJONG RANGKAS (35.20 Km)



m = 2.0
I = 1/3,600 (0.00028)
Q = 130 m³/s

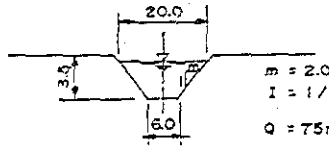
CITARIK RIVER

CITARUM (0.00 Km)
TO
CIUNGGALA (10.00 Km)



m = 2.0
I = 1/4,500 (0.00022)
Q = 100 m³/s

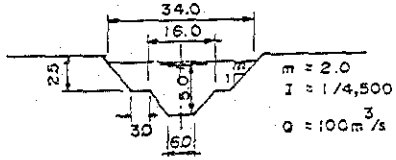
CIUNGGALA (10.00 Km)
TO
CIBODAS (15.00 Km)



m = 2.0
I = 1/1,100 (0.00091)
Q = 75 m³/s

CIKERUH RIVER

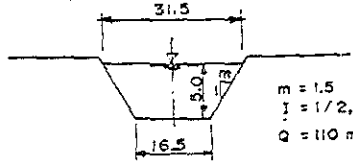
CITARUM (0.00 Km)
TO
CIPANJALU (2.00 Km)



m = 2.0
I = 1/4,500 (0.00022)
Q = 100 m³/s

CISANGKUY RIVER

CITARUM (0.00 Km)
TO
RANCAENGANG (8.50 Km)



