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BRIEF NOTE ON LIMO DAM DEVELOPMENT FOR FLOOD CONTROL PURPOSE

JULY 1996

STUDY TEAM ON COMPREHENSIVE RIVER WATER MANAGEMENT PLAN
IN JABOTABEK

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Table of Contents

List of Tables

List of Figures

1. OBJECTIVE OF THE DEVELOPMENT

A single purpose dam development for flood control has been proposed as one of the mesures of flood control plan of the Cengkareng Floodway system. Flood regulation effect by the dam reservoir is expected to mitigate a flood magnitude of the Pesanggrahan river and the Cengkareng Floodway and also to make it possible that smaller scale river improvement plan will be realized.

2. DAM SITE

2.1 River

The proposed Limo dam site is located in the Pesanggarahan river basin. The Pesanggarahan river originates in the hilly area which is north of the city of Bogor with an elevation of approximately 175 m, and join the Cengkareng Floodway. The river has a catchment area of 107 km^2 and a length of about 66 km at the confluence with the Cengkareng Floodway. In the upper and middle reaches, the Pesanggrahan river has formed dissected valley and flow through alluvial coastal plain in the lower reaches. The coastal floodplain have been mainly utilized for residential area. The upper and middle reaches will be completely urbanized in the future.

The general feature of the Pesanggarahan river basin (upstream of the confluence of the Cengkareng Floodway) is as follows:

(i)	Catchment area	:	107 km2
(ii)	Length	:	65.5 km
(iii)	Elevation	:	3.0 m to 175.0 m
(iv)	Average slope	:	1 / 380

2.2 Dam Site and Present Situation

Dam construction on the Pesanggrahan river in Cinere was once planned in the Cisadane-Jakarta-Cibeet Water Resources Development Plan in 1980. However, it has been confronted with land acquisition and resettlement problems due to dense land use by rapid urbanization of the DKI Jakarta outskirts and discontinued also for the reason of relatively small river catchment area.

It has been proposed in the present study to consider again this scheme for flood control purpose by modifying facilities or scale as well as shifting the dam site upstream.

The following location of Limo dam site has been identified after reviewing the previous studies and in consideration of topography and hydrology.

- Pesanggrahan river, close to Limo, with a watershed of 72 km^2 out of the total watershed of 107 km^2.

The location of the avobe dam site is shown in Fig.1.

3. GEOLOGICAL INVESTIGATION

3.1 Previous Study

As shown in the geological map (Fig.2) and the generalized geological cross-section (Fig.3), the Limo dam sites A, B, and C, as well as Depok dam site are located on a quite similar formation, the Bojongmanik Formation, which is overlain by an Alluvial Fan (overburden). Also a correlation study based on the results of drilling works for the Limo dam sites in the present study and the previous investigation results of the Depok dam site (Detailed Design Works of the Depok Dam, Stage II, 1985, by P.T Indra Karya) shows that the geology at the Limo dam sites corresponds to the Depok dam site, i.e., the lower layer belongs to the Bojongmanik Formation, the sedimentary rock consisting of an alternation of sandstone and claystone with an intercalation of limestone and tuff, and the upper layer consists of the deposit called Alluvial Fan or overburden, consisting of soft clay to stiff clay, silt, sand, gravel, and boulders. Therefore, the geotechnical conditions and the detailed design undertaken for the Depok dam in 1986 could be referred to for the Limo dams in the present study.

The baserocks of the Depok dam and Limo dams are the sedimentary rocks belonging to the Bojongmanik Formation and classified as rather soft rock from geotechnical point of view.

3.2 Field Investigation

In order to obtain the basic geological and geotechnical information on the Limo dam sites, the following geotechnical investigation works were carried out by the local contractor under a subcontract basis.

Dam Site	Drilling Site	Drilling Depth(m)	Remarks
Limo Dam A	PDA - 1	50	Right abutment
Limo Dam B	PDB - 1	50	Right abutment
	PDB - 2	40	River bed
Limo Dam C	PDC - 1	60	Left abutment
	PDC - 2	40	River bed
Total	5 holes	240	

Locations of the above drilling works are shown in Fig.4 .

In total, 5 drillings with standart penetration test (SPT) and permeability test (Constant Head Test) in uncemented deposits, and water pressure test in bedrocks (Lugeon Test) were carried out.

3.3 Geotechnical Consideration for Dam Construction

Core drilling was carried out a total depth of 240 m at 5 holes at the proposed dam sites in the Pesanggrahan river. The drilling result at both abutments of the 3 dam sites shows the presence of clayey silt, sandy silt and loose gravelly sand with N values in the range of 7 to 25 mostly in the upper portion of less than 13 m in depth. Dense sand, very stiff to hard sandy silt or clayey silt, and weathered limestone layers with N values of more than 50 exist in the lower portion in general.

The engineering properties of baserocks applied in the Depok dam design were as follows:

Density : γ_{wet} = 1.77 t/m³, γ_{sat} = 1.78 t/m³

Shearing strength : C' = 8.5 t/m², Ø' = 24.2°

where,

γ_{wet} : wet density

γ_{sat} : saturated density

C' : cohesion in terms of effective stress

Ø' : internal friction angle in terms of effective stress

A part of sedimentary rocks for dam foundation such as sandstone, intercalation of limestone and tuff and pumiceous tuff layer, have a little higher permeability coefficient ranging from 10^{-3} to 10^{-4} cm/s.

In case the storage dam scheme for multiple purposes is adopted instead of the check dam scheme for only flood control purpose, countermeasures against water leakages from the foundation, such as grout treatment or impervious blanket treatment, will be required.

Availability of embankment materials in quality and quantity and transportation of the same are also another important conditions for dam type selection. In consideration of the available embankment materials in and around the Project area, the earthfill dam type is recommendable for the Limo dam considering mainly the difficulty of obtaining rock embankment materials, and also the limitation of dam height being less than 40 m from riverbed because of the topographic condition.

From the geological point of view, the Limo A, B and C dam sites are almost similar as far as the dam construction is concerned.

3.4 Construction Material Sources

The potential construction material sources for the proposed filltype dams are shown in Fig.5, which were proposed in the water resources and flood control studies in the past and confirmed by the field reconnaisance in the present study.

(a) Impervious Earth Material

In general it would be rather easy to obtain a large amount of suitable earth materials in the vicinity of the proposed dam sites because all the potential borrow sites are composed of weathered volcanic rocks or alluvial fan (overburden), which have been confirmed to be suitable impervious materials, through actual constructions and according to the data of the previous studies.

The engineering properties of impervious materials applied in the previous studies, which correspond to the embankment works for such structures as filltype dam and dike on the river in the Study Area, are as follows:

Density : γ_{wet} = 1.61 ~ 1.68 t/ m^3, γ_{sat} = 1.65 ~ 1.72 t/m^3

Shearing strength : C = 2.0 ~ 5.4 t/m^2, C' = 1.0 ~ 2.0 t/m^2

Ø =9.0 ~ 12.5°, Ø' = 25.0 ~33.0

where,

C: cohesion in term, of total stress

Ø: internal friction angle in terms of total stress

The compaction of the above materials was performed mostly by tamping roller or pneumatic roller.

(b) Sand and Gravel Material

Sand and gravel to be used for concrete and filter or transition material can be obtained mainly along the Cisadane river, Ciapus river and Cipamingkis river, where large deposits of sand, gravel and stone are available. Several private companies are exploiting these deposits and processing sand and gravel by operating crushing plants. Among these materials, the Cipamingkis river materials are rather inferior in quality for concrete aggregate due to a high/ content of pumice fragments. The engineering properties of materials for filter zone applied in the past studies are as follows:

Density : γ_{wet} = 1.74 t/m^3, γ_{sat} = 1.89 t/m^3

Shearing strength : C(C') = 0 t/m^2 Ø (Ø') = 35.0°.

(c) Rock Materials

The promising rock quarries are composed of Andesite of Sudamanic Volcano or Older Volcanic Rock named in the Bogor Quadrangle (1986), which are located in the western hilly part (Rumpin) of the Study Area. Private companies are producing sand and gravel, and rock material by operating crushing plants. Other quarries such as the proposed quarries in G. Cibodas and Cibinong Limestone, which are composed of limestone of the Klapanunggal Formation, could be recommended for the inner shell zone of rockfill dams or base materials for roads. The northern steep ridges of G. Salak, around El. 900 m (near Taman, upstream of

Ciapus river), are composed of hard andesitic rocks, mainly andesitic lava.

All the above rock material sources except the limestone quarries have some difficulties in transportion because most roads are in poor condition.

3.5 Geotechnical Condition at Limo Dam Site

It is concluded that as shearing strength of baserock is estimated to be less than 50 tons/m^2 from N values obtained in the previous investigations and the present investigation, the rockfill or earthfill dam type should be selected for rather soft foundation.

4. HYDROLOGICAL STUDY

4.1 Rainfall Analysis

Through the various rainfall analyses such as probability analysis of annual maximum daily areal rainfall for the basin of the Ciliwun river and others, as well as the probability analysis of annual maximum daily point rainfall at BMG station, the probable rainfalls for several return periods are obtained as summarized below and also shown in Fig.6:

Area	2-year		5-year		10-year		25-year		50-year		100-year	
Point Rainfall	98	(100%)	135	(100%)	160	(100%)	192	(100%)	215	(100%)	238	(100%)
Ciliwung(215km^2)	63	(65%)	85	(62%)	99	(61%)	116	(61%)	129	(60%)	142	(60%)
Ciliwung(442km^2)	67	(69%)	86	(63%)	98	(61%)	114	(59%)	125	(58%)	137	(57%)
Cisadane(1,411km^2)	49	(50%)	67	(50%)	79	(49%)	94	(49%)	105	(49%)	116	(49%)

The rainfall masscurves for several return periods are worked out as shown in Fig.7 based on the predetermined rainfall duration of 24 hours and the time distribution patterns which were adopted in the previous Jakarta Drainage and Flood Control Master Plan.

4.2 Runoff Analysis

The flood runoff calculation model using the storage function method is developed based on the river systems divided into each sub-basin as shown in Fig.8. The schematic diagram of the basin and river channel model for the Cengkareng Floodway system is presented in Fig.9.

The calculated hydrographs at the design control points of the Pesanggrahan river under the future land use condition are given in Fig. 10. The design peak discharge at the design control point for the predetermined design scale of each river and those specific discharge are summarized in Fig.11 and Fig.12, respectively.

4.3 Sediment Yield

A sediment yield of the Pesanggrahan river in the proposed Limo dam catchment is determined at 0.53 mm /year by assuming that the study results of the Detailed Design Works of the Depok

Dam, Stage II could be applicable for the Limo catchment which is rather near from and seems to have similar characteristics with the Depok dam catchment.

5. DAM DEVELOPMENT PLAN

5.1 Dam Development Alternatives

Following 4 alternatives have been studied for the formulation of flood control master plan for the Cengkareng Floodway system:

(i) River improvement (CKR-1)

(ii) River improvement + **Limo Dam** (CKR-2)

(iii) River improvement + Angke Floodway (CKR-3)

(iv) River improvement + **Limo Dam** + Angke Floodway (CKR-4)

To examine the viability of alternatives of CKR-2 and CKR-4, a preliminary design of the Limo dam have been carried out.

5.2 Dam Development Scale

5.2.1 Dam Type and Height

As described in the preceding Section 3.3, the earthfill dam type has been selected for the Limo dam due to the geological condition of the sites as well as mainly the difficulty of obtaining rock embankment materials in and around the Project area.

The maximum dam height is determined to be less than 40 m from riverbed because of the topographic condition.

From the geological point of view, the Limo A, B and C dam sites are almost similar as far as the dam construction is concerned.

5.2.2 Prospective Site

Based on the predetermined dam height limitation, a possible dam scale and a reservoir area of each dam site is designed on the presently available topographical maps scaled of 1: 25,000 as shown in Figs.13 to 15, respectively.

The Limo dam C, which is at the most upstream location, has been selected as the most prospective and realistic site for development among the 3 dam site alternatives, in consideration of the present land use of the dam and reservoir area(less resettlement aspect) though the site C may not be the most advantageous one in reservoir scale aspect.

5.2.3 Reservoir Development Scale

The reservoir storage curve has been worked out based on the aforementioned topographical map as shown in Fig.16.

The reservoir development scale has been determined that the dam height is set at the geotechnically maximum and dam freeboard has been set out at 4 m from dam crest to the maximum waterlevel. The principal development scale of the Limo dam C is as follows:

(1)	Dam Crest Elevation	:	EL.64.0 m (4.0 m freeboard)
	Dam Height	:	51.5 m incld. 15 m excavation
(2)	High Water Level	:	EL.60.0 m
	Gross Storage Volume		8.997 x 10^6 m^3
(3)	Sediment Level	:	EL.52.4 m
	Sediment Volume	:	3.816 x 10^6 m^3
			(0.53 mm /yr x 72 km^2 x 100yr x10^3)
(4)	Riverbed Elevation	:	EL.27.5 m
(5)	Net Storage Volume	:	5.181 x 10^6 m^3

5.3 Flood Control Effect

The flood regulation effect by the Limo dam C(reservoir) has been examined for the design peak flood inflow of 390 m^3/sec by assuming the effective flood regulation volume of 4,318,000m^3(5,181,000 m^3/1.2). As being shown in Fig.11, the regulated peak outflow is estimated to be 25 m^3/sec, which would mitigate flood discharge magnitude in the downstream reaches.

5.4 Preliminary Design of Dam and Major Structure

Referring to the geological investigation result conducted in the present study as well as the presently available topographic maps scaled of 1: 25,000, the preliminary design has been carried out for the dam at the Limo dam C site. Due to unavailability of sufficiently large-scale topographic maps, the design is limited to a just preliminary level.

The designed structures are dam, spillway, cofferdam and temporary diversion tunnel, as follows:

(1)	Dam	Earthfill type dam			
		Crest elevation	:	El. 64.0	m
		Crest length	:	560	m
		Height	:	51.5 m including 15 m excavation from riverbed	
		Embank. vol.	:	1,832,000	m^3

(2) Spillway Concrete non-gate type with drain conduit

Max. spillout capacity	:	1,075	m^3/s
Crest elevation	:	El. 57.0	m
Crest length	:	100	m
Sill El. of conduit	:	1 m above designed sediment level	

(3) Diversion Tunnel

Nos.	:	1	
Diameter	:	5.2	m (standard horse shoe type)
Length	:	800	m
Max. discharge capacity	:	259	m^3/s

Diversion tunnel will be used for a temporary drain conduit until sediment level will reach to the tunnel invert level.

The typical cross section of the dam is presented in Fig.17.

6. PROJECT COST AND EVALUATION

6.1 Dam Construction Cost

The construction cost of the Limo dam has been estimeted on the basis of work quantities obtained from the preliminary design result and prevailing unit prices of Late 1995 level. The costs are broken down in the forein currency portion(Japanese Yen) and the local currency portion(Indonesia Rupiah). The foreign exchange rate of Yen 1.0 = Rp.22.7 has been applied in the estimate.

The construction cost of the Limo dam is summarizedas follows and detaifed in Table 1:

(unit : million)

	Forein Currency (J.Yen)	Local Currency (Rupiah)	Total Amount (Rupiah)
Dam	2,872.6	11,311.0	76,520.1
Spillway	6,977.0	86,573.0	244,951.0
Cofferdam	121.6	573.1	3,333.0
Diversion Tunnel	768.2	9,988.9	27,426.3
Total	10,739.4	108,446.0	352,230.3

6.2 Project Cost

The financial project costs for the 4 alternatives(CKR-1 thru CKR-4), in which CKR-2 and CKR-4 contain the dam construction measures, have been estimated of the direct construction costs including dam and other facilities, land acquisition and house compensation. The financial project costs for the Cengkareng Floodway system is shown below:

(Billion Rupiah)

	Construction Cost of Dam	Total Project Cost			
		CKR - 1	**CKR - 2**	CKR - 3	**CKR - 4**
Direct Construction Cost	352.2	86.3	419.1	385.7	708.6
Land Acquisition/House Compensation	398.5	406.3	621.3	294.8	570.7
Administration Cost	37.5	24.6	52.0	34.0	64.0
Engineering Services	59.9	14.7	71.2	65.6	120.5
Sub-total	848.1	531.9	1,163.6	780.1	1,463.8
Phisical Contingency	84.8	53.2	116.4	78.0	146.4
Total Cost	932.9	585.1	1,280.0	858.1	1,610.2

6.3 Economic Evaluation and Conclusion

The economic project cost and the Economic Internal Rate of Return(EIRR) have been assesed for the evaluation of each alternative as shown below:

Alternative	Economic Cost (Billion Rupiah)	EIRR (%)	Note
CKR - 1	141.6	42.9	(R.Imprv)Big land acquisition cost
CKR - 2	610.0	11.4	(R.Imprv+Dam)
CKR - 3	520.4	13.7	(R.Imprv+Floodway)
CKR - 4	982.0	7.4	(R.Imprv+Dam+Floodway)

The alternatives which include the Limo dam construction plan have bigger amount cost and lower EIRR value than those without a dam construction. Furthermore, the land acquisition/house compensation cost of both alternatives with dam construction need much bigger than the others.

Upon due consideration of the advantages of respective alternatives, the alternative of CKR-3 has been selected as the most advantageous flood control masterplan for the Cengkareng Floodway system from the less land acquisition point of view while the CKR-1 has been evaluated as the higest EIRR and smallest project cost of all.