m = 1.5
I = 1/2,800 (0.00036)
Q = 110 m³/s

FIG. H.26 DESIGN RIVER CROSS SECTIONS FOR LONG-TERM PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

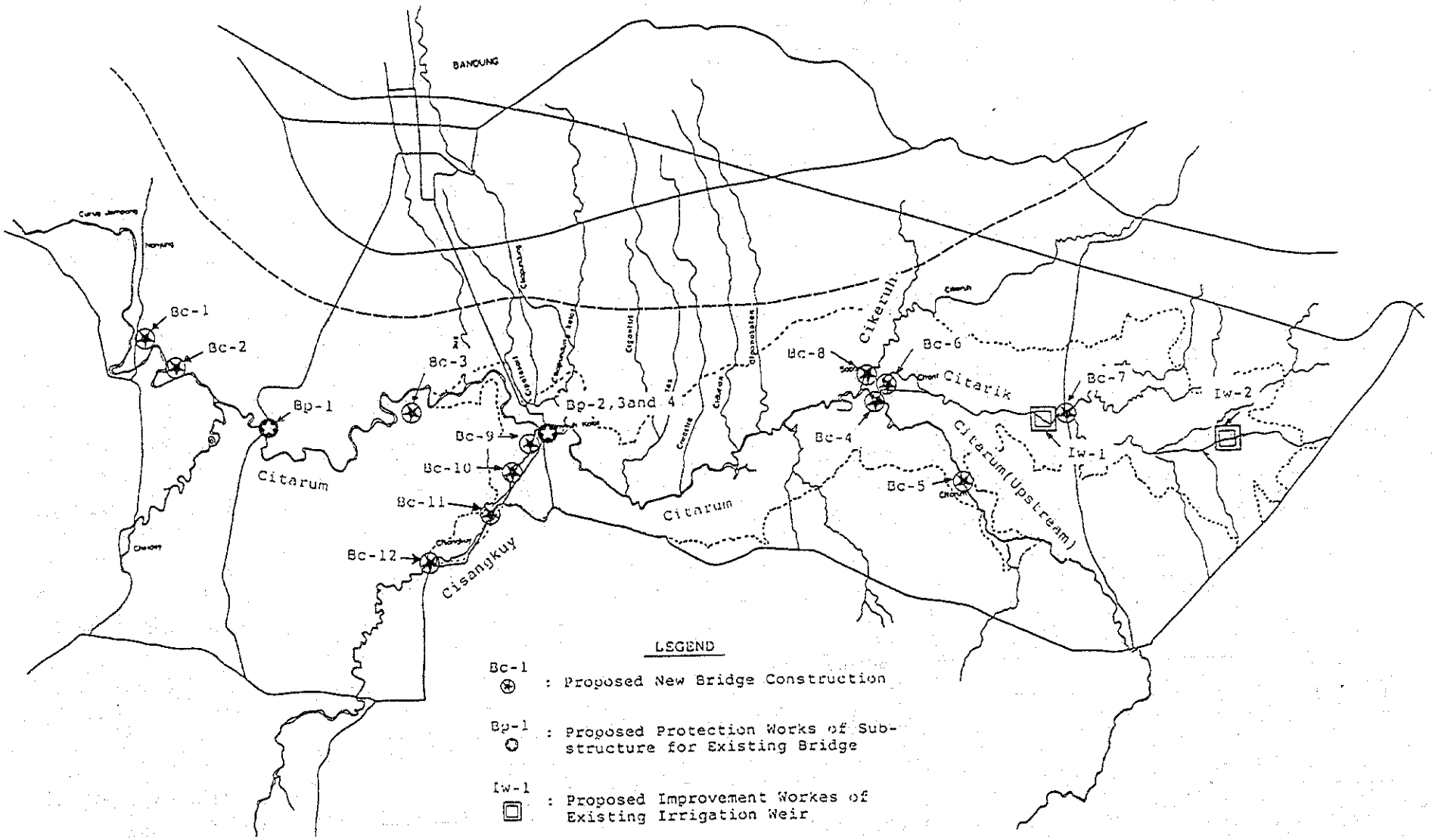


FIG. H.27 LOCATION MAP OF PROPOSED MAJOR STRUCTURES FOR LONG-TERM PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

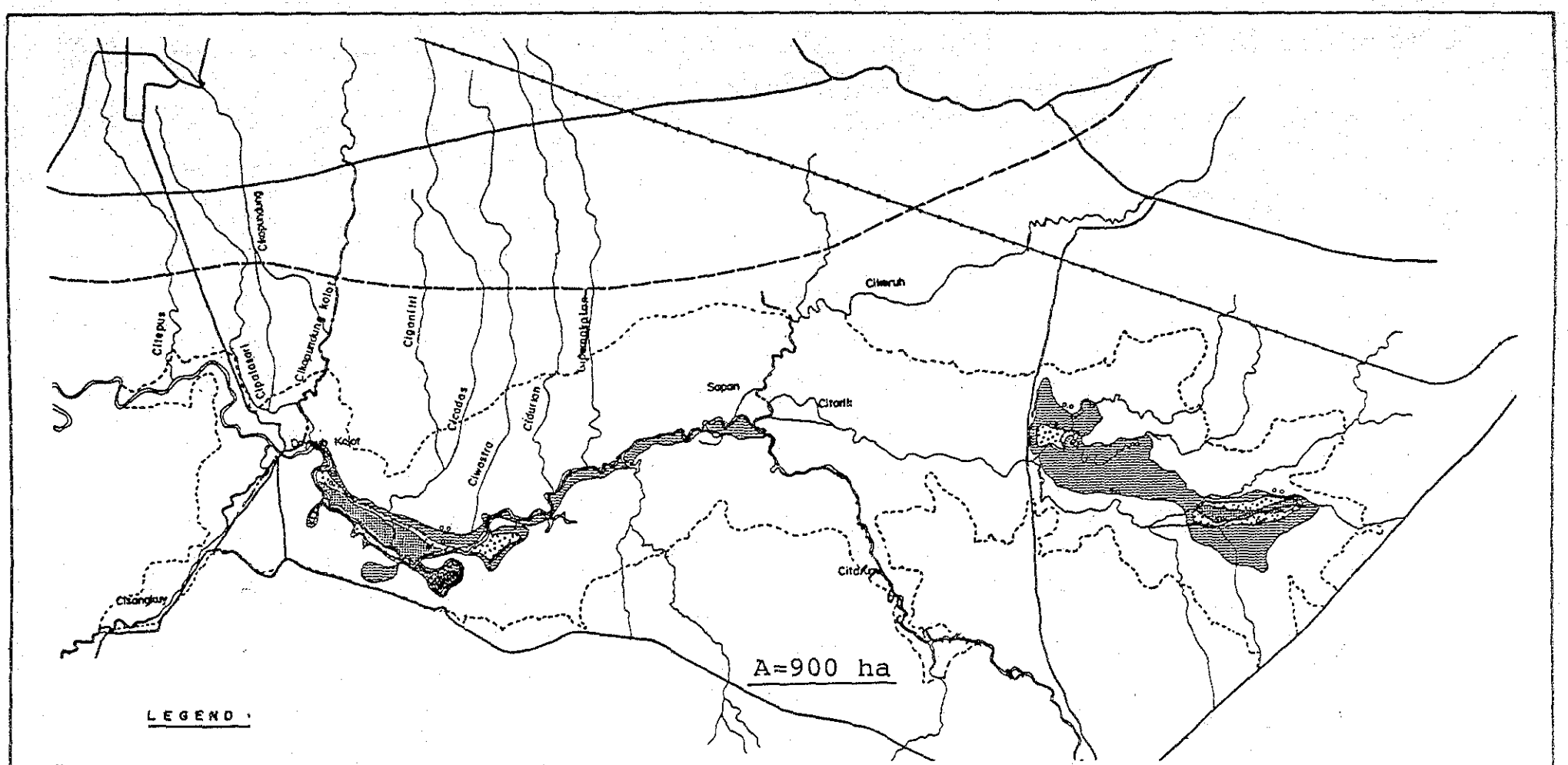


FIG. H.28 FLOOD RISK MAP BY 20-YEAR FLOOD AFTER COMPLETION OF LONG-TERM PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