Table 1 LAND ACQUISITION AND CONSTRUCTION COST OF LIMO DAM

JY.1.0 = Rp. 22.7

Item No.	Work Item	Unit	Q'ty	Foreign Currency (Yen) Unit Price	Foreign Currency (Yen) Amount	Local Currency (Rupiah) Unit Price	Local Currency (Rupiah) Amount	Total(Rupiah) Amount
	GRAND TOTAL				**10,739,399,070**		**506,920,964,900**	**750,705,323,789**
A.	LAND ACQUISITION AND COMPENSATION				0		398,475,000,000	398,475,000,000
1	Land Acquisition	ha	65.9	0	0	6,000,000,000	395,400,000,000	395,400,000,000
2	House Compensation	nos	123.0	0	0	25,000,000	3,075,000,000	3,075,000,000
B.	CONSTRUCTION				10,739,399,070		108,445,964,900	352,230,323,789
1.	**Diversion Tunnel**				768,166,560		9,988,922,000	27,426,302,912
1.1	Earth Work				435,396,720		5,331,042,200	15,214,547,744
001/	Preparatory works(10%)				35,983,200		440,582,000	1,257,400,640
002/	Clearing and stripping	ha	2	1,500,000	3,000,000	11,000,000	22,000,000	90,100,000
003/	Open-air excavation in common	m³	12,800	390	4,992,000	2,200	28,160,000	141,478,400
004/	Tunnel excavation in common	m³	33,500	10,500	351,750,000	130,000	4,355,000,000	12,339,725,000
005/	Backfill in random materials	m³	300	300	90,000	2,200	660,000	2,703,000
	Others (10 %)				39,581,520		484,640,200	1,383,140,704
1.2	Foundation Treatment				16,879,500		205,095,000	588,259,650
001/	Preparatory works(10%)				1,395,000		16,950,000	48,616,500
002/	500mm dia., PC pile	m	1,500	9,300	13,950,000	113,000	169,500,000	486,165,000
	Others (10 %)				1,534,500		18,645,000	53,478,150

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JY 1.0 = R p. 22.7

Item No.	Work Item	Unit	Q'ty	Foreign Currency (Yen) Unit Price	Foreign Currency (Yen) Amount	Local Currency (Rupiah) Unit Price	Local Currency (Rupiah) Amount	Total(Rupiah) Amount
1.3	Concrete Work				307,678,800		3,912,656,000	10,896,964,760
001/	Preparatory works(10%)				25,428,000		323,360,000	900,575,600
002/	Open-air structure for guide wall tunnel portal and facing	m^3	800	15,600	12,480,000	167,000	133,600,000	416,896,000
003/	Concrete in tunnel lining	m^3	15,500	15,600	241,800,000	200,000	3,100,000,000	8,588,860,000
	Others (10 %)				27,970,800		355,696,000	990,633,160
1.4	Grouting Work				2,207,040		49,948,800	100,048,608
001/	Preparatory works(10%)				182,400		4,128,000	8,268,480
002/	Consolidation grouting	ton	48	38,000	1,824,000	860,000	41,280,000	82,684,800
	Others (10 %)				200,640		4,540,800	9,095,328
1.7	Miscellaneous Work				544,500		70,180,000	82,540,150
001/	Preparatory works(10%)				45,000		5,800,000	6,821,500
002/	Wet rubble masonry wall for slope protection	m^2	250	1,800	450,000	232,000	58,000,000	68,215,000
	Others (10 %)				49,500		6,380,000	7,503,650
1.9	Road Work				5,460,000		420,000,000	543,942,000
001/	5.00m(width), Construction road	m	2,000	2,600	5,200,000	200,000	400,000,000	518,040,000
	Others (5%)				260,000		20,000,000	25,902,000
2.	**Coffer Dam**				121,582,010		573,092,300	3,333,003,927
2.1	Earth Work				121,582,010		573,092,300	3,333,003,927
001/	Preparatory works(10%)				10,048,100		47,363,000	275,454,870
002/	Clearing and stripping	ha	3	1,500,000	4,500,000	11,000,000	33,000,000	135,150,000
003/	Open-air excavation	m^3	55,400	390	21,606,000	2,200	121,880,000	612,336,200
004/	Embankment for dam body	m^3	106,250	700	74,375,000	3,000	318,750,000	2,007,062,500
	Others (10 %)				11,052,910		52,099,300	303,000,357

Table 1 LAND ACQUISITION AND CONSTRUCTION COST OF LIMO DAM

JY.1.0 = R p. 22.7

Item No.	Work Item	Unit	Q'ty	Foreign Currency (Yen) Unit Price	Foreign Currency (Yen) Amount	Local Currency (Rupiah) Unit Price	Local Currency (Rupiah) Amount	Total(Rupiah) Amount
3.	Dam				2,872,647,590		11,310,966,200	76,520,066,493
3.1	Earth Work				2,859,785,390		10,884,034,700	75,801,163,053
001/	Preparatory works(10%)				236,345,900		899,507,000	6,264,558,930
002/	Clearing and stripping	ha	14	1,500,000	21,000,000	11,000,000	154,000,000	630,700,000
003/	Open-air excavation	m³	446,100	390	173,979,000	2,200	981,420,000	4,930,743,300
004/	Embankment in core	m³	1,274,600	700	892,220,000	3,000	3,823,800,000	24,077,194,000
005/	Embankment in riprap	m³	182,100	1,800	327,780,000	7,500	1,365,750,000	8,806,356,000
006/	Backfill in random materials	m³	5,200	300	1,560,000	2,200	11,440,000	46,852,000
007/	Embankment in filter	m³	364,200	2,600	946,920,000	7,300	2,658,660,000	24,153,744,000
	Others (10 %)				259,980,490		989,457,700	6,891,014,823
3.3	Concrete Work				8,494,200		90,931,500	283,749,840
001/	Preparatory works(10%)				702,000		7,515,000	23,450,400
002/	Precast parapet wall	m³	450	15,600	7,020,000	167,000	75,150,000	234,504,000
	Others (10 %)				772,200		8,266,500	25,795,440
3.9	Road Work				4,368,000		336,000,000	435,153,600
001/	5.00m (width), Construction road	m	1,600	2,600	4,160,000	200,000	320,000,000	414,432,000
	Others (5 %)				208,000		16,000,000	20,721,600

Table 1 LAND ACQUISITION AND CONSTRUCTION COST OF LIMO DAM

JY.1.0 = R p. 22.7

Item No.	Work Item	Unit	Q'ty	Foreign Currency (Yen) Unit Price	Foreign Currency (Yen) Amount	Local Currency (Rupiah) Unit Price	Local Currency (Rupiah) Amount	Total(Rupiah) Amount
4.	**Spillway**				6,977,002,910		86,572,984,400	244,950,950,457
4.1	Earth Work				485,864,610		2,863,513,400	13,892,640,047
001/	Preparatory works(10%)				40,154,100		236,654,000	1,148,152,070
002/	Clearing and stripping	ha	6	1,500,000	9,000,000	11,000,000	66,000,000	270,300,000
003/	Open-air excavation in common	m³	875,900	390	341,601,000	2,200	1,926,980,000	9,681,322,700
004/	Backfill in random materials	m³	169,800	300	50,940,000	2,200	373,560,000	1,529,898,000
	Others (10 %)				44,169,510		260,319,400	1,262,967,277
4.2	Foundation Treatment				3,845,150,100		46,720,641,000	134,005,548,270
001/	Preparatory works(10%)				317,781,000		3,861,210,000	11,074,838,700
002/	500mm dia., PC pile	m	341,700	9,300	3,177,810,000	113,000	38,612,100,000	110,748,387,000
	Others (10 %)				349,559,100		4,247,331,000	12,182,322,570
4.3	Concrete Work				2,539,656,900		28,410,558,000	86,060,769,630
001/	Preparatory works(10%)				209,889,000		2,347,980,000	7,112,460,300
002/	Open-air structure concrete	m³	134,400	15,600	2,096,640,000	167,000	22,444,800,000	70,038,528,000
003/	Bridge	nos	6	375,000	2,250,000	172,500,000	1,035,000,000	1,086,075,000
	Others (10 %)				230,877,900		2,582,778,000	7,823,706,330
4.7	Miscellaneous Work				62,835,300		8,098,772,000	9,525,133,310
001/	Preparatory works(10%)				5,193,000		669,320,000	787,201,100
002/	Wet rubble masonry wall for slope protection	m²	28,850	1,800	51,930,000	232,000	6,693,200,000	7,872,011,000
	Others (10 %)				5,712,300		736,252,000	865,921,210
4.8	Mechanical Work				40,766,000		269,500,000	1,194,888,200
001/	Gate(1.5w x 1.5h)	nos	6	510,000	3,060,000	7,500,000	45,000,000	114,462,000
002/	Gate(4.5w x 4.5h)	nos	4	8,500,000	34,000,000	50,000,000	200,000,000	971,800,000
	Others (10 %)				3,706,000		24,500,000	108,626,200
4.9	Road Work				2,730,000		210,000,000	271,971,000
001/	5.00m(width), Construction road	m	1,000	2,600	2,600,000	200,000	200,000,000	259,020,000
	Others (5 %)				130,000		10,000,000	12,951,000