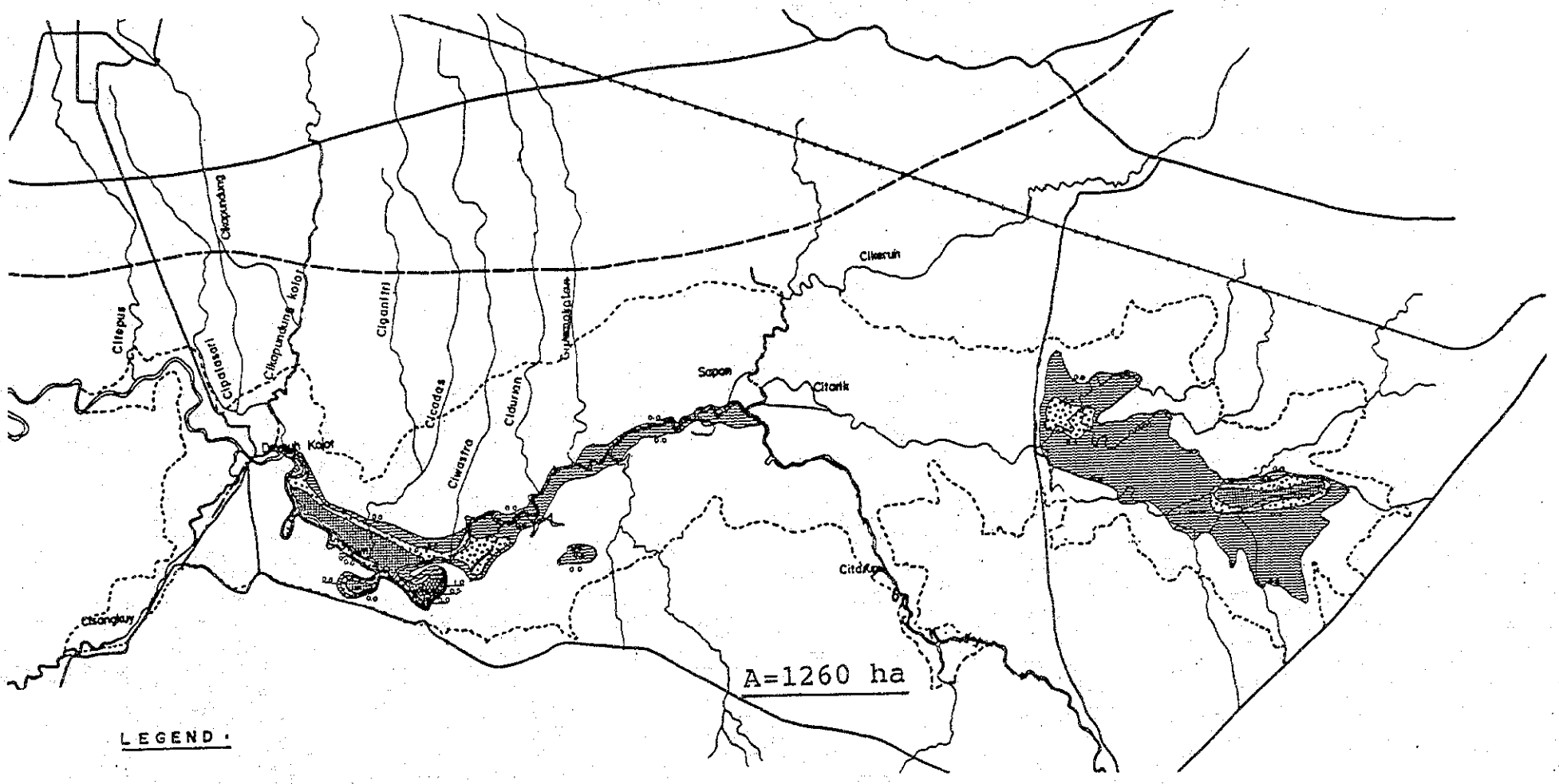


FIG. H. 29 FLOOD RISK MAP BY 50-YEAR FLOOD AFTER COMPLETION OF LONG-TERM PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

SUPPORTING REPORT I

URGENT FLOOD CONTROL PLAN

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SUPPORTING REPORT I
URGENT FLOOD CONTROL PLAN

1. General

The overall flood control plan is prepared aiming at the mitigation of flood damage in the potential flood area (maximum flood area in the past). The economic index (EIIR) of the plan under the present development stage indicates a reasonable value, 11.6% for its implementation.

However, much fund and time will be required to implement such a big project. The time is not quite ripe for the execution of the overall flood control plan.

In this Supporting Report, the necessity of the urgent flood control project and its concrete measures are described.

2. Necessity of Urgent Flood Control Project

In recent years, the Bandung city and its surrounding area have been affected by serious floods. The flood damages of March 1986 flood with the inundation area of 7,249 ha, which is the largest flood, are estimated as follows:

- Affected residents : 112,252 persons
- Damaged houses : 27,310 houses
- Damaged paddy : 6,363 ha
- Damage amount : 14,630 Million Rp.

The frequent floods has occurred in the low-lying area in two (2) or three (3) times a year. According to the flood and flood damage survey results, the affected area and its flood damages are estimated as follows:

- Affected area : Approx. 2,000 ha
- Affected residents : 40,387 persons
- Damaged houses : 10,169 houses
- Damaged paddy : 1,794 ha
- Damage amount per one time : Rp.3.28 billion
- Expected damage amount per anual : Rp.8.20 billion

Moreover, the average annual flood damage estimated for various frequency floods under the present socio-economic conditions without project is estimated to be Rp. 17,508 million.

The implementation of the overall flood control project for the mitigation of the potential flood area will require much fund and time, because of the project scale and co-ordination with agencies concerned.

From the above considerations, the urgent flood control plan based on the overall plan shall be studied to prepare a priority project for immediate implementation, in consideration of the technical and economic effectiveness of the project under the present conditions.

3. Improvement Reaches

The estimated average annual flood damage of the Citarum River is approximately Rp. 16.14 billion in economic price. Its distribution by region is shown below. Location of each zone is shown in Fig. E.2.

Zone	Average Annual Flood Damage (Million ERp.)	Ratio (%)
A	3,664	22.7%
B	3,960	24.6%
C	5,357	33.2%
D	1,234	7.6%
E	1,921	11.9%
Total	16,136	100%

The river reaches between Curug Jompong and Sapan are selected at the target reaches of the urgent plan based on the following considerations.

(1) The prime aim of the urgent plan shall be to eliminate the frequent flooding that occurs two (2) or three (3) times a year.

(2) Such frequent floods mostly occur in A, B and C zones between Dayeuh Kolot and Sapan (See Fig. D.1 of Supporting Report D).

(3) The average annual flood damage of the upstream of Sapan (D and E zones) is low, compared to that of the downstream (A, B and C zones).

(4) More than 70% of the flood damage of D zone will be eliminated by the river improvements at downstream of Sapan (Refer to Supporting Report K, Table K.22 and Table K.24).

The target river reaches of the urgent plan are given below and their locations are shown in Fig. I.1.

- Citarum River : Curug Jompong - Sapan
  (existing river length is 40.2 km)

- Cisangkuy River : Dayeuh Kolot - Rancaengang
  (existing river length is 8.5 km)

4. Alternative Study of Design Flood Frequency

The design flood frequency of the urgent plan is determined, comparing the achievement rates of 2-year and 5-year plans to that of the long-term plan (20-year) in terms of the following factors.

(1) River discharge capacity at Dayeuh Kolot
(2) Flood depth at Dayeuh Kolot for the 20-year frequency flood
(3) Number of house relieved from the 20-year frequency flood
(4) Produced average annual flood damage reduction
(5) Required construction cost

The comparison is shown below.

Comparison of Design Flood Alternatives

Item	Design Flood		
	2-year	5-year	20-year
(1) Discharge Capacity (m^3/s)	320 (65%)	390 (80%)	490 (100%)
(2) Flood Depth (m)	1.3	0.6	0
(3) No. of Relieved House (houses)	4,200 (17%)	15,900 (64%)	24,900 (100%)
(4) Annual Flood Damage Reduction (Million Rp.)	13,457 (84%)	15,211 (95%)	16,006 (100%)
(5) Construction Cost (Million Rp.)	65,311 (60%)	81,465 (75%)	108,747 (100%)

Note: 1. For details on item (1) and (2) refer to Fig. G.19 of Supporting Report G.
2. For item (3) and (4) refer to Table K.21 and K.25 of Supporting Report K.
3. For item (5) refer to Table I.1.

The 2-year plan is economically more efficient. However, it will attain only 17% of the long-term plan in house relief from flood and will inundate Dayeuh Kolot in 1.3 m depth when the 20-year frequency flood occurs as shown in Fig. G.19 of Supporting Report G.

From the above considerations, 5-year frequency flood is proposed to apply as the design flood of the urgent river improvement plan.

5. Proposed Urgent River Improvement Plan

5.1 Improvement Plan of River Channel

5.1.1 Planning Policy and Design Criteria

The urgent river improvement is planned and designed in accordance with the following policy and criteria.

(1) Planning policy and design criteria in long-term plan will be basically followed.

(2) The plans are to be especially prepared to mitigate flood damage between Dayeuh Kolot and Sapan.

(3) Design flood and rainfall pattern are applied to a 5-year frequency flood and the March 1986 Storm respectively.

(4) A feature of the proposed river improvement will be determined within the proposed one in long-term plan.

(5) Manning's coefficient of roughness for design of low-water and high-water channel adopted are 0.030 and 0.035 respectively based on the channel conditions.

(6) A standard bank slope of the river channel will be adopted as follows:

Citarum River	:	downstream reaches from Dayeuh Kolot 1:1.5
Citarum River	:	upstream reaches from Dayeuh Kolot 1:2
Cisangkuy River	:	1:2

The following survey data are used for design of the river channel improvement.

(1) A series of the topographic maps and aerial photograph of 1/10,000 scale are used for the design river channel alignment.

(2) The river cross sections surveyed by DGWRD and the Study Team in 1988 are adopted for design of river channel.

5.1.2 Design Discharge Distribution

The design discharge distribution of the Citarum and Cisangkuy Rivers and design discharge hydrograph at Dayeuh Kolot are shown in Fig. I.2.

5.1.3 Design River Alignment, Profile and Cross Section

(1) The Citarum River

The design river alignment is the same as that of the long-term plan as described in Supporting Report H. The proposed plans of the urgent river channel improvement are illustrated from Fig. I.3 to Fig. I.9.

The design flood water level and river bed slope are also proposed to be the same as that of the long-term plan. The river bed elevation is, however, set 1.0 m above that of the long-term plan, considering the design river cross sections as mentioned below. The design river profile is shown in Fig. I.10.

The design river cross sections are proposed based on the following considerations:

1) Double section will be applied in principle to maintain stability of the river course and bed.

2) River width will be set to be the same as that of long-term plan so that land acquisition may not be required again in future.

3) Bank slopes to be adopted for the up and downstream stretches of Dayeuh Kolot are 1:1.5 and 1:2 respectively based on the present soil condition along the bank.