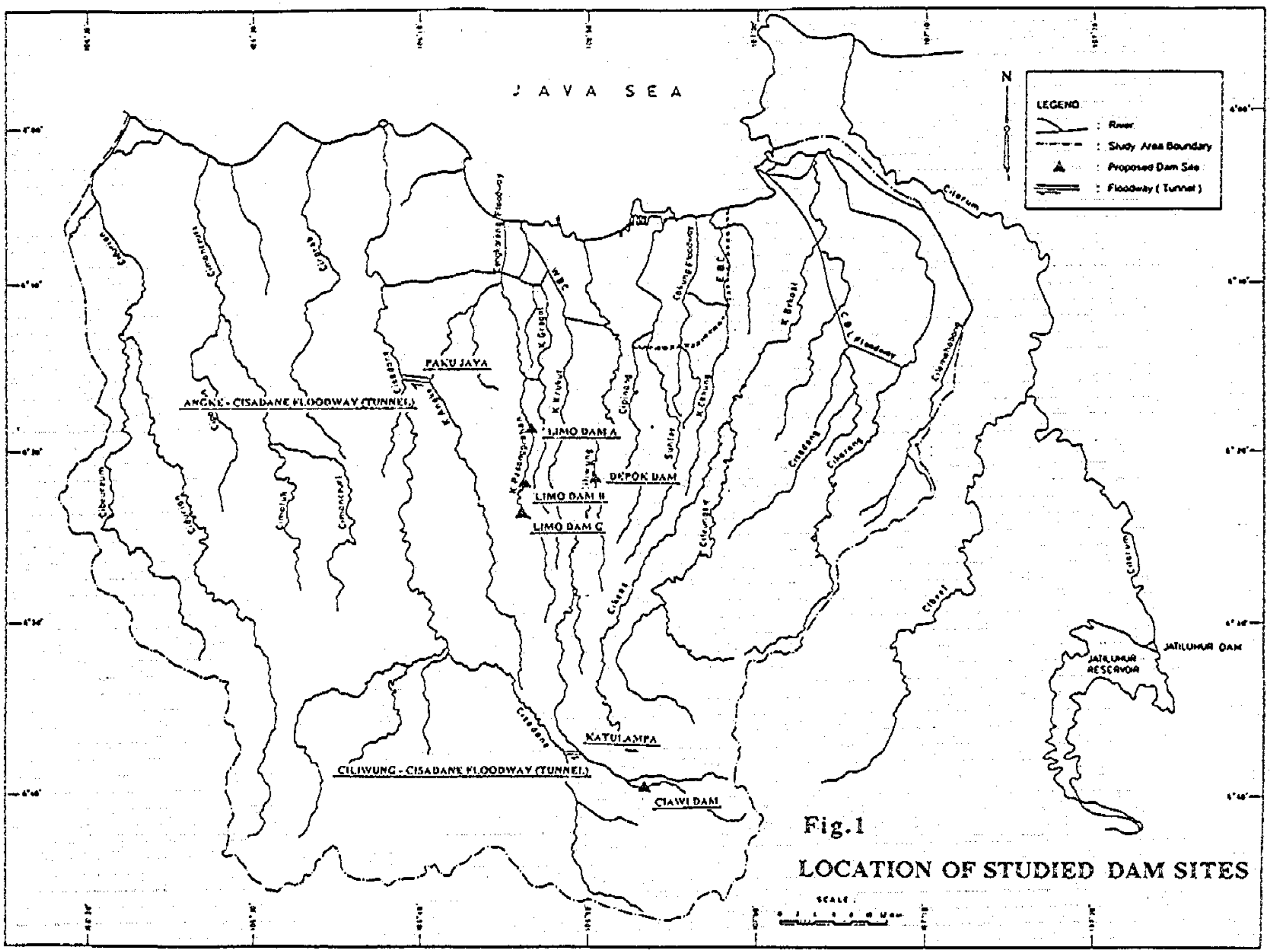


Fig.1

LOCATION OF STUDIED DAM SITES

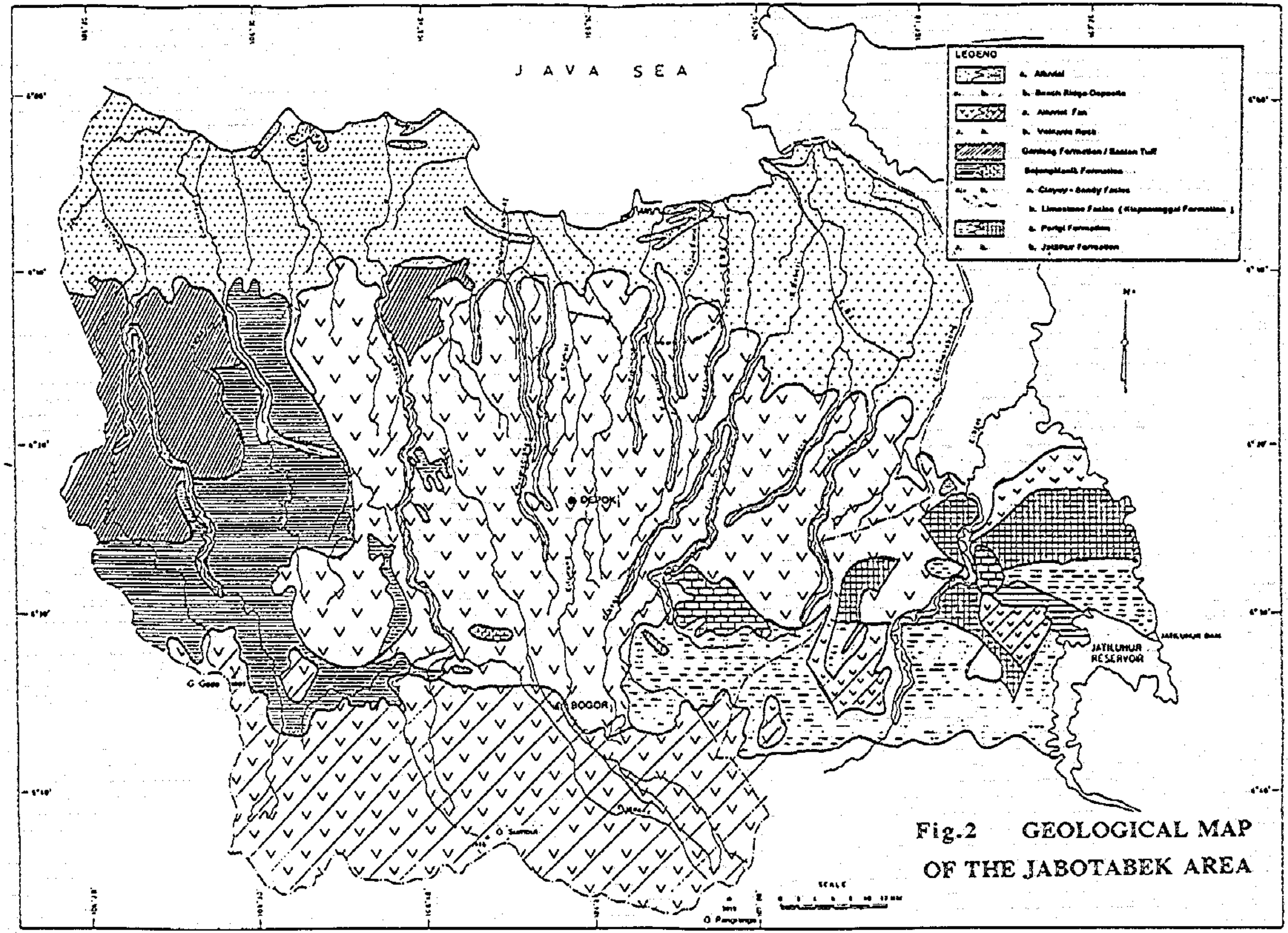


Fig.2 GEOLOGICAL MAP OF THE JABOTABEK AREA

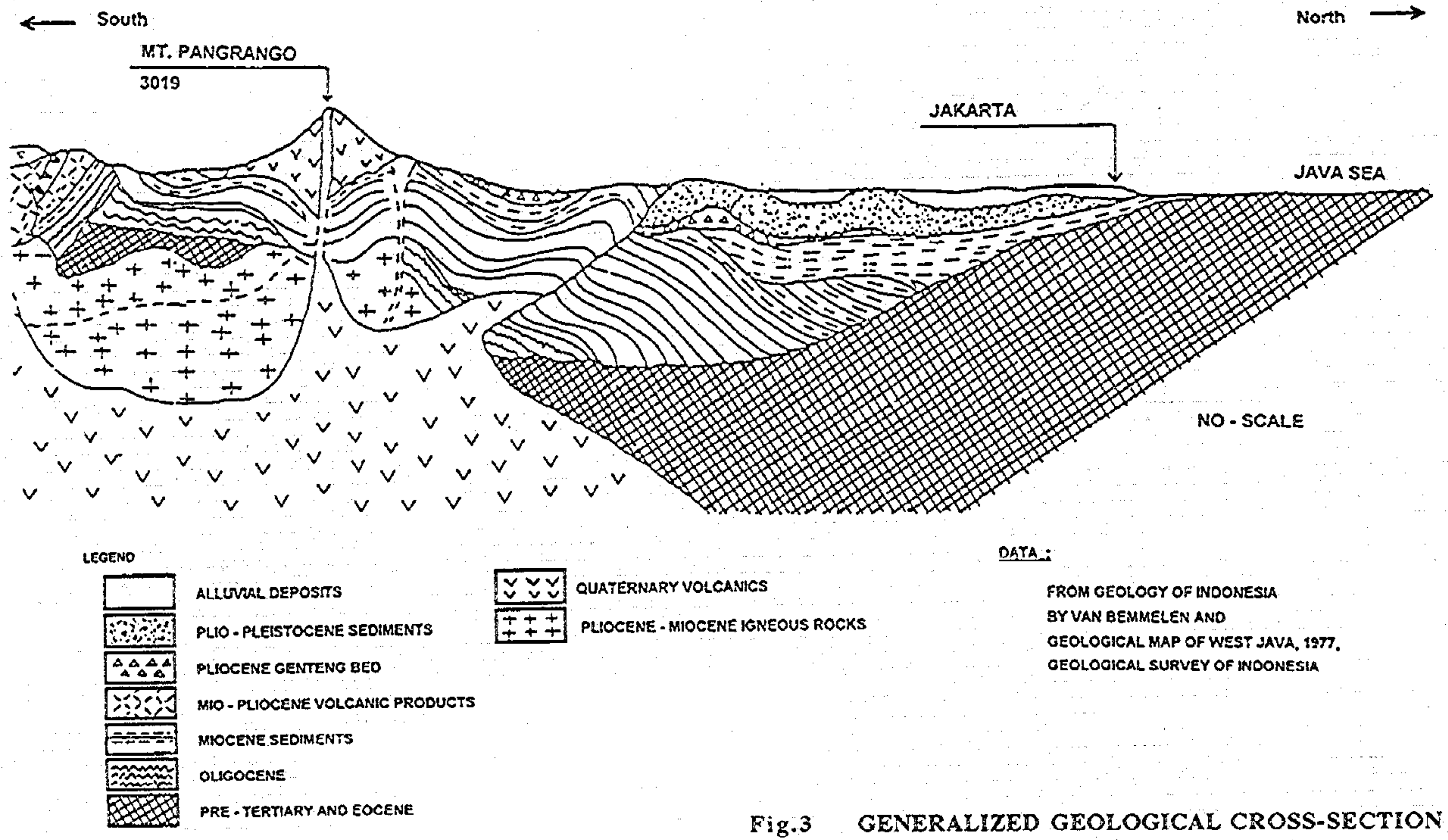


Fig.3 GENERALIZED GEOLOGICAL CROSS-SECTION FROM SOUTH TO NORTH IN THE STUDY AREA

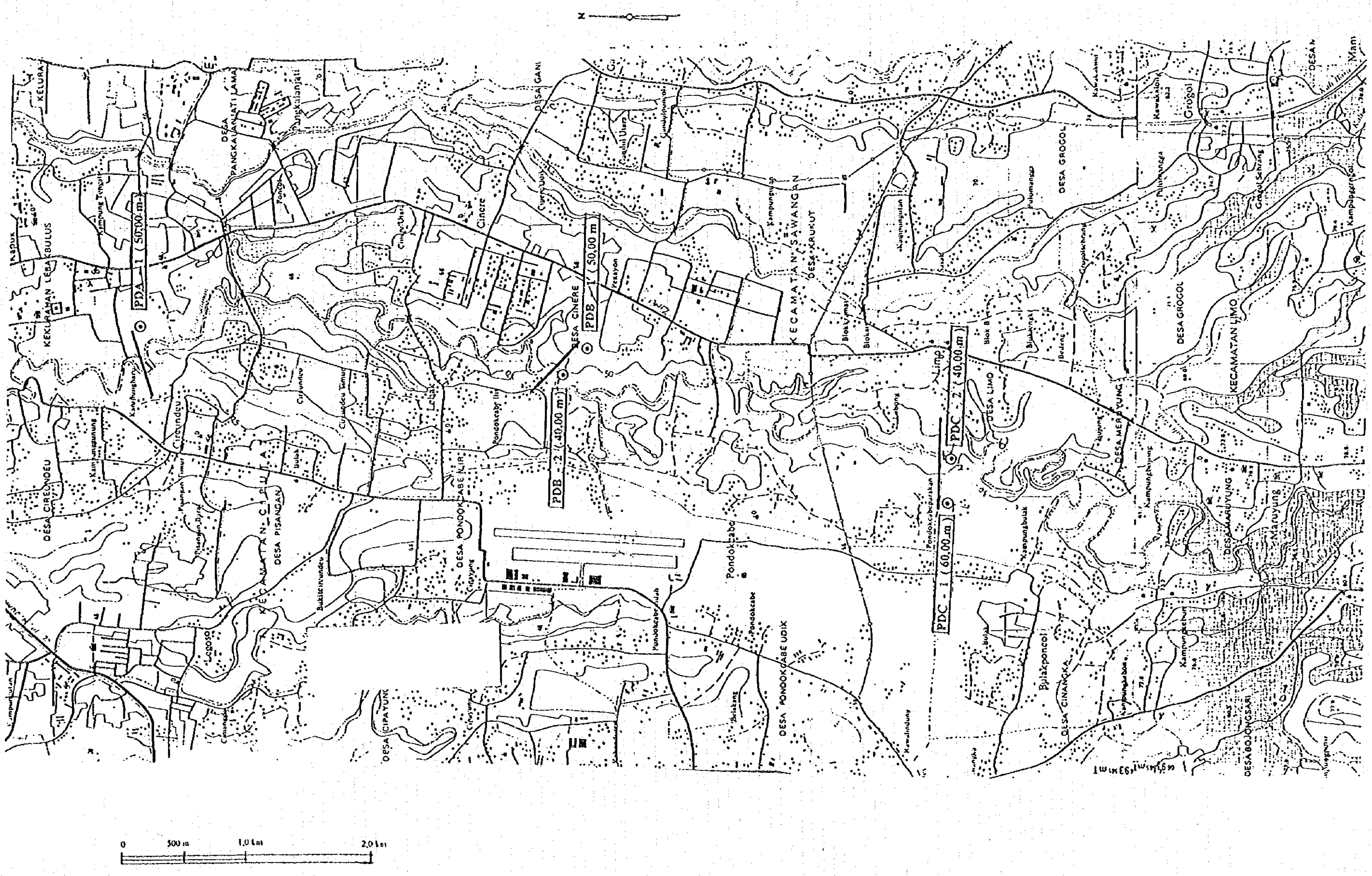


Fig.4 LOCATION OF LIMO DAMS AND DRILLING WORKS

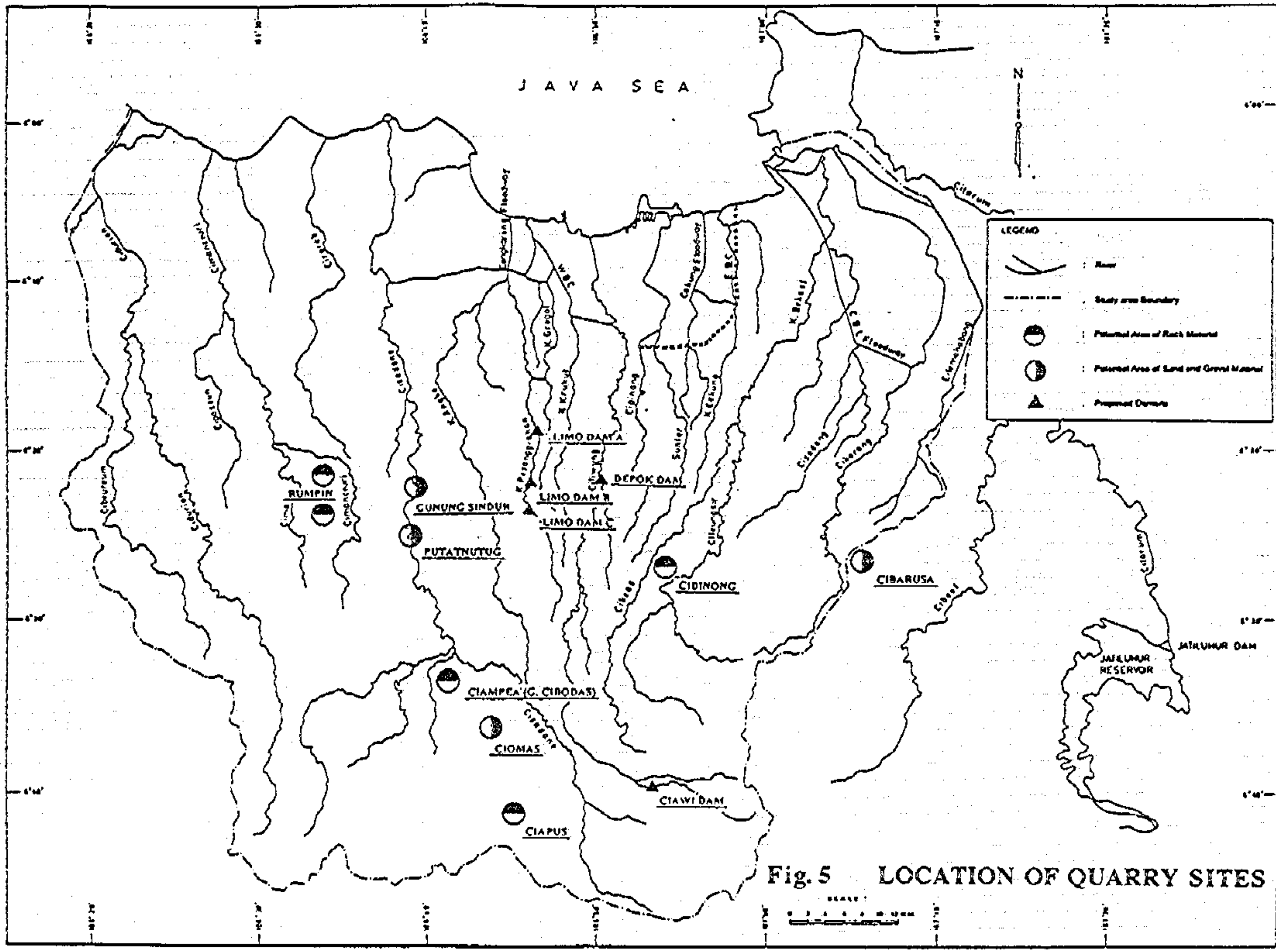


Fig. 5 LOCATION OF QUARRY SITES

Return Period (year)	Jakarta Point Rainfall (mm)	Ciliwung $A=215\ km^2$ (mm)	Ciliwung $A=442\ km^2$ (mm)	Cisadane $A=1,411\ km^2$ (mm)
1000	315.2	185.6	174.7	153.1
500	292.1	172.7	163.3	142.0
250	269.1	159.7	151.9	131.0
200	261.6	155.5	148.2	127.5
100	238.5	142.5	136.8	116.4
50	215.3	129.4	125.3	105.3
30	198.1	119.8	116.7	97.1
25	191.9	116.3	113.7	94.1
20	184.3	112.0	109.9	90.5
10	160.3	98.6	98.1	79.0
5	135.4	84.5	85.7	67.1
2	97.7	63.3	67.1	49.1

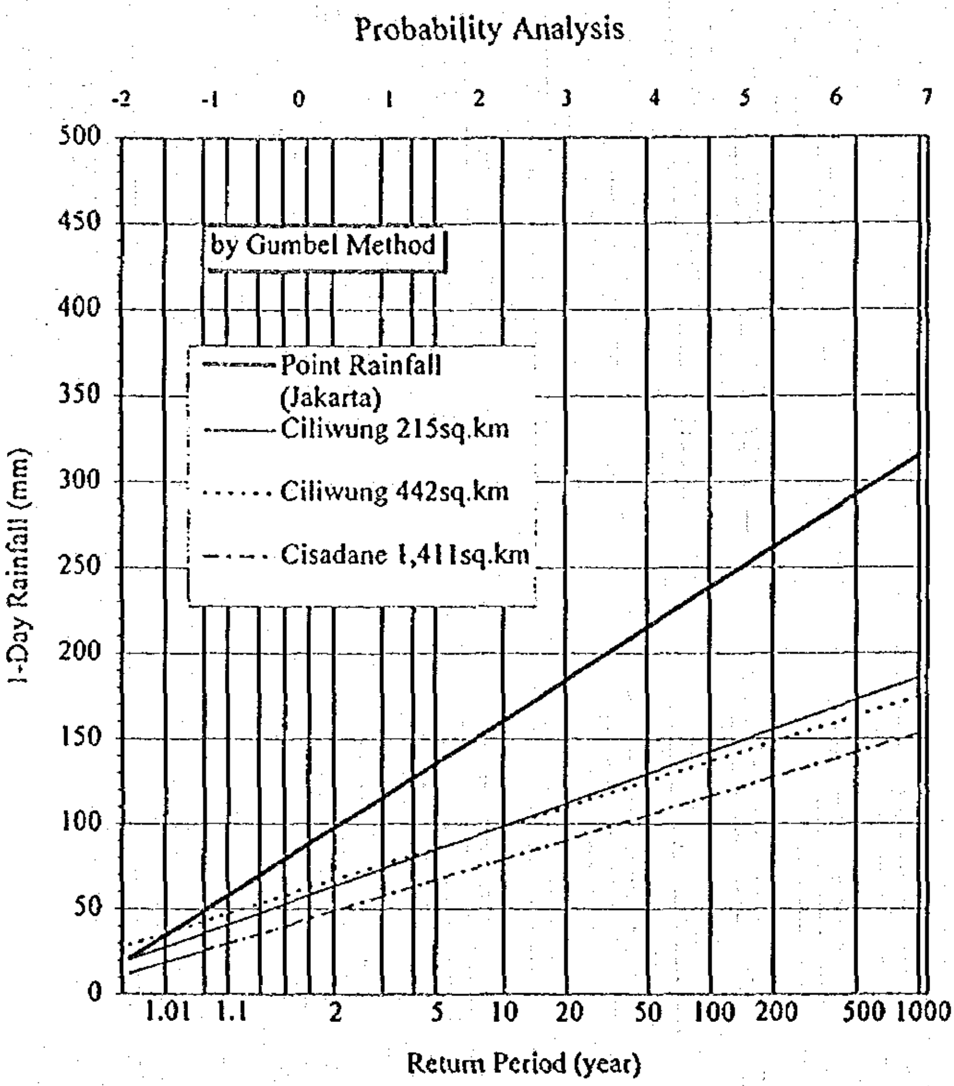


Fig. 6 PROBABLE DAILY RAINFALL

	2-yr	5-yr	10-yr	20-yr	25-yr	30-yr	50-yr	100-yr
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	55.4	64.8	72.2	79.1	82.7	84.9	90.8	96.1
2	64.2	79.9	91.8	98.0	105.1	107.0	114.4	134.2
3	69.5	88.8	101.5	113.3	120.4	122.9	130.8	151.4
4	73.0	95.0	108.7	124.1	132.1	134.4	143.5	162.3
5	76.6	100.3	114.9	133.0	140.2	143.2	153.5	170.5
6	79.2	104.8	120.3	140.2	146.5	150.3	161.7	177.7
7	81.0	107.4	125.6	144.7	151.9	155.6	167.1	184.1
8	82.7	110.1	129.2	148.3	156.4	160.0	172.6	190.4
9	84.5	111.9	132.3	151.9	160.0	164.5	178.0	195.9
10	86.2	113.6	135.0	154.6	163.6	168.0	181.7	200.4
11	87.1	115.4	137.6	157.3	166.3	171.5	185.3	204.9
12	88.0	117.2	139.9	160.0	169.0	174.2	188.5	208.6
13	88.9	119.0	142.1	162.7	171.7	176.8	191.2	212.2
14	89.8	120.7	143.9	165.0	173.9	179.5	193.9	214.9
15	90.6	122.5	145.6	167.2	176.1	182.1	196.2	217.6
16	91.5	124.3	147.4	169.4	177.9	183.9	198.5	220.4
17	92.4	126.1	149.2	171.7	179.7	185.7	200.7	223.1
18	93.3	127.4	151.0	173.5	181.5	187.4	203.0	225.8
19	94.2	128.7	152.8	175.3	183.3	189.2	205.3	228.5
20	95.0	130.1	154.6	177.1	185.1	191.0	207.5	231.2
21	95.9	131.4	156.3	178.9	186.9	192.7	209.8	233.0
22	96.8	132.7	157.7	180.7	188.7	194.5	211.6	234.9
23	97.2	134.1	159.0	182.5	190.5	196.3	213.5	236.7
24	97.7	135.4	160.3	184.3	191.9	198.1	215.3	238.5