4) Flow areas are estimated based on the uniform flow condition.

5) No new maintenance road will be provided to minimize the land acquisition and resettlement.

The standard design river cross sections are proposed as shown in Fig. I.11. The typical cross sections are shown in Fig. I.3 to Fig. I.9.

(2) Cisangkuy River

The design river alignment is the same as that of the long-term plan. The proposed plans of the urgent river channel improvement are illustrated in Fig. I.12 and Fig. I.13.

The design flood water level, river bed elevation and also slope are proposed to be the same as that of the long-term plan. The proposed river profile is shown in Fig. I.14.

The design river cross sections are proposed based on the following conditions:

1) Single section will be applied in principle to minimize the required land acquisition and resettlement.

2) Bank slope is adopted to be 1:2.0, more gentle than that of the long-term plan 1:1.5.

3) Flow areas are estimated based on the uniform flow condition.

4) The existing road along the left bank is useful for the maintenance works. No new maintenance road will be provided.

The standard design river cross sections are proposed as shown in Fig. I.14. The typical cross sections are illustrated in Fig. I.12 and Fig. I.13.

(3) Hydraulic Effect of Fall at Curug Jompong

The evaluation of the hydraulic effect of the Curug Jompong Fall for the urgent plan (5-year frequency flood) was carried out by the same method for the long-term plan described in Supporting Report H.

According to the study result as shown in Fig. H.25, the lowest stretch of approximately 3.0 km will not require any river improvement except the bank clearing and grubbing works.

5.1.4 Related River Structure

Among the related river structures proposed for the long-term plan, the bank protection and bridge are proposed for the urgent plan of the Citarum and Cisangkuy River improvement.

The proposed bank protection and bridge improvements are listed in Table I.2 to Table I.4, and these location are shown in Figs. I.3 to I.9, Fig. I.12 and Fig. I.13.

Preliminary design of the proposed bank protection and bridge improvements are shown in Fig. I.15 to Fig. I.18.

5.2 Proposed Construction Works

Major improvement works of the urgent river improvement plan are river dredging including cut-off channels, bank protection and bridge improvement works. The required major construction works are as follows:

- River dredging	:	$6{,}953 \times 10^3$	m^3
Existing channel	:	4351×10^3	m^3
Cut-off channel	:	$2{,}602 \times 10^3$	m^3
- Bank clearing and grubbing	:	3.0	km
- Bank protection	:	6,100	m
- Bridge improvement	:	11	places
New construction	:	7	places
Strengthening	:	4	places
- Maintenance/Connection Road	:	2.15	km

Break-down of the construction works are shown in Table I.5.

5.3 Land Acquisition and Compensation

Land acquisition and house resettlement compensation are required prior to the implementation of the construction works. The quantities of land acquisition and compensation are summarized below:

- Land acquisition : 110.6 ha
- House compensation : 223 houses

Break-down of land acquisition and house compensation are shown in Table I.5.

6. Flood Plain Management

Flood plain management of the urgent flood control plan consists of the land-use regulation in the flood risk area, and of the establishment of the flood forecasting and warning system.

6.1 Flood Risk Map

Flood risk areas affected by a 5, 20 and 50-year flood are identified in the floo dprone area after completionof the proposed urgent plan. The estimated flood risk areas and number of flood risk houses under the above three (3) conditions are as follows:

Flood	Flood Risk Area (ha)	Number of Flood Risk House	
		Inundation Depth>0cm	Inundation Depth>50cm
5-year	3,160	8,047	3,200
20-year	4,710	15,054	7,100
50-year	5,640	20,011	10,400

The flood risk maps with depth contours for the above three (3) conditions are shown in Fig. I.19 to Fig. I.22.

6.2 Target Area of Flood Plain Management

The flood risk area of a 50-year flood is considered as target area of the flood plain management. This area is 5,640 ha for the period after completion of the urgent plan. However, it will decrease to 1,260 ha after completion of the long-term plan.

The following 27 desas are included in the flood risk area of the urgent plan.