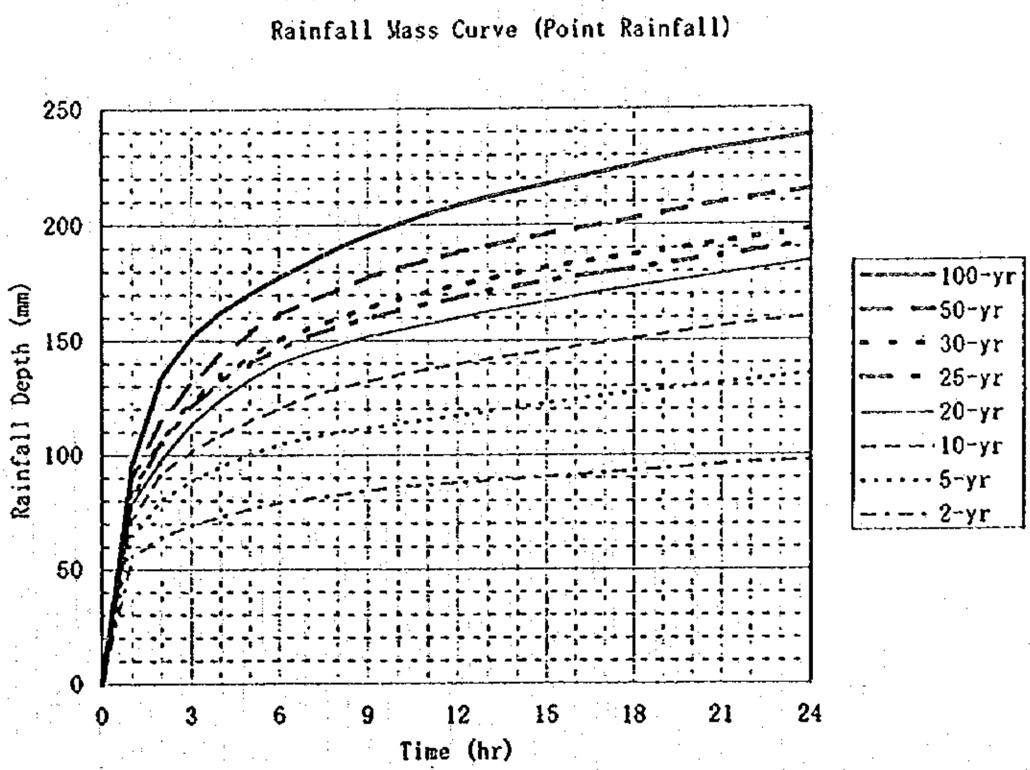


Fig.7 POINT RAINFALL MASS CURVE

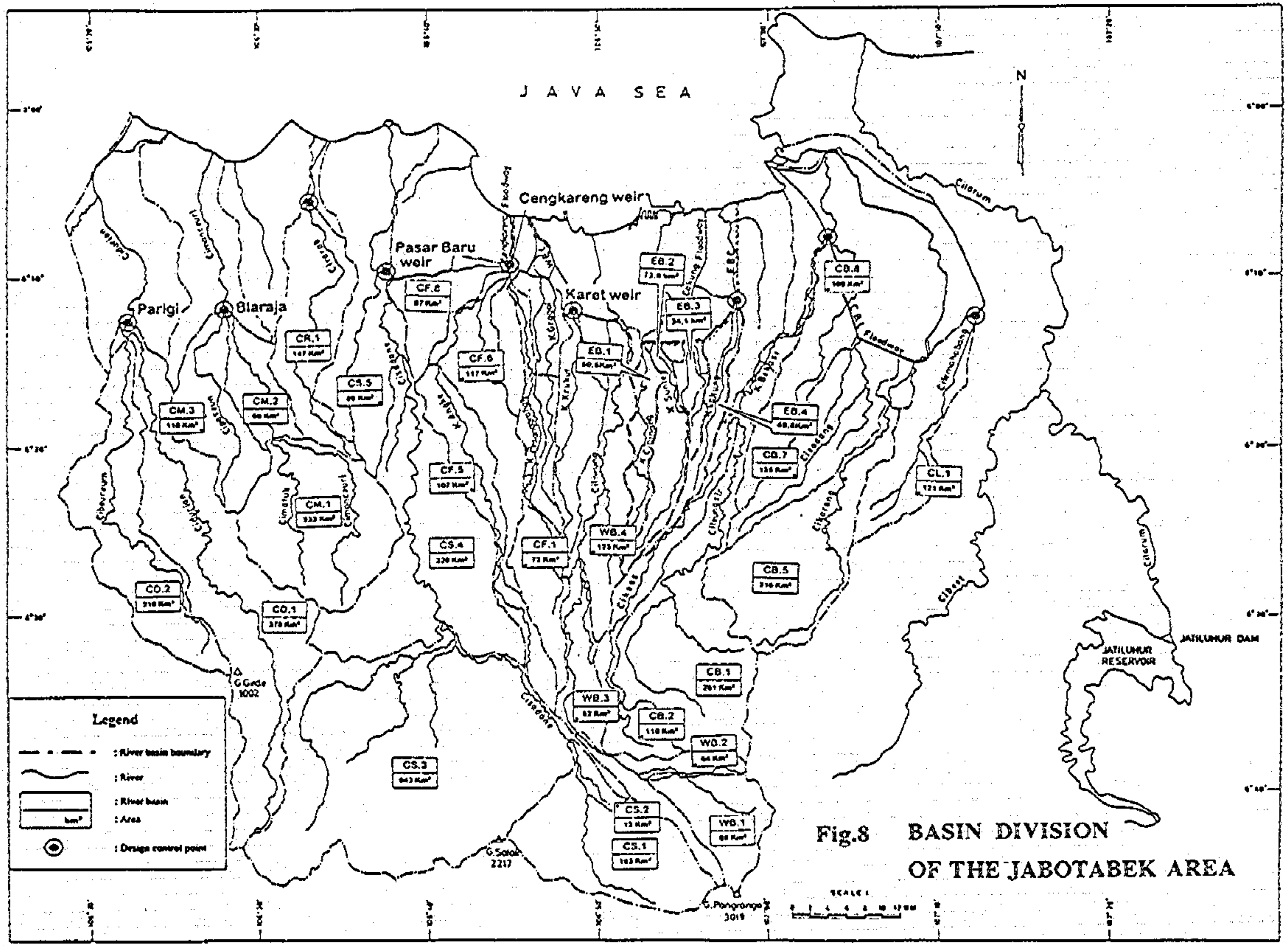


Fig.8 BASIN DIVISION OF THE JABOTABEK AREA

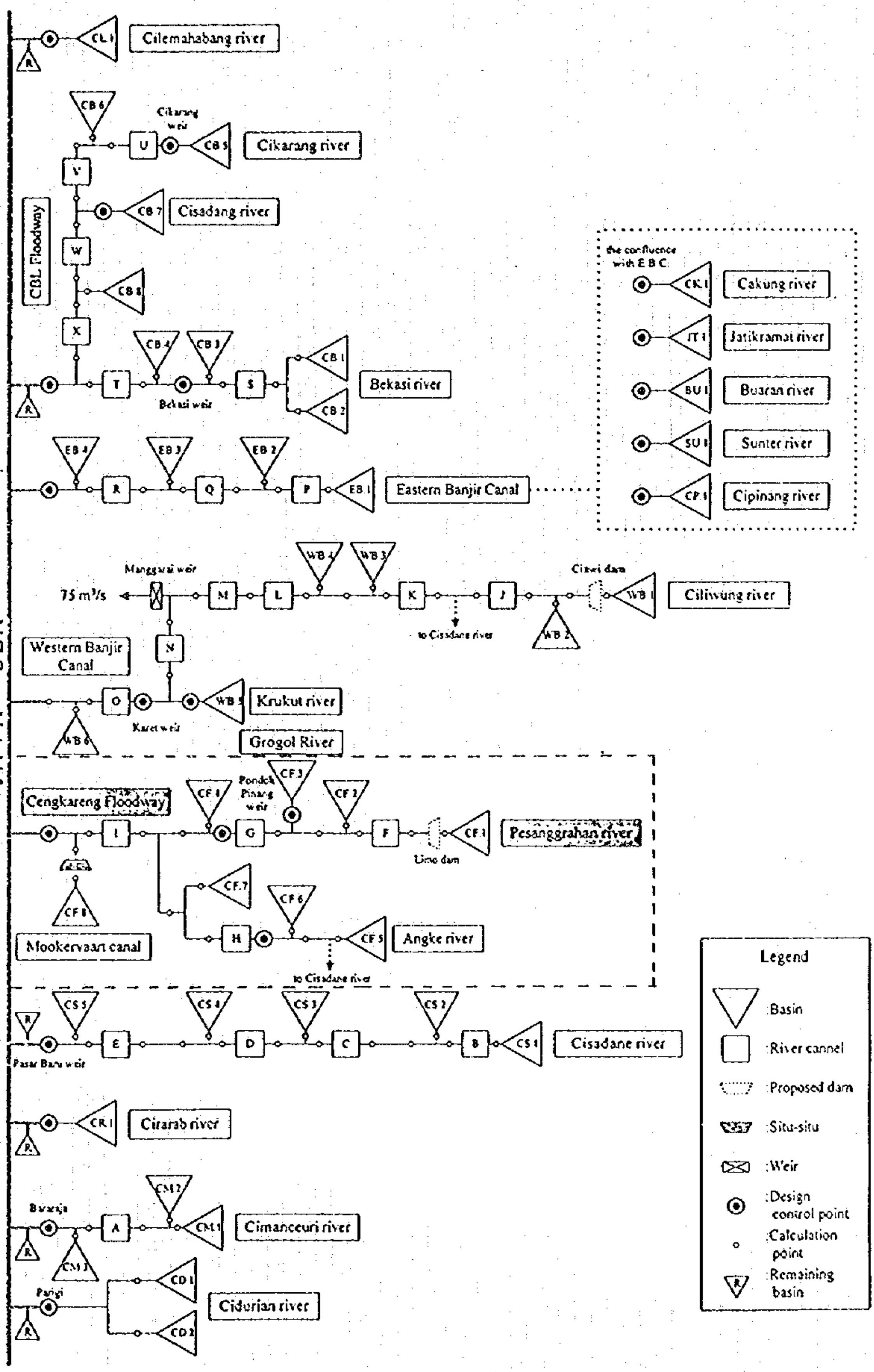


Fig.9 BASIN AND RIVER CHANNEL MODEL

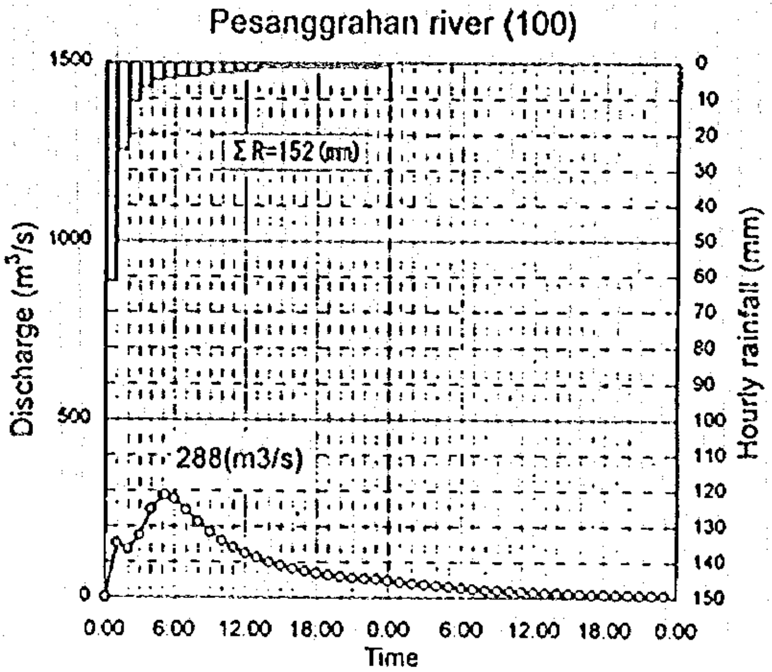


Fig.10 PROBABLE FLOOD RUNOFF OF PESANGGRAHAN RIVER

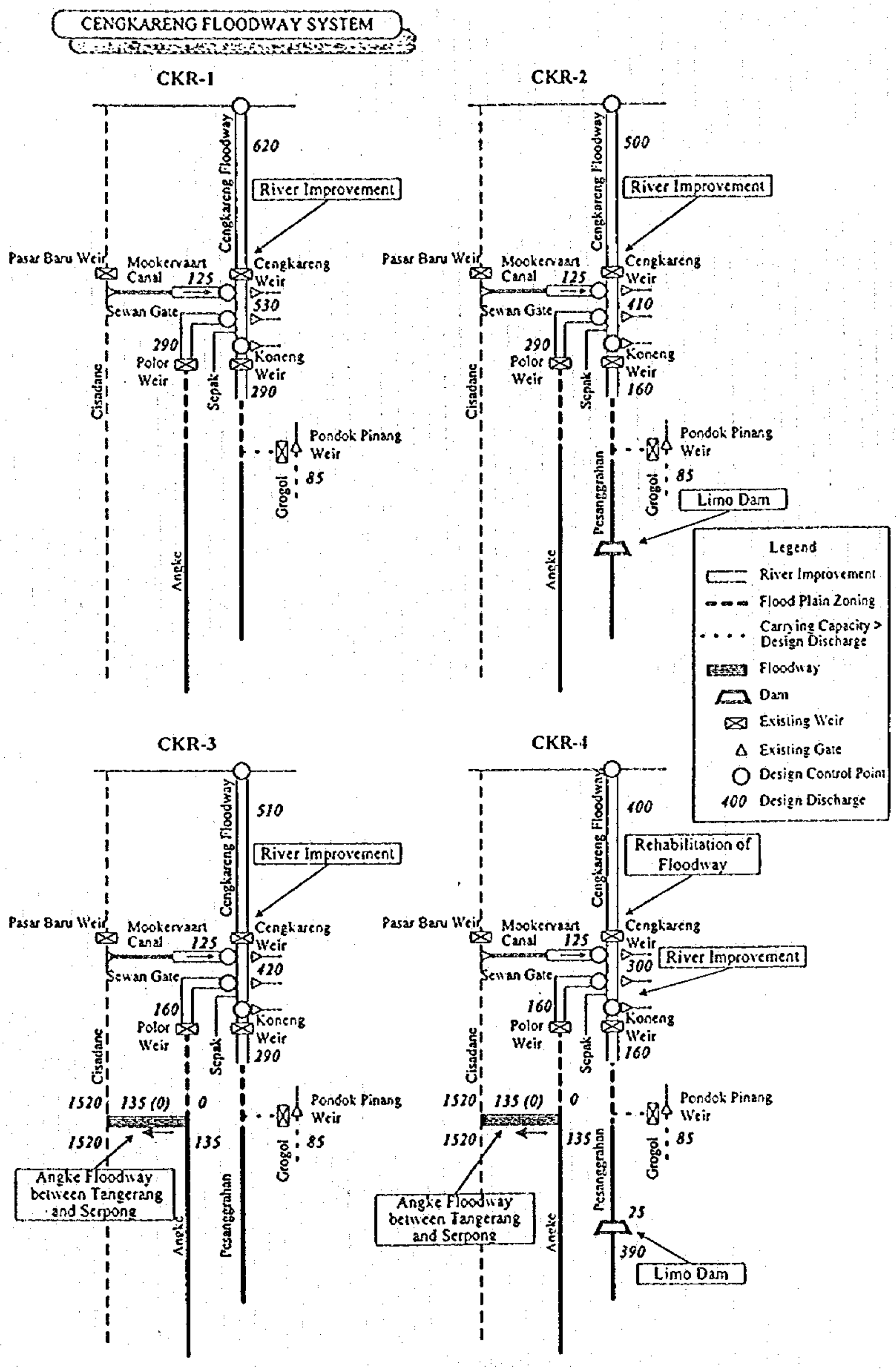


Fig.11 CONCEIVABLE FLOOD CONTROL MEASURES FOR CENGKARENG FLOODWAY SYSTEM

Probable Flood Peak

River system	Design control point	Design scale (year)	Design 1-day rainfall (mm)	Catchment area (km^2)	Peak discharg (m^3/s)	Specific discharcg (m^3/s/km^2)
Cidurian river	parigi	25	104	596	650	1.09
Cimanceuri river	Balaraja	25	108	415	290	0.70
Cirarab river	(Road bridge)	25	121	147	75	0.51
Cisadane river	Pasar Baru Weir	50	108	1,248	1,600	1.28
Cengkareng Floodway system	Cengkareng Weir	100	133	459	620	1.35
Mookervaart Canal	the conflence with Cengkareng Floodway	25	132	67	125	1.87
Angke river	the conflence with Cengkareng Floodway	100	144	224	290	1.29
Pesanggrahan river	the conflence with Cengkareng Floodway	100	152	137	290	2.12
Grogol river	Pondok Pinang Weir	25	144	30	85	2.83
Western Banjir Canal system	Karet Weir	100	134	421	670	1.59
Ciliwung river	Manggrai Weir	100	134	337	570	1.69
Krukut river	Before the conflence with W.B.C.	25	129	84	135	1.61
Eastern Banjir Canal System	After the conflence with Cikarang river	100	145	207	370	1.79
Cipinang river	Before the conflence with E.B.C.	25	136	50.5	85	1.68
Sunter river	Before the conflence with E.B.C.	25	131	73.1	105	1.44
Buaran river	Before the conflence with E.B.C.	25	158	13.0	50	3.85
Jatikramat river	Before the conflence with E.B.C.	25	154	16.5	45	2.73
Cakung river	Before the conflence with E.B.C.	25	142	34.5	60	1.74
CBL Floodway system	After the conflence with Bekasi river	50	112	877	780	0.89
Bekasi river	Bekasi Weir	50	122	389	590	1.52
Cisadang river	Before the conflence with CBL Floodway	25	122	135	130	0.96
Cikarang river	Cikarang Weir	25	116	216	210	0.97
Citemahabang river	(Road bridge)	25	124	121	55	0.45

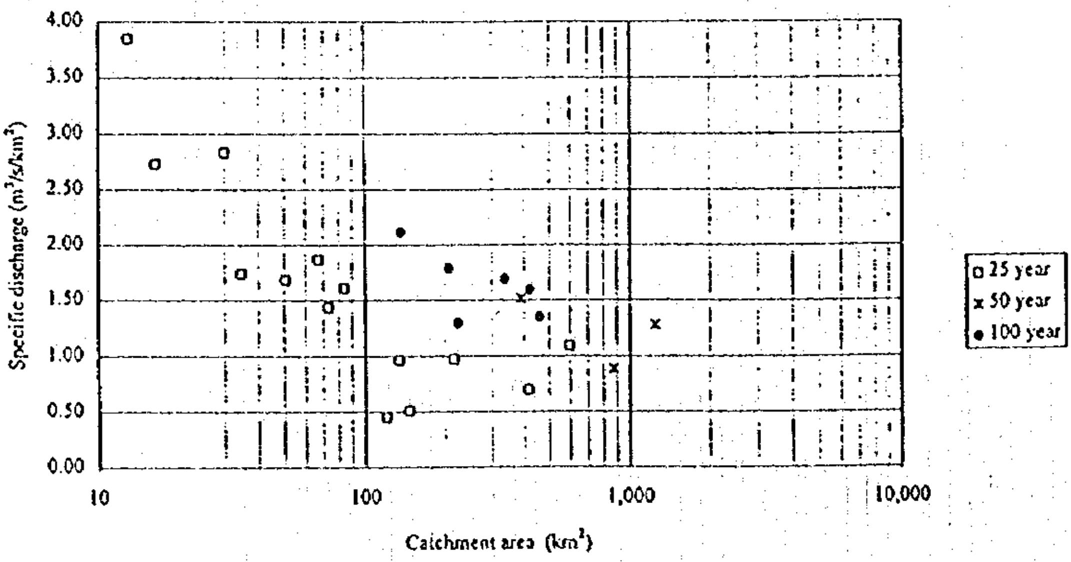


Fig.12 PROBABLE FLOOD PEAK

Fig.13 DAM SITE AND RESERVOIR AREA (LIMO DAM A)

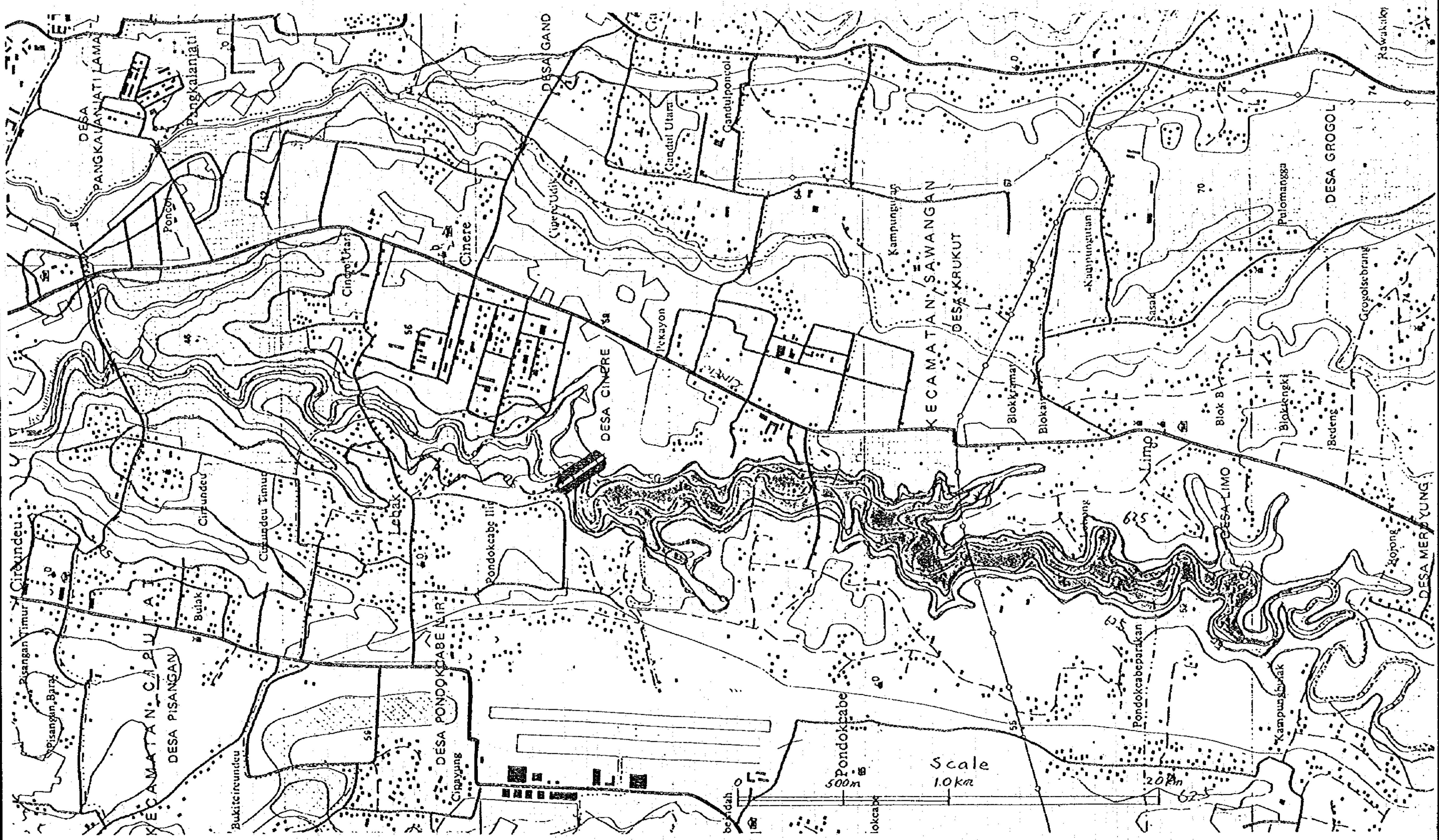


Fig.14 DAM SITE AND RESERVOIR AREA (LIMO DAM B)

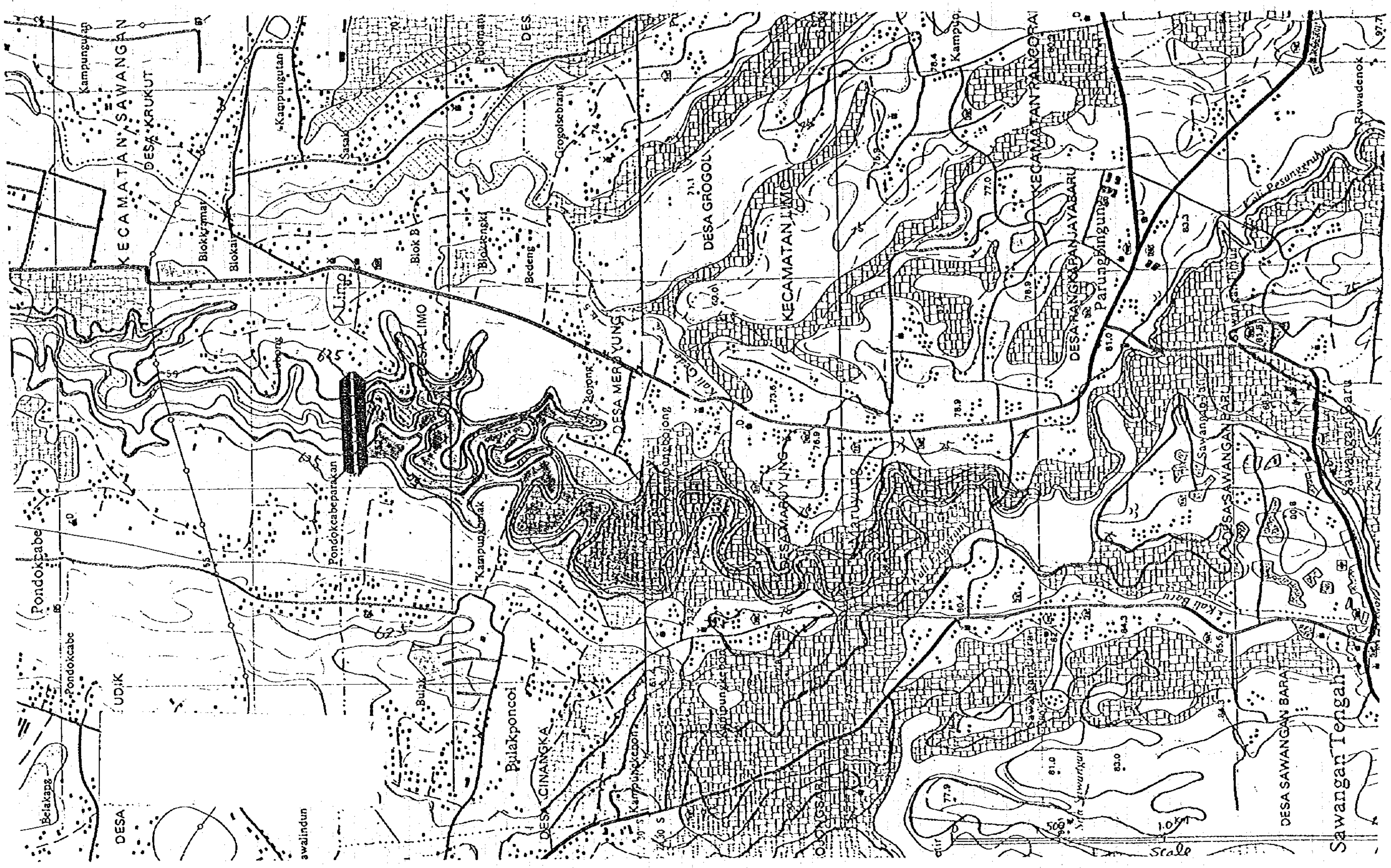
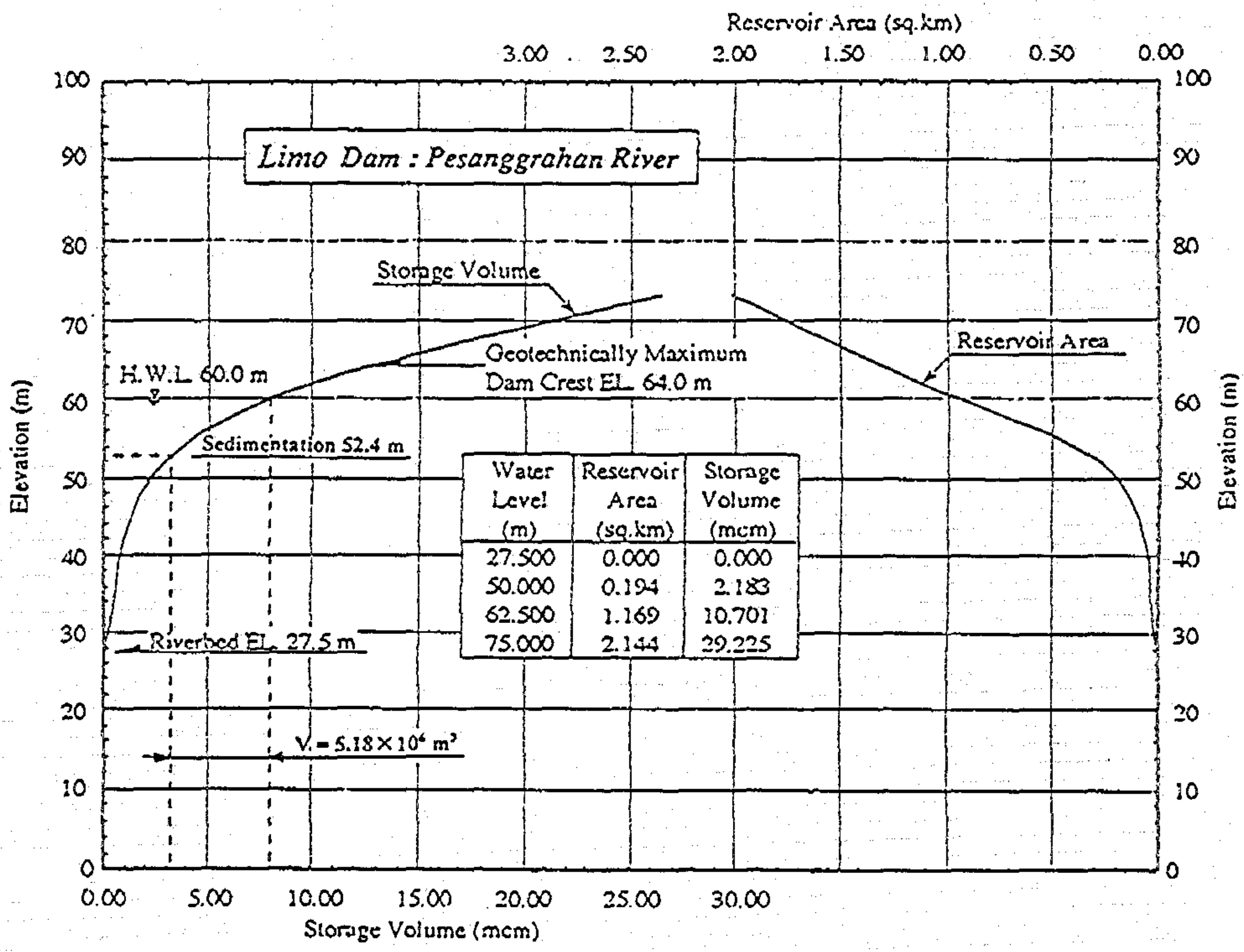


Fig.15 DAM SITE AND RESERVOIR AREA (LIMO DAM C)



Water Level (m)	Reservoir Area (sq.km)	Storage Volume (mcm)
27.500	0.000	0.000
50.000	0.194	2.183
62.500	1.169	10.701
75.000	2.144	29.225

Fig.16 RESERVOIR WATERLEVEL - AREA - STORAGE VOLUME CURVE

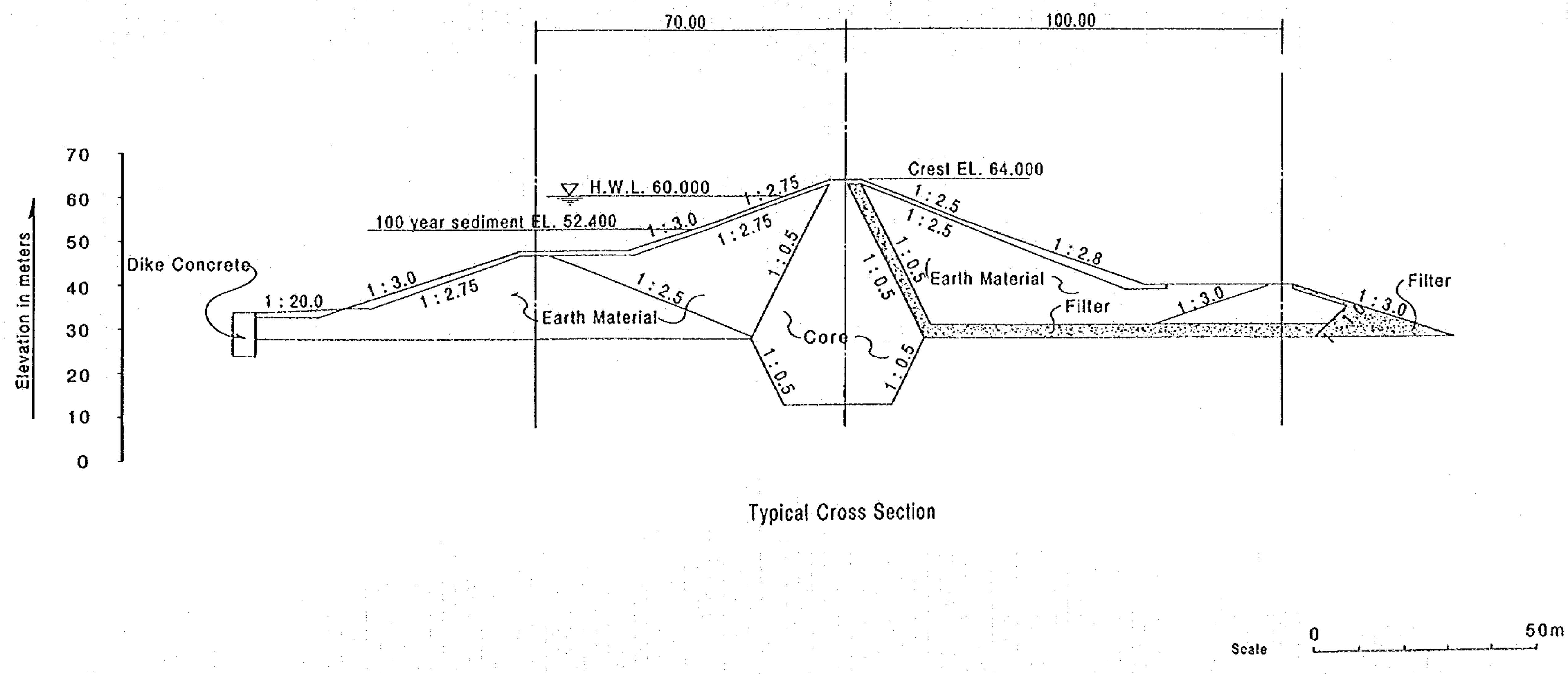


Fig.17 TYPICAL CROSS SCTION OF LIMO DAM

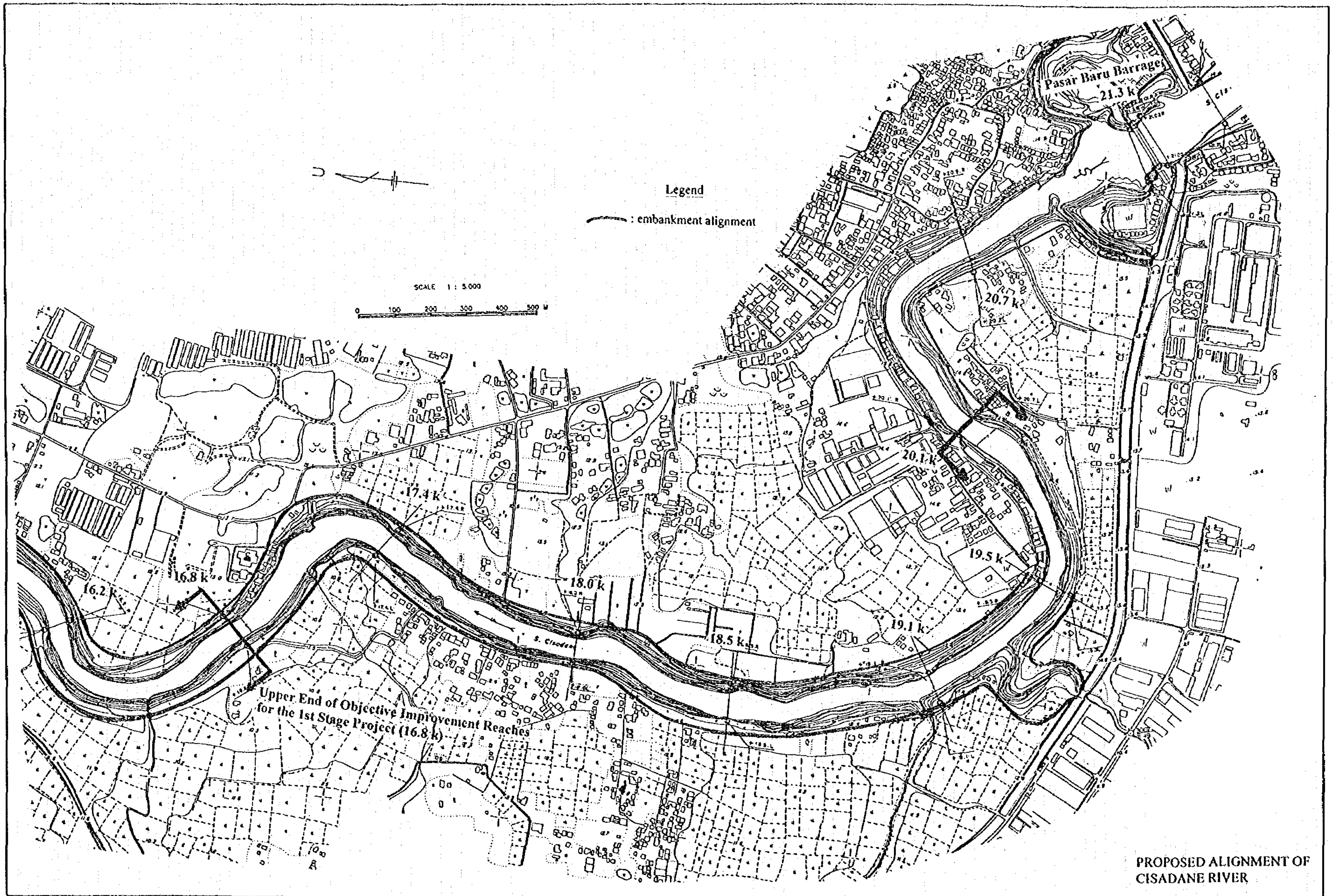
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MINISTRY OF PUBLIC WORKS
THE REPUBLIC OF INDONESIA

PRELIMINARY DESIGN OF CISADANE RIVER FOR 50-YEAR (MASTER PLAN) DESIGN SCALE

DECEMBEER, 1996

JICA STUDY TEAM FOR
COMPREHENSIVE RIVER WATER MANAGEMENT PLAN
IN JABOTABEK



PROPOSED ALIGNMENT OF
CISADANE RIVER

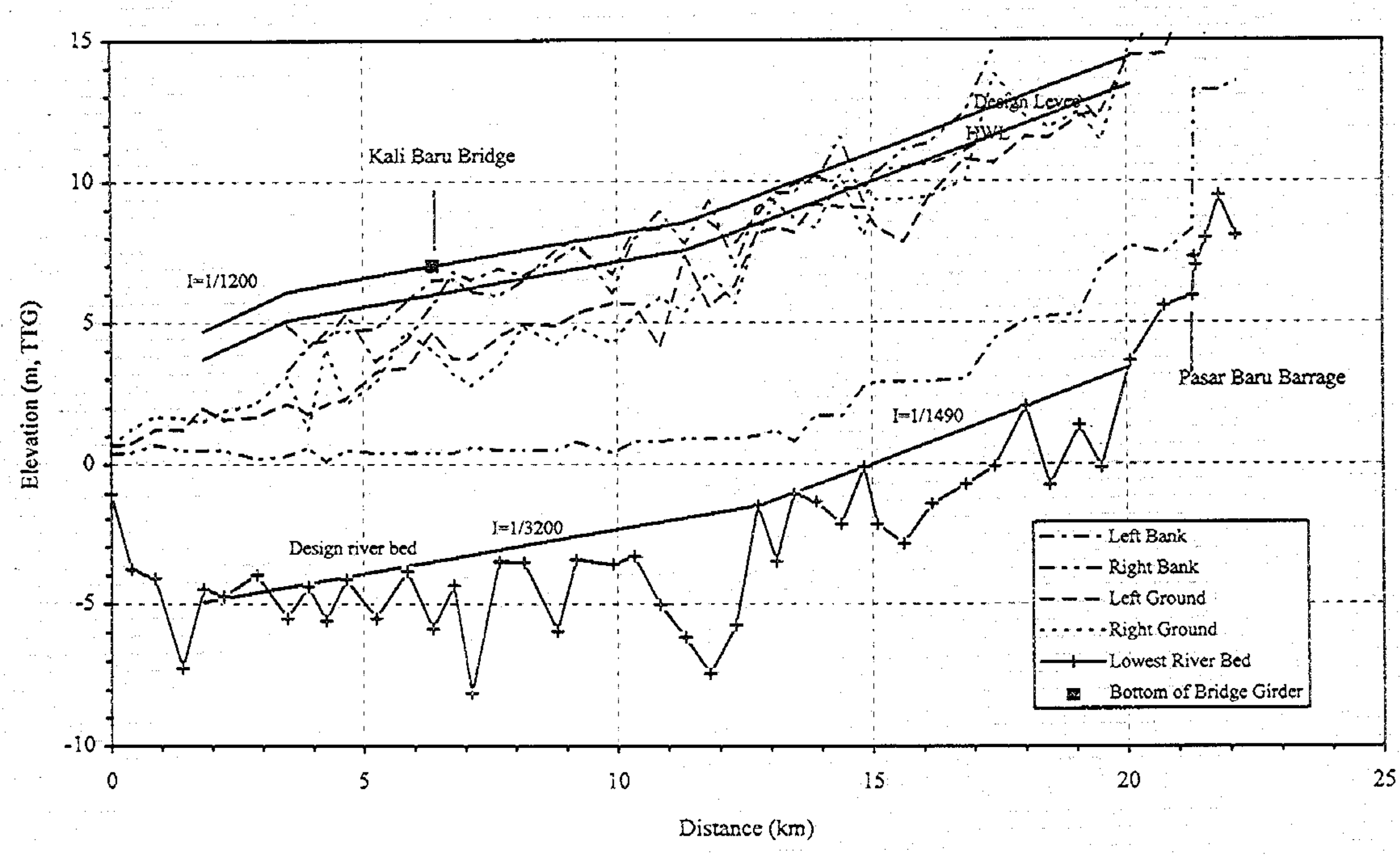
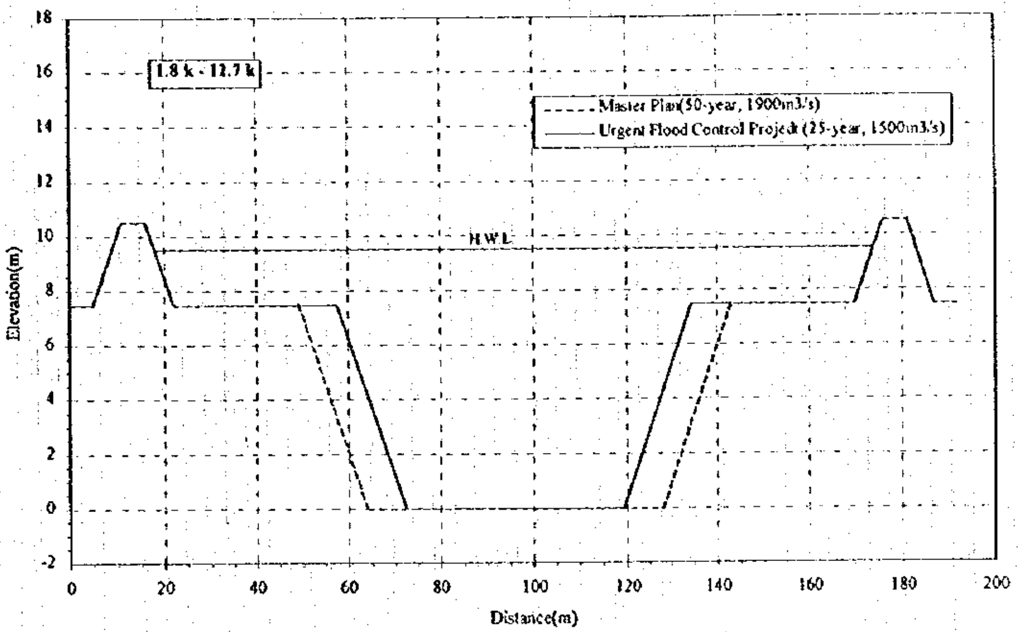


Figure PROPOSED LONGITUDINAL PROFILE OF CISADANE RIVER (Master Plan)

Figure PROPOSED LONGITUDINAL PROFILE OF CISADANE RIVER (Master Plan)

Section No.	Distance	Accumulative Distance	Existing River Bed	Existing Ground		Existing Dike		Design		
				Left	Right	Left	Right	River Bed	H.W.L.	Dike
	(km)	(km)	(m, TTG)	(m, TTG)	(m, TTG)	(m, TTG)	(m, TTG)	(m, TTG)	(m, TTG)	(m, TTG)
0.0	0.000	0.000	-1.07	0.67	0.67					
0.4	0.400	0.400	-3.79	0.74	1.25					
0.9	0.465	0.865	-4.10	1.23	1.70					
1.4	0.545	1.410	-7.22	1.23	1.63					
1.8	0.417	1.827	-4.48	2.00	1.51			-4.93	3.71	4.71
2.2	0.400	2.227	-4.73	1.57	1.87			-4.80	4.01	5.04
2.9	0.650	2.877	-3.97	1.67	2.14			-4.60	4.58	5.58
3.5	0.610	3.487	-5.50	2.15	3.11	4.94	3.30	-4.41	5.09	6.09
3.9	0.412	3.899	-4.39	1.78	1.24	4.26	4.10	-4.28	5.22	6.22
4.3	0.357	4.256	-5.59	2.12	4.06	4.37	4.70	-4.17	5.33	6.33
4.7	0.397	4.653	-4.13	2.30	2.11	5.30	4.70	-4.05	5.45	6.45
5.3	0.598	5.251	-5.50	3.26	2.92	3.62	4.77	-3.86	5.64	6.64
5.9	0.605	5.856	-3.84	3.41	4.69	4.42	5.79	-3.67	5.83	6.83
6.4	0.505	6.361	-5.87	4.65	4.00	5.64	6.50	-3.51	5.99	6.99
6.8	0.415	6.776	-4.34	3.70	3.20	6.77	6.53	-3.38	6.12	7.12
7.1	0.350	7.126	-8.10	3.70	2.78	6.50	6.10	-3.27	6.23	7.23
7.7	0.540	7.666	-3.51	4.51	3.53	6.89	5.94	-3.10	6.40	7.40
8.2	0.498	8.161	-3.53	4.96	4.87	6.65	6.48	-2.95	6.55	7.55
8.8	0.650	8.814	-5.95	4.89	4.22	7.20	7.60	-2.75	6.75	7.75
9.2	0.364	9.178	-3.45	5.32	4.86	7.70	7.90	-2.63	6.87	7.87
9.9	0.726	9.904	-3.61	5.69	4.27	6.70	6.05	-2.41	7.10	8.10
10.3	0.423	10.327	-3.33	5.66	5.22	8.20	7.95	-2.27	7.23	8.23
10.8	0.510	10.837	-5.04	4.13	5.89	8.30	8.90	-2.11	7.39	8.39
11.3	0.492	11.329	-6.16	7.33	5.37		7.80	-1.96	7.54	8.54
11.8	0.475	11.804	-7.42	5.57	6.75	8.60	9.30	-1.81	7.85	8.85
12.3	0.505	12.309	-5.74	6.33	5.68	7.82	6.96	-1.65	8.19	9.19
12.7	0.440	12.749	-1.51	8.14	8.17	8.84	9.07	-1.52	8.48	9.48
13.1	0.360	13.109	-3.51	8.34	9.23	9.60	9.40	-1.27	8.73	9.73
13.5	0.350	13.459	-1.08	8.19	8.72	9.57	9.90	-1.04	8.96	9.96
13.9	0.438	13.897	-1.37	9.20	8.31	10.23	9.96	-0.75	9.25	10.25
14.4	0.495	14.392	-2.20	9.08	10.22	9.75	11.55	-0.41	9.59	10.59
14.8	0.446	14.838	-0.09	9.08	8.05	9.75	9.25	-0.11	9.89	10.89
15.1	0.255	15.093	-2.20	8.37	9.34	10.35	10.30	0.06	10.06	11.06
15.6	0.520	15.613	-2.90	7.82	9.35	10.51	11.10	0.41	10.41	11.41
16.2	0.561	16.174	-1.45	9.55	9.45	10.62	11.40	0.78	10.78	11.78
16.8	0.668	16.842	-0.74	10.79	10.07	11.08	12.49	1.23	11.23	12.23
17.4	0.570	17.412	-0.08	10.63	13.75	11.64	14.70	1.61	11.61	12.61
18.0	0.610	18.022	2.05	11.59	12.32			2.02	12.02	13.02
18.5	0.465	18.487	-0.77	11.52	11.89	11.87	12.50	2.34	12.34	13.34
19.1	0.582	19.069	1.36	12.30	12.45		12.95	2.73	12.73	13.73
19.5	0.435	19.504	-0.13	12.46	11.44		12.04	3.02	13.02	14.02
20.1	0.570	20.074	3.62	14.46	14.86			3.40	13.40	14.40
20.7	0.662	20.736	5.59	14.49	15.60					
21.3	0.550	21.286	5.92	17.30	16.34					
21.32	0.030	21.316	7.30	17.39	16.76					
21.35	0.030	21.346	6.99	16.55	16.13					
21.5	0.200	21.546	7.97	15.11	15.29					
21.8	0.255	21.801	9.49	15.93	15.29					
22.1	0.329	22.130	8.06	15.31	15.62					



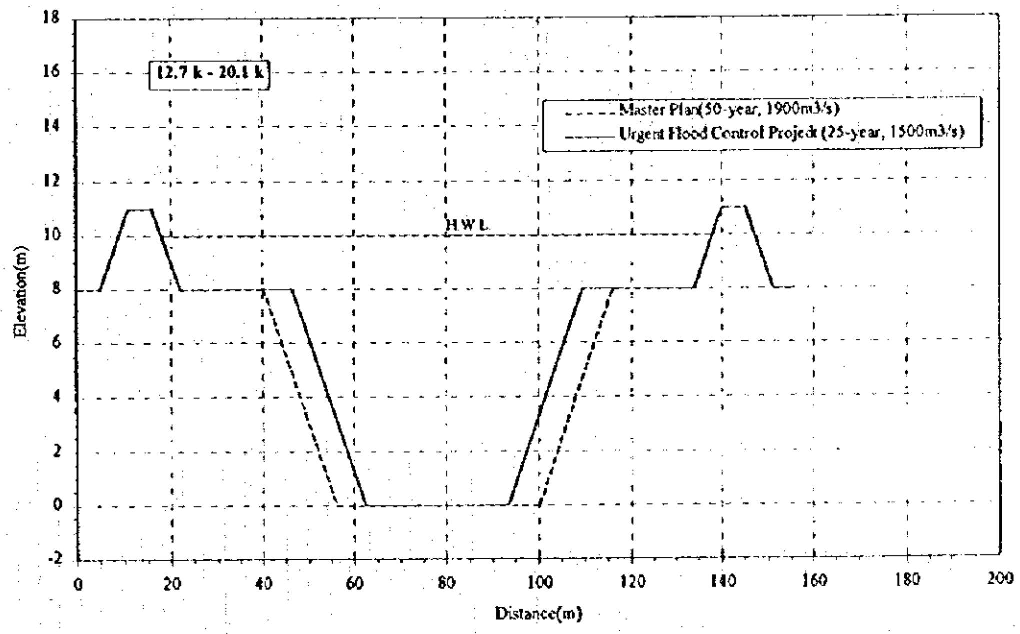


Figure PROPOSED STANDARD CROSS SECTION OF CISADANE RIVER

Table PROPOSED STANDARD CROSS SECTION OF CISADANE RIVER

Master Plan (50-year, 1900m3/s)

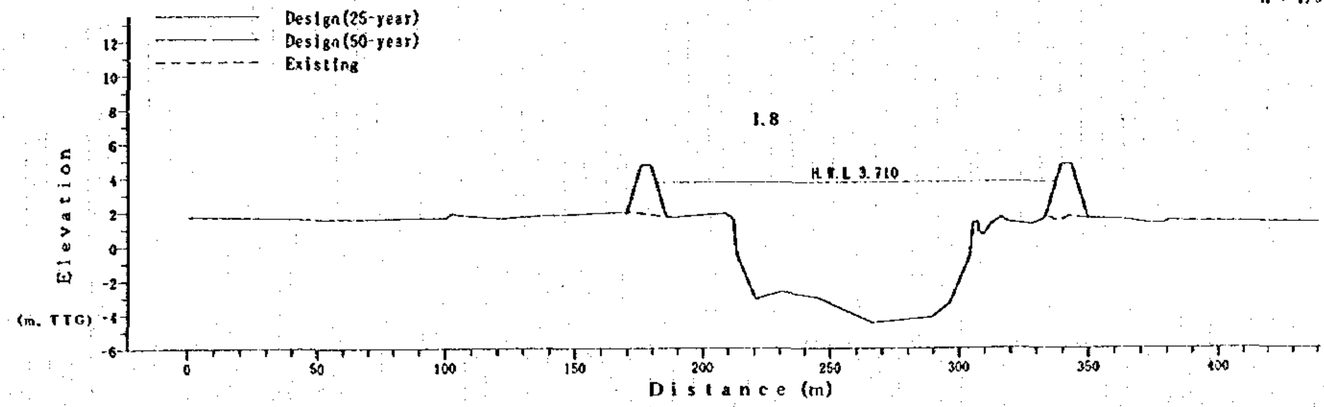
1.8 k - 12.7 k

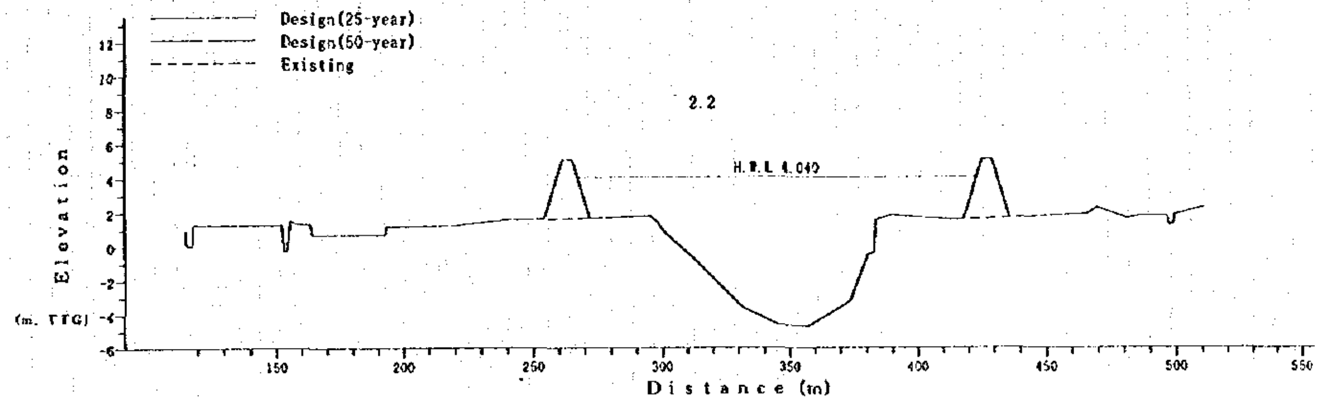
			Gradient	1/3200		
			Water level	9.50		Q(ql+2qh,m³/s)
Low Water Channel	Width(top,m)	94.0	Total water depth(m)	9.50		1901.6
	Width(bottom,m)	64.0	Water depth(m)	7.50		Free board(m)
	Depth	7.50	Width(m)	94.0		1.0
	I	2.0	A(m²)	780.5		Crown width(m)
	n	0.030	S(m)	97.54		5.0
	Bed height(m)	0.0	R(m)	8.002	V(m/s)	2.36
			ql(m³/s)	1839.9		
High Water Channel	Width(one side)	27.0	Water depth	2.00	S(m)	31.5
	Slope gradient	2.0	Width(m)	31.0	R(m)	1.843
	n	0.050	A(m²)	58.0	qh(m³/s)	30.8
			V(m/s)	0.53	2qh(m³/s)	61.6

12.7 k - 20.1 k

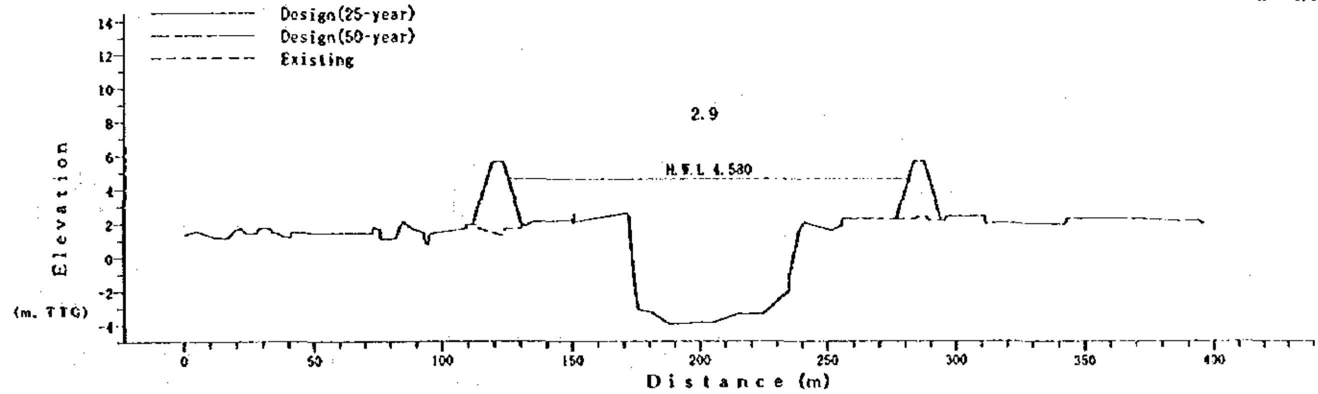
			Gradient	1/1490		
			Water level	10.00		Q(ql+2qh,m³/s)
Low Water Channel	Width(top,m)	76.0	Total water depth(m)	10.00		1919.9
	Width(bottom,m)	44.0	Water depth(m)	8.00		Free board(m)
	Depth	8.00	Width(m)	76.0		1.0
	I	2.0	A(m²)	632.0		Crown width(m)
	n	0.035	S(m)	79.78		5.0
	Bed height(m)	0.0	R(m)	7.922	V(m/s)	2.94
			ql(m³/s)	1859.0		
High Water Channel	Width(one side)	18.0	Water depth	2.00	S(m)	22.5
	Slope gradient	2.0	Width(m)	22.0	R(m)	1.780
	n	0.050	A(m²)	40.0	qh(m³/s)	30.4
			V(m/s)	0.76	2qh(m³/s)	60.9

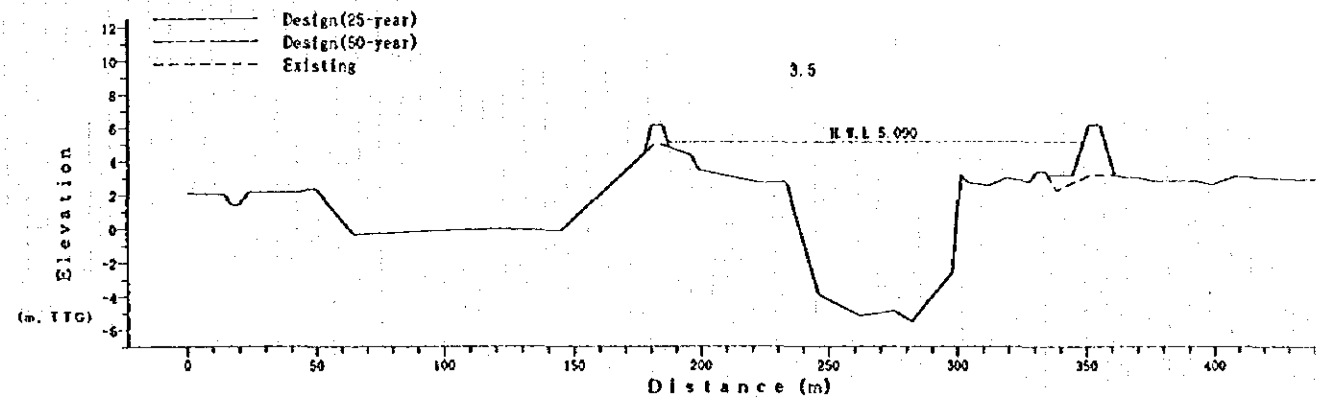
B : 1/2
H : 1/3



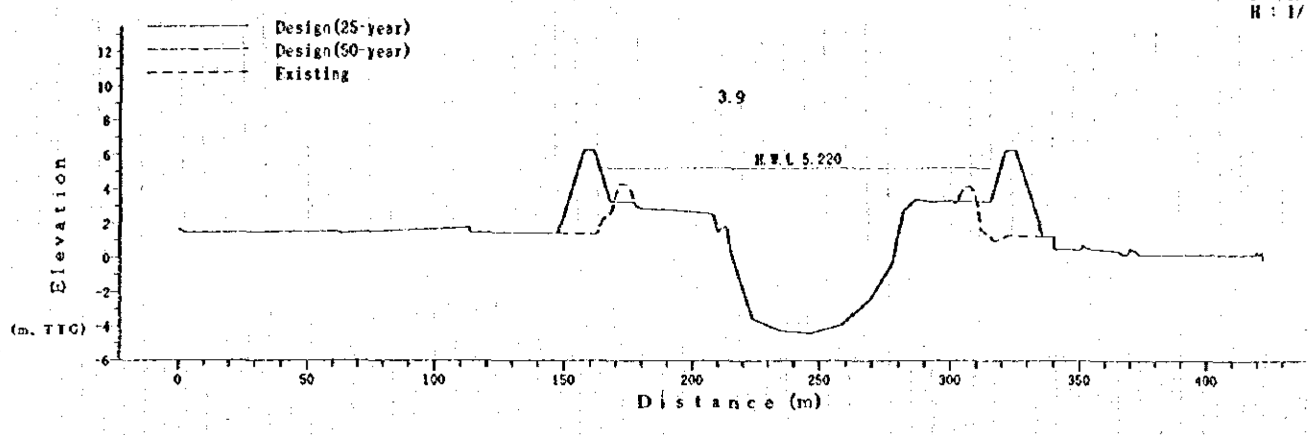


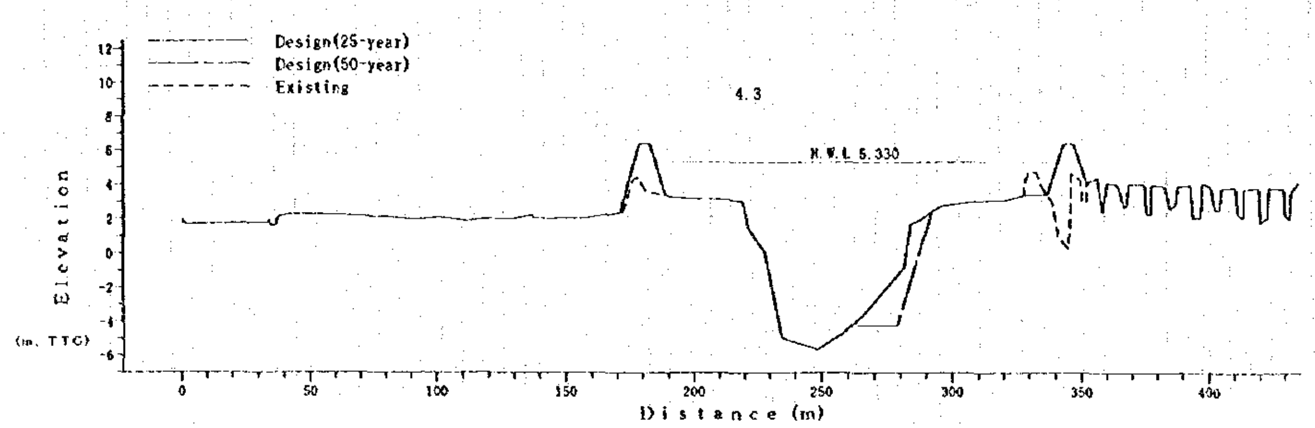
B : 1/2
H : 1/3



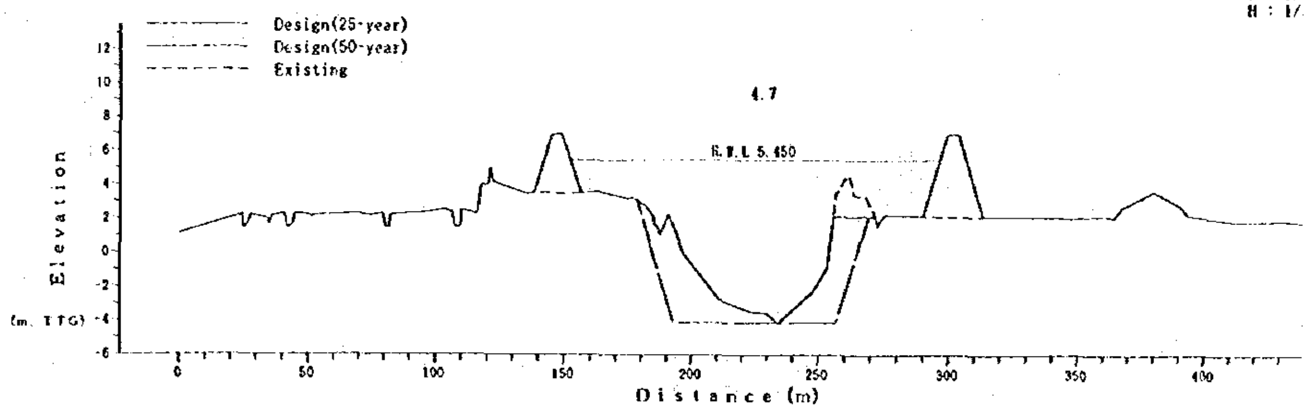


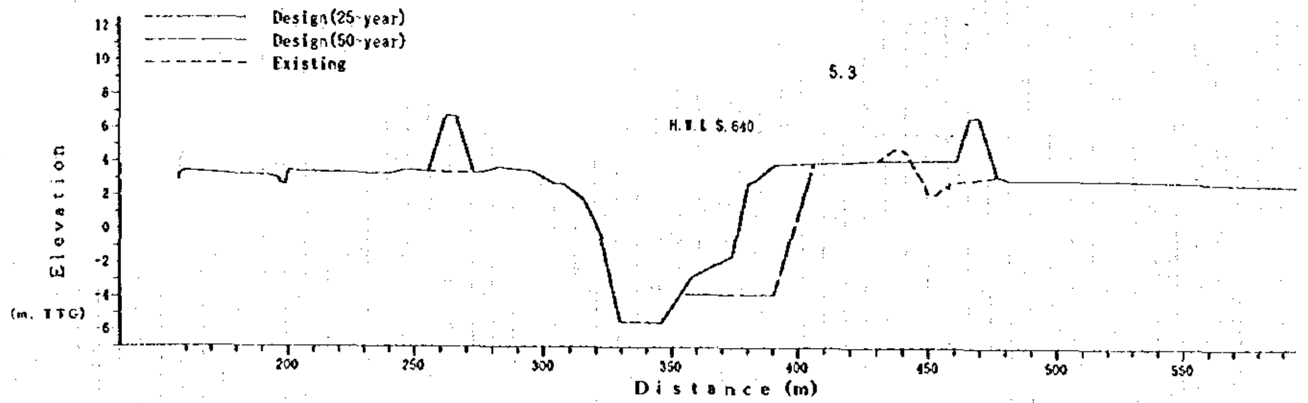
B : 1/
H : 1/


Design(25-year)
Design(50-year)
Existing
3.9
H.W.L 5.220
Elevation
(m, TTG)
Distance (m)

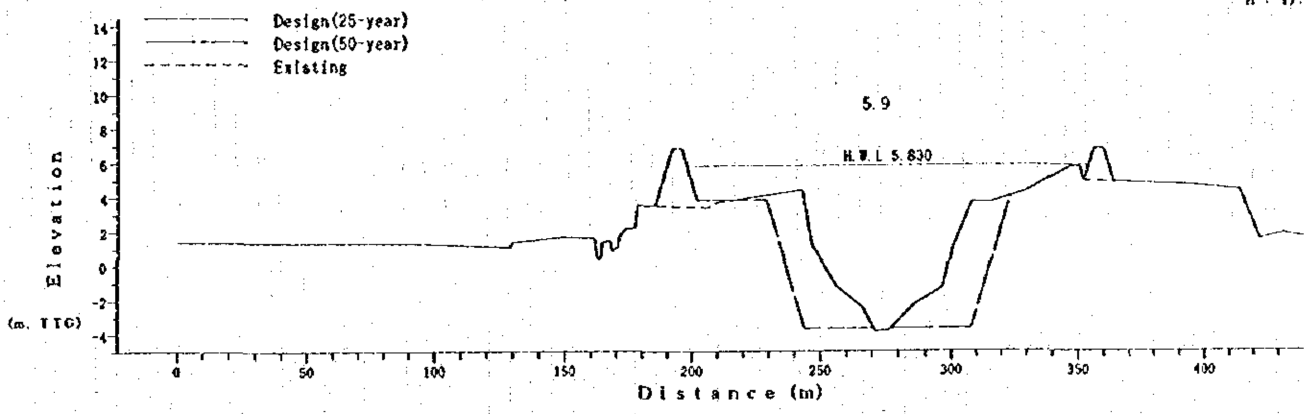

Design(25-year)
Design(50-year)
Existing
4.3
H.W.L 5.330
Elevation
(m, TTG)
Distance (m)

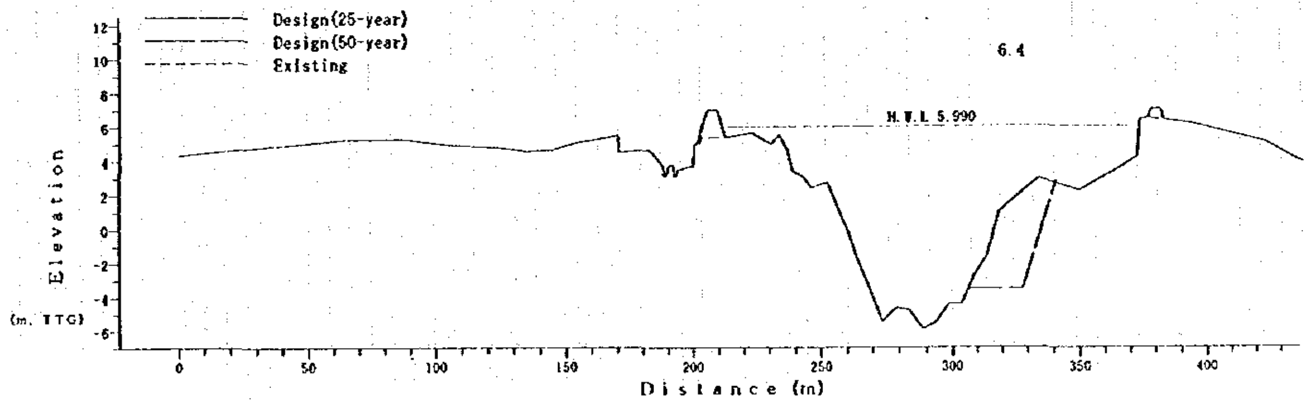
B : 1/
H : 1/


Design(25-year)
Design(50-year)
Existing
4.7
H.W.L 5.450
Elevation
(m, TTG)
Distance (m)

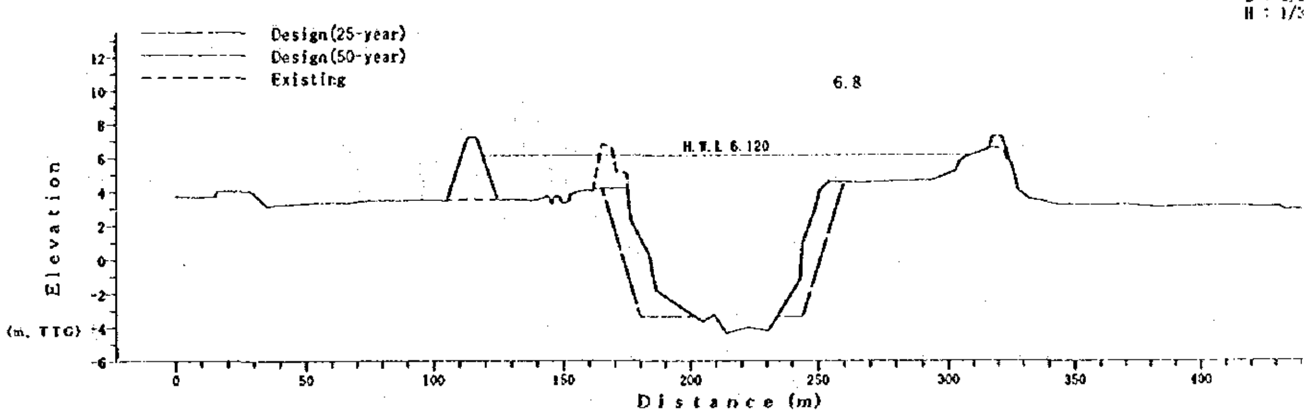

Design(25-year)
Design(50-year)
Existing
5.3
H.W.L 5.640
Elevation
(m, TTG)
Distance (m)

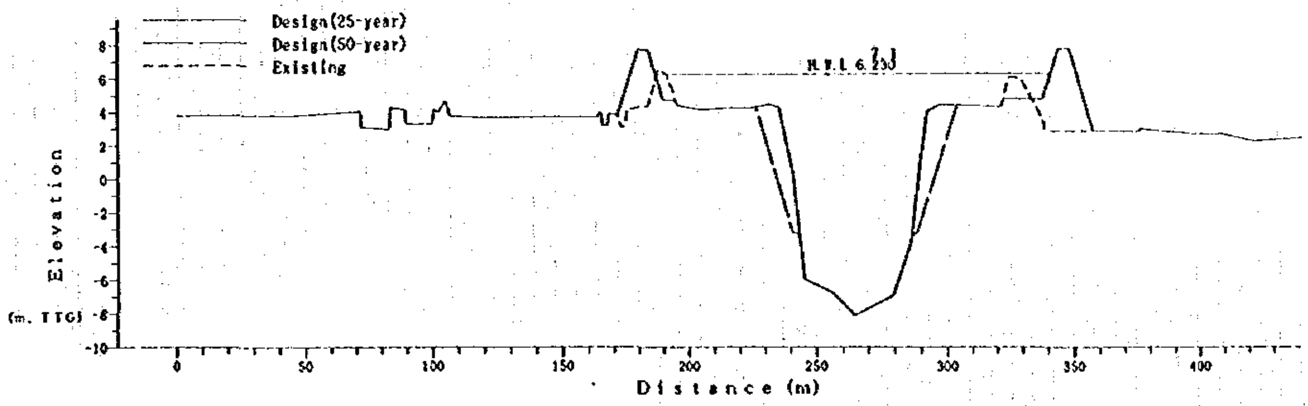
B : 1/
H : 1/

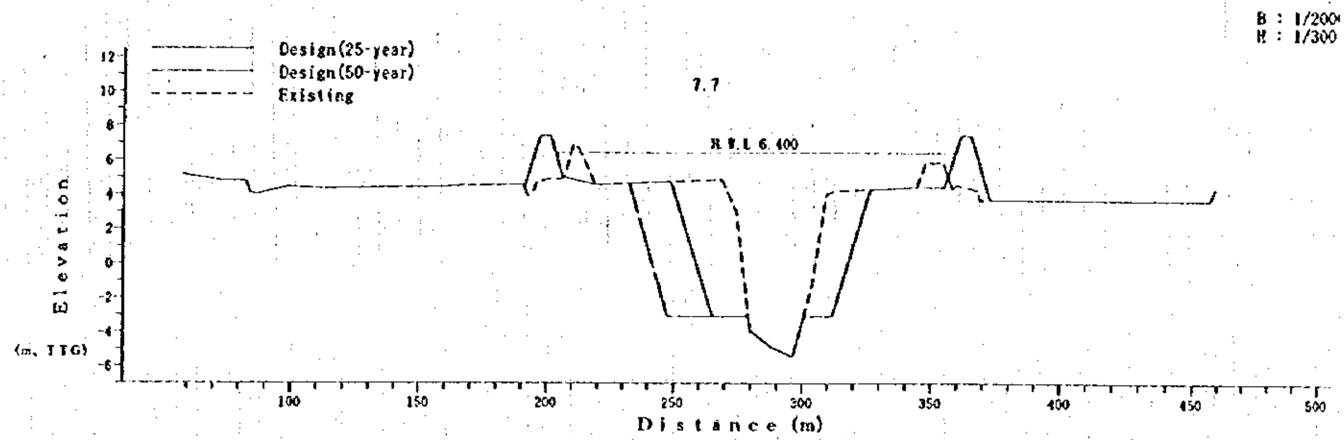

Design(25-year)
Design(50-year)
Existing
5.9
H.W.L 5.830
Elevation
(m. TTG)
Distance (m)

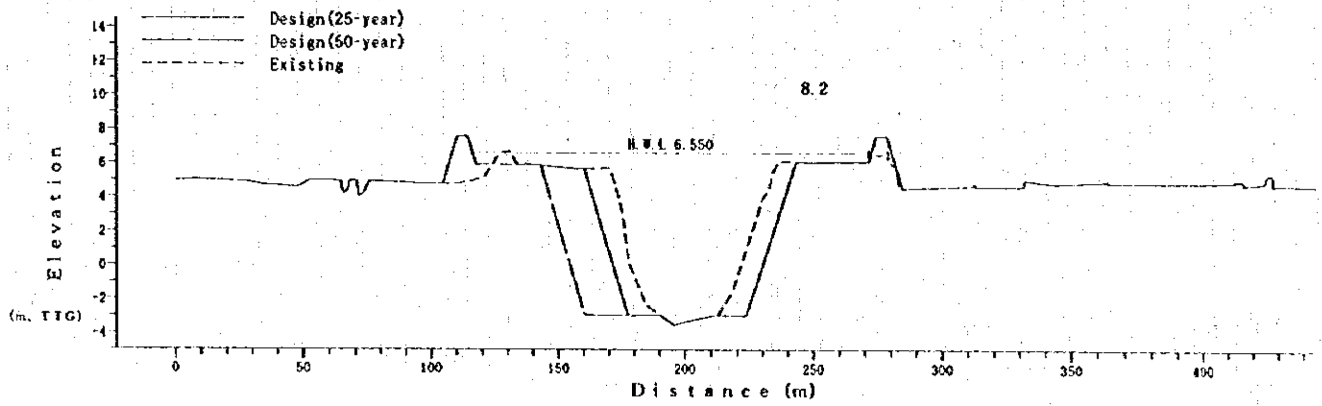

Design(25-year)
Design(50-year)
Existing
6.4
H.W.L 5.990
Elevation
(m. TTG)
Distance (m)

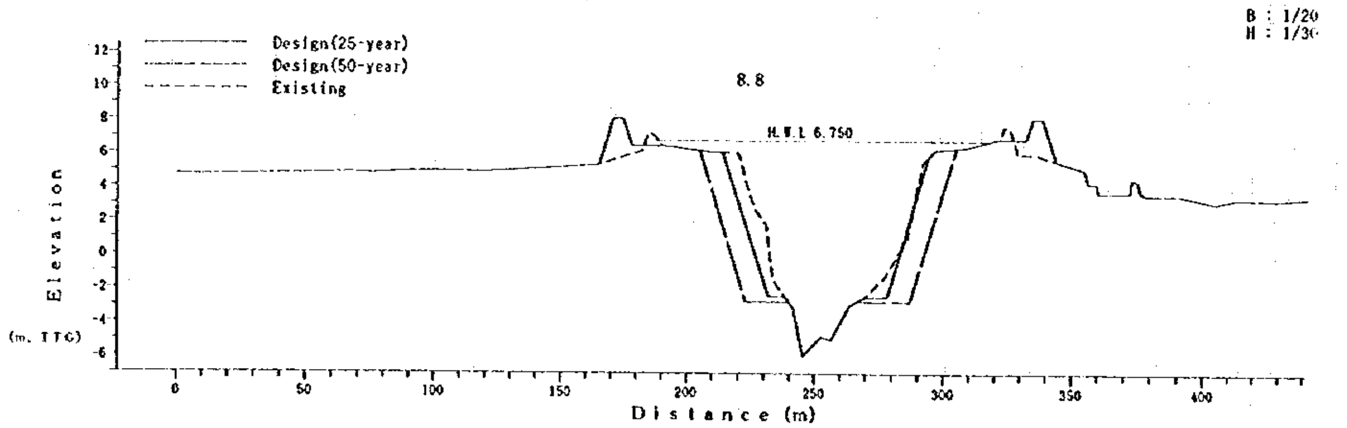
B : 1/2
H : 1/3

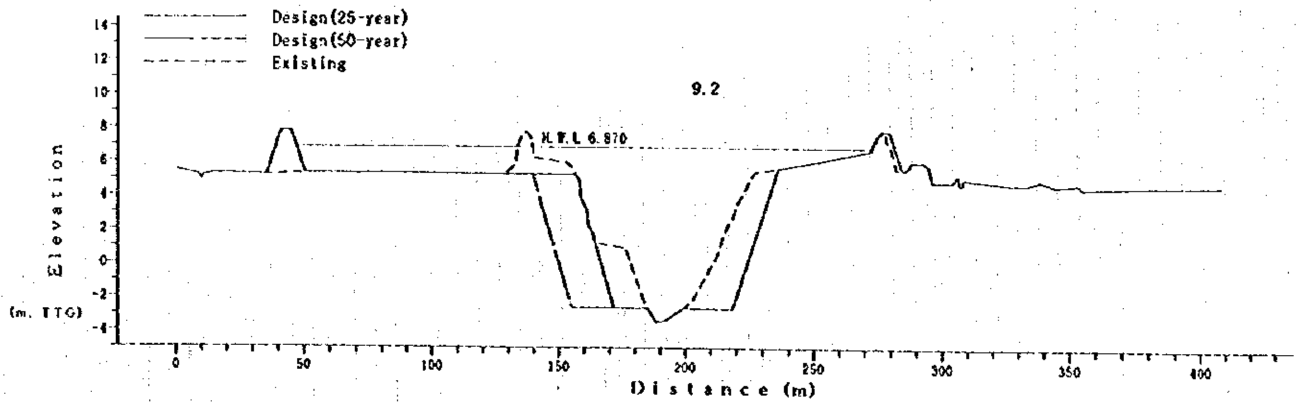

Design(25-year)
Design(50-year)
Existing
6.8
H.W.L 6.120
Elevation
(m. TTG)
Distance (m)


Design(25-year)
Design(50-year)
Existing
Elevation
(m. TTG)
Distance (m)

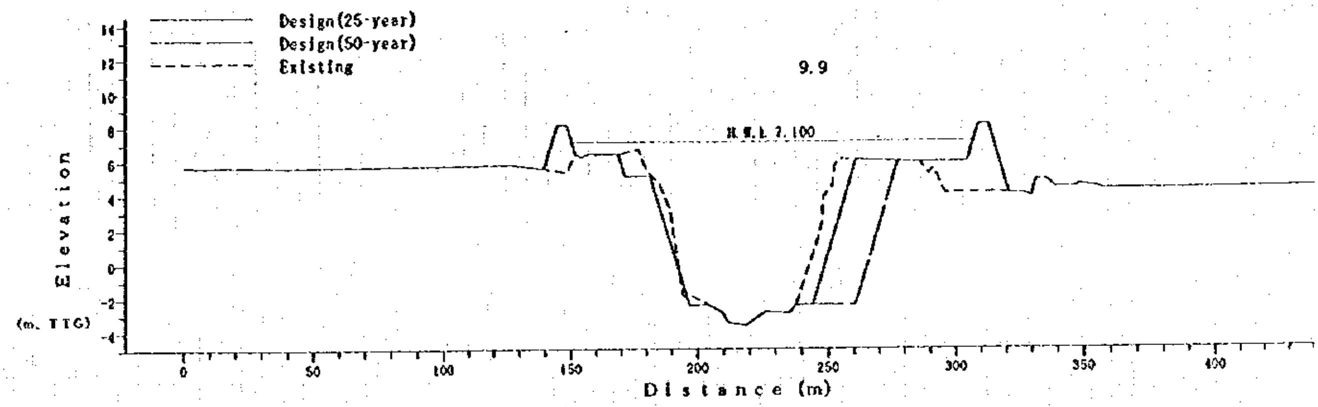

B : 1/200
H : 1/300
Design(25-year)
Design(50-year)
Existing
7.7
H.W.L 6.400
Elevation
(m, TTG)
Distance (m)

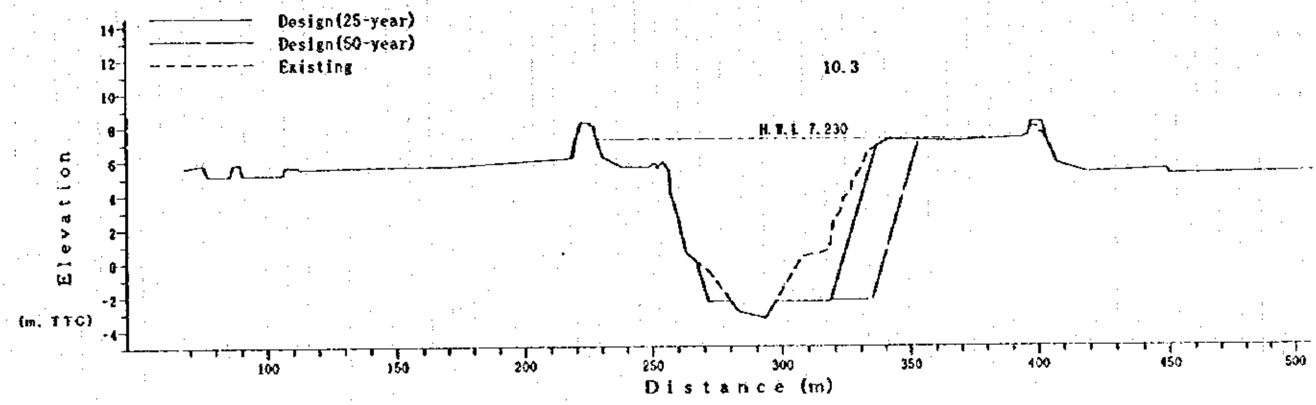

Design(25-year)
Design(50-year)
Existing
8.2
H.W.L 6.550
Elevation
(m, TTG)
Distance (m)


B : 1/20
H : 1/3
Design(25-year)
Design(50-year)
Existing
8.8
H.W.L 6.750
Elevation
(m, TTG)
Distance (m)

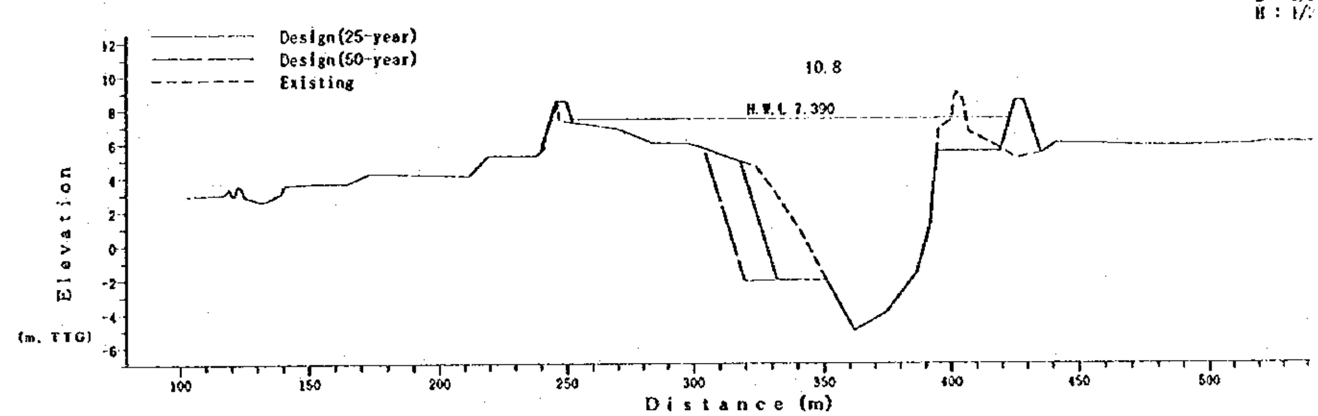

Design(25-year)
Design(50-year)
Existing
9.2
H.W.L 6.870
Elevation
(m, TTG)
Distance (m)

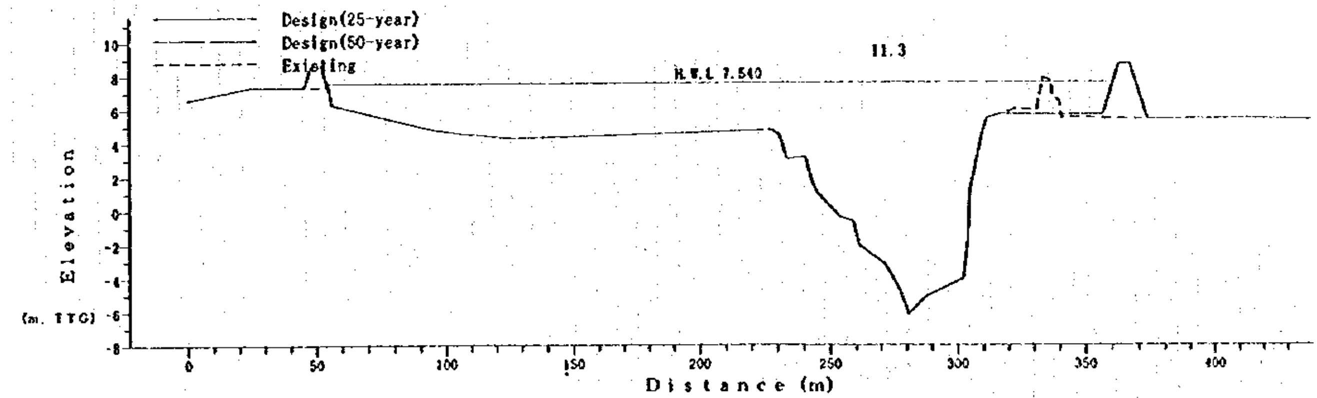
B : 1/2
H : 1/2



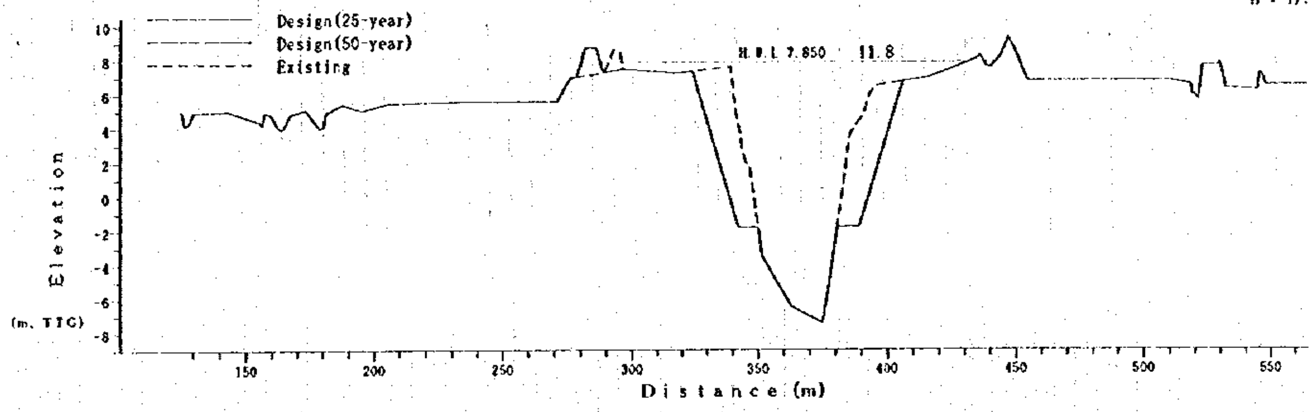


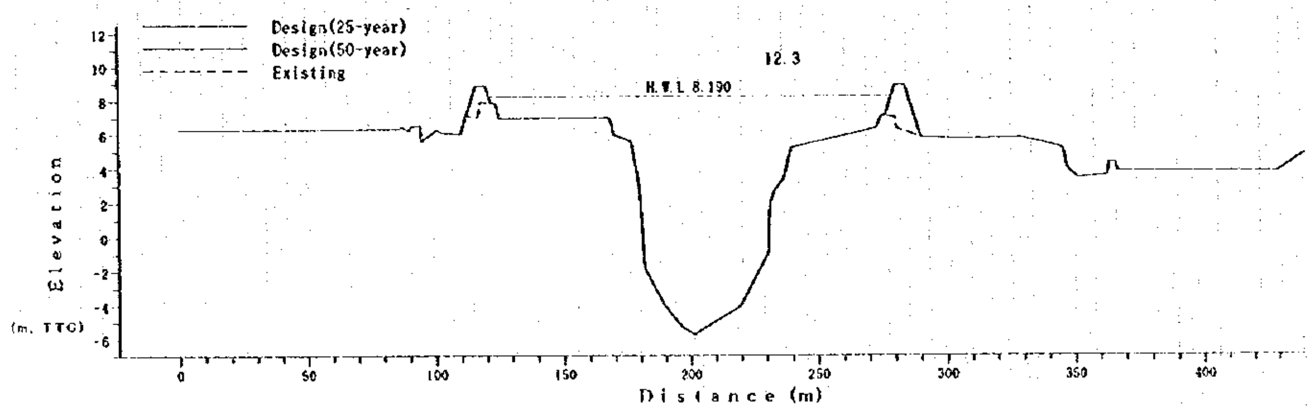
B : 1/2
H : 1/2



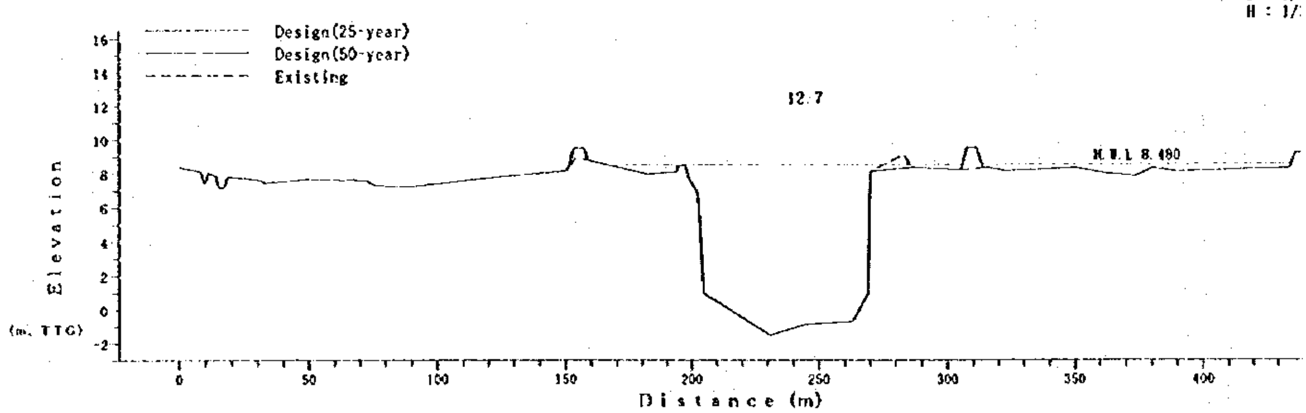


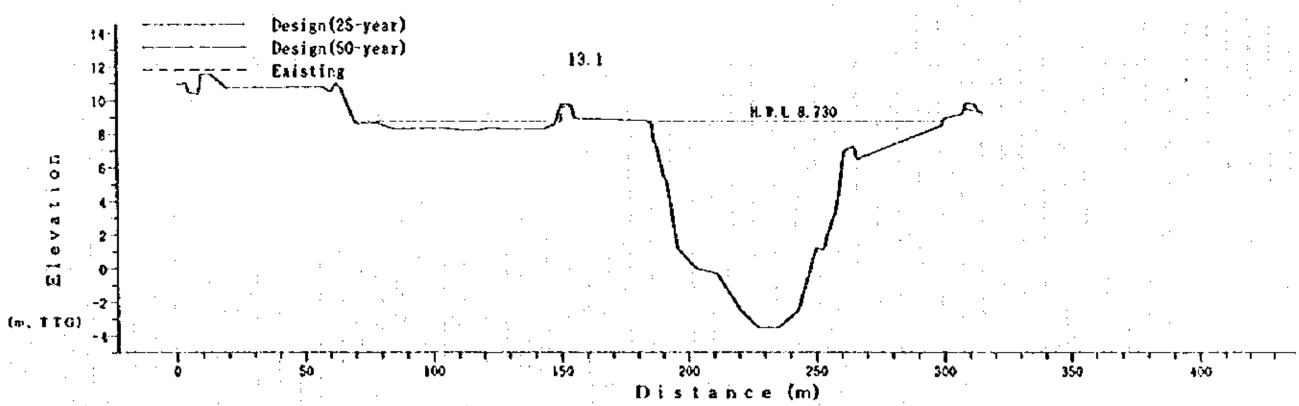
B : 1/
H : 1/


Design(25-year)
Design(50-year)
Existing
H.W.L 7.850
11.8
Elevation
(m, TTG)
Distance (m)

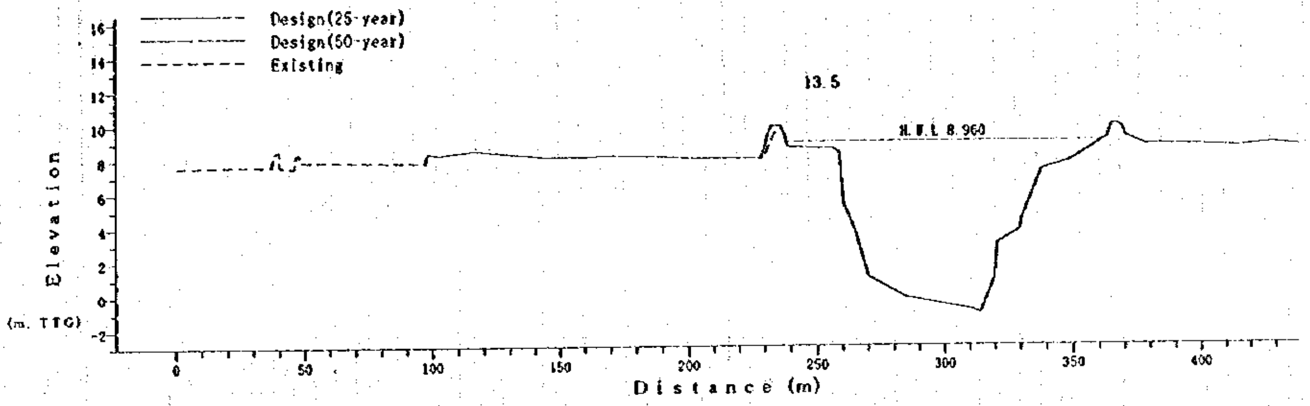

Design(25-year)
Design(50-year)
Existing
12.3
H.W.L 8.190
Elevation
(m, TTG)
Distance (m)

B : 1/
H : 1/

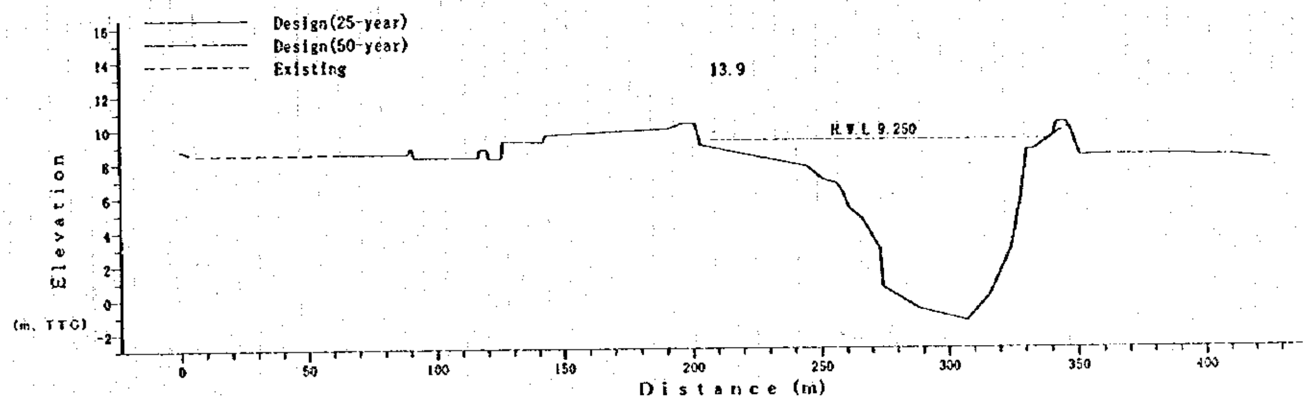

Design(25-year)
Design(50-year)
Existing
12.7
H.W.L 8.490
Elevation
(m, TTG)
Distance (m)


Design(25-year)
Design(50-year)
Existing
13.1
H.W.L 8.730
Elevation
(m, TTG)
Distance (m)

B : 1/
H : 1/

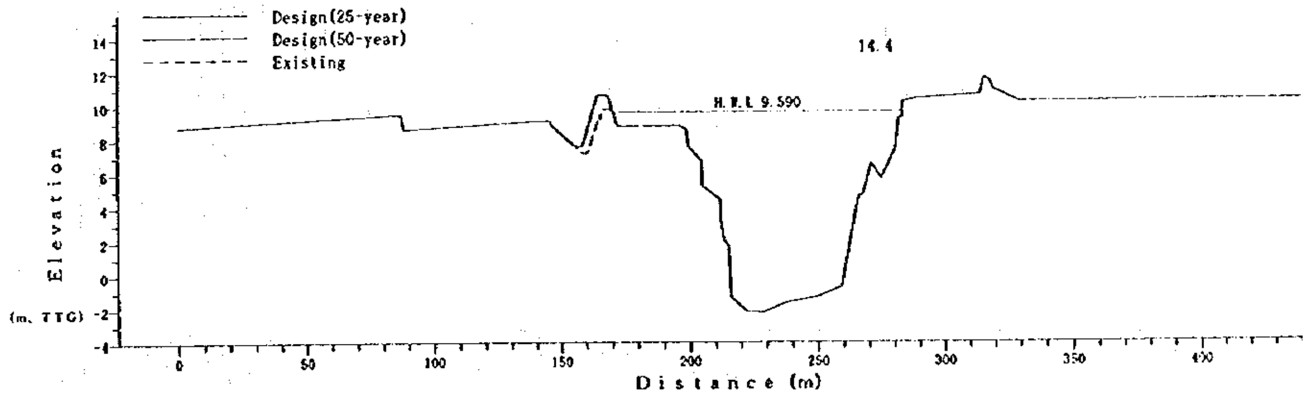


Design(25-year)
Design(50-year)
Existing
13.5
H.W.L 8.960
Elevation
(m, TTG)
Distance (m)

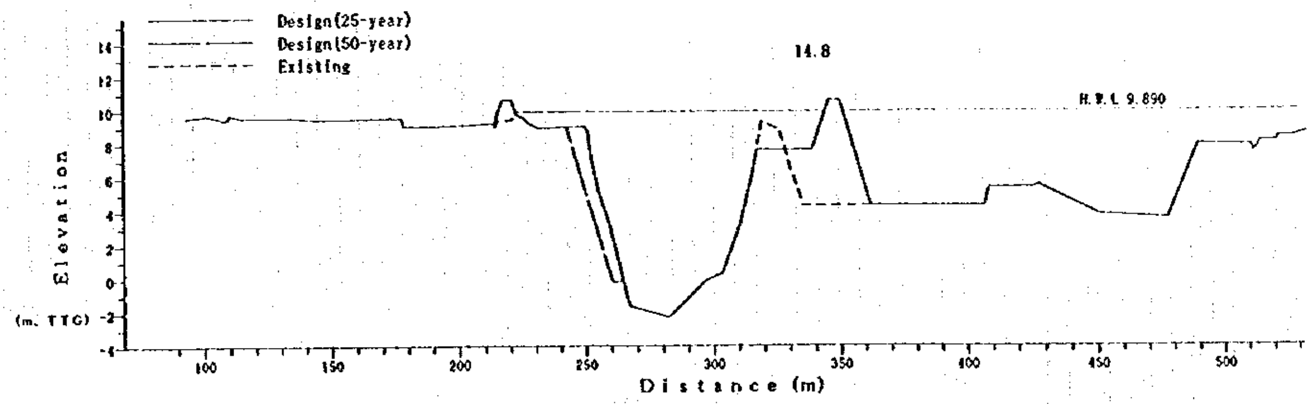


Design(25-year)
Design(50-year)
Existing
13.9
H.W.L 9.250
Elevation
(m, TTG)
Distance (m)

B : 1/2
H : 1/3

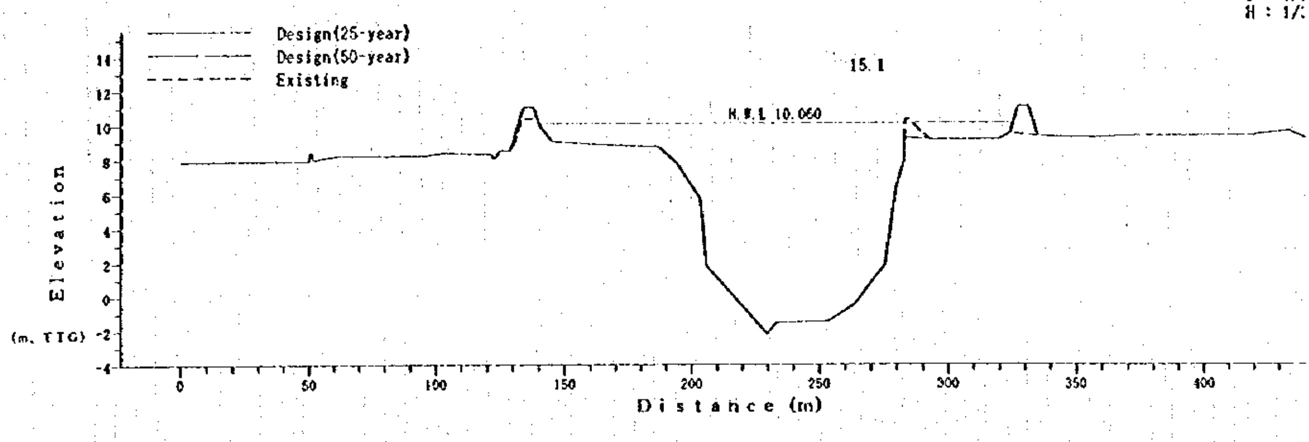