Kecamatan	Desa	No.
Ciparay	Bale Endah, Mang Gahang, Jelekong, Sumber Sari	(4)
Buah Batu	Bojong Soang, Bojong Sari, Tegal luar, Lengkong	(4)
Majalaya	Ranca Sumba, Solokan Jeruk, Cibodas, Langen Sari, Pada Mukti	(5)
Rancaekek	Tengal Sumedang, Sukamanah, Bojong Loa, Jelegong, Sukamanah Sangiang, Ranca Ekek Kulon, Linggar, Haur Pugur	(8)
Paseh	Tangsi Mekar, Cigentur, Cipeles, Cijagra	(4)
Cisalengka	Tanjunglaya, Ciluluk	(2)
	Total	(27)

6.3 Land-use Regulation

A proper land-use regulation by the government is required to curb the increase of the flood damage potential. The conceivable land-use regulation includes:

- Restriction of housing development in critical flood prone areas
- Guidance for flood-proof housing development

The following non-structural measures will be required to relieve the existing houses in the flood prone areas.

- Land filling of house yard
- Raising of house floor
- Construction of flood wall surrounding house

6.4 Flood Forecasting, Warning, and Evacuation System

6.4.1 Existing System

There are two (2) systems exist for the flood forecasting, warning and evacuation activities of the Upper Citarum Basin. One is "Flood Forecasting and Warning System for Saguling Hydropower Project" and the other is "Evacuation System Coordinated by SATKORLAK".

The flood forecasting and warning system for the Saguling hydropower project functions for the operation of the dam and to transmit warning concerning water release from dam to downstream. The existing real-time hydrological data collection system covers the Upper Citarum Basin.

The evacuation system coordinated by SATKORLAK directly functions for the Upper Citarum Basin.

(1) Saguling Flood Forecasting and Warning System

A real-time hydrological data collection system is provided to determine the optimum dam operation and to issue water release warning to the downstream of the dam.

Hydrological telemetering system consists of the following stations.

- One (1) master station (Dam Control Center)
- Three (3) VHF repeater stations (Lalakon, Cililin and Cipanas)
- One (1) monitor station (IHE office)

- 11 rainfall gauging stations (Cinchona, Paseh, Cicalengka, Ciparay, Ujungberung, Cisondari, Bandung, Sukawarna, Cililin, Montaya, and Saguling Dam)

- Three (3) water level gauging stations (Nanjung, Saguling Dam and Buntar Caringin).

The system is illustrated in Fig. I.23.

Rainfall and water level data observed at each station are collected via the VHF radio links in 70 MHz band. IHE station monitors the observation data collected by the hydrological telemetering system and the calculated dam data. The master station is able to call the gauging stations by the following methods in addition to oral communications.

- Automatic calling directed to all gauging stations started by a clock device (for automatic periodical measurement).

- Manual calling directed to individual gauging stations started manually at any arbitrary time and any station.

- Re-calling when a station fails to respond.

The monitor station in IHE office performs the data code checks for the following data.

- Hydrologic data: rainfall and water level

- Dam processing data: effective storage volume, free overflow discharge, total discharge, generating discharge, gate discharge, inflow and reference point inflow.

The discharge warning system consists of one (1) master station, one (1) VHF repeater station, one (1) siren warning station, 15 speaker warning station and one (1) mobile warning station. It operates the motor siren and broadcasts a warning by tone and by voice.

(2) Evacuation System

SATKORLAK is a co-ordination body to conduct preparation of a refuge facilities for the residents evacuated from flood area and other activities related to the evacuation, and flood damage estimation. It is composed of the members of the concerning agencies such as the Public Works Service, Department of Agriculture and Indonesian Red Cross, etc, directly functions for the Upper Citarum Basin.

There are four (4) kinds of SATKORLAK, namely Province, Kabupaten, Kecamatan and Desa.

Flood conditions of each Desa is communicated from Desa SATKORLAK staffs to Kec., Kab. and Provincial SATKORLAK by carrier, transceiver, telephone and radio. Based on the information conveyed from Desas, judgment to prepare refuge places and to take required actions is done by SATKORLAK.

Major activities of SATKORLAK are:

- to get information of flood conditions
- to prepare refuge facilities
- to supply evacuated people with food, medicine, etc.
- rescue and other activities
- to survey flood damages and make a report

Residents living in flood risk area will judge by themselves whether to move to refuge places or not. Refuge places are mosque, railway station (Dayeuh Kolot), Desa office, school, settlement, warehouse, etc.

The existing flood information and evacuation system is shown in Fig. I.24.

6.4.2 Proposed Flood Forecasting and Warning System

A flood forecasting and warning system will be established to support the flood evacuation activities of the Upper Citarum Basin. The required hydrological data collection and transmission system will be accomplished fully by providing the existing system of the Saguling Hydropower Project with additional six (6) water level stations with telemetering system.

As a result, the Upper Citarum Basin will be covered by a real-time hydrological data collection and transmission system consisting of the following stations.

- Eight (8) existing rainfall stations
- One (1) existing and six (6) additional telemeters at existing water level stations
- One (1) existing repeater station
- One (1) expansion existing monitoring station (IHE) and one (1) additional master station (DPUP)

The proposed flood forecasting and warning system is shown in Fig. I.25.

The urgent flood control project will be responsible for providing hydrological information required for flood warning and flood evacuation activities of the Upper Citarum Basin.

The proposed flow chart of the flood forecasting and warning of the Upper Citarum Basin is shown in Fig. I.26.

Table I.1 COST COMPARISON OF DESIGN FLOOD ALTERNATIVES

(Unit : Million Rp.)

Item	2-Year Plan	5-Year Plan	20-Year Plan
I. Civil Work Cost			
(a) Citarum (main)	42,528.8	53,161.0	73,234.3
(b) Cisangkuy	2,074.4	2,593.0	3,010.6
II. Flood Warning System	1,265.2	1,265.2	1,265.2
III. Land Acquisition/ Compensation	5,316.0	6,645.0	7,715.0
IV. Administration Cost	2,559.2	3,183.2	4,261.3
V. Engineering Service Cost	5,630.3	7,211.9	9,374.8
Total	59,373.9	74,059.3	98,861.2
VI. Physical Contingency	5,937.4	7,405.9	9,886.1
Grand Total	65,311.3	81,465.2	108,747.3

Note 1. Civil work, flood warning system, and land acquisition/ compensation cost of the citarum(main) in 2-year plan is assumed as 80% of that of 5-year plan based on the design discharge rate at Dayeu Kolot (310m3/s/390m3/s)

2. Civil work, flood warning system, and land acquisition/ compensation cost of the Cisangkuy river in 2-year plan is also assumed as 80% of that of 5-year plan based on the design rate at Dayeu Kolot (310m3/s/390m3/s)

3. Administration and engineering costs are assumed as 5% and 11% of the construction cost respectively

4. Physical contingency is assumed 10% of the sum of civil work, flood warning system, land acquisition/compensation, administration, and engineering service costs.

Table I.2 LIST OF BANK PROTECTION

Name	Location		Length (m)
	Station	Bank	
G-1	Citarum River STA.6.95 - STA.7.25	Left	300
G-2	Citarum River STA.7.40 - STA.7.95	Right	550
G-3	Citarum River STA.7.50 - STA.7.80	Left	300
G-4	Citarum River STA.7.95 - STA.8.10	Left	150
G-5	Citarum River STA.8.40 - STA.8.60	Left	200
G-6	Citarum River STA.8.75 - STA.8.90	Left	150
G-7	Citarum River STA.9.30 - STA.9.55	Right	250
G-8	Citarum River STA.10.05 - STA.10.20	Left	150
G-9	Citarum River STA.10.35 - STA.10.55	Right	200
G-10	Citarum River STA.11.45 - STA.11.60	Left	150
G-11	Citarum River STA.13.40 - STA.13.60	Left	200
G-12	Citarum River STA.14.30 - STA.14.35	Left	150
G-13	Citarum River STA.17.45 - STA.17.70	Right	250
G-14	Citarum River STA.18.00 - STA.18.20	Left	200
G-15	Citarum River STA.18.35 - STA.18.50	Right	150
G-16	Citarum River STA.19.25 - STA.19.50	Left	250
G-17	Citarum River STA.19.75 - STA.20.85	Right	1,100
G-18	Citarum River STA.19.75 - STA.20.85	Left	1,100
G-19	Citarum River STA.21.25 - STA.21.40	Left	150
G-20	Citarum River STA.21.80 - STA.21.95	Left	150
Total			6,100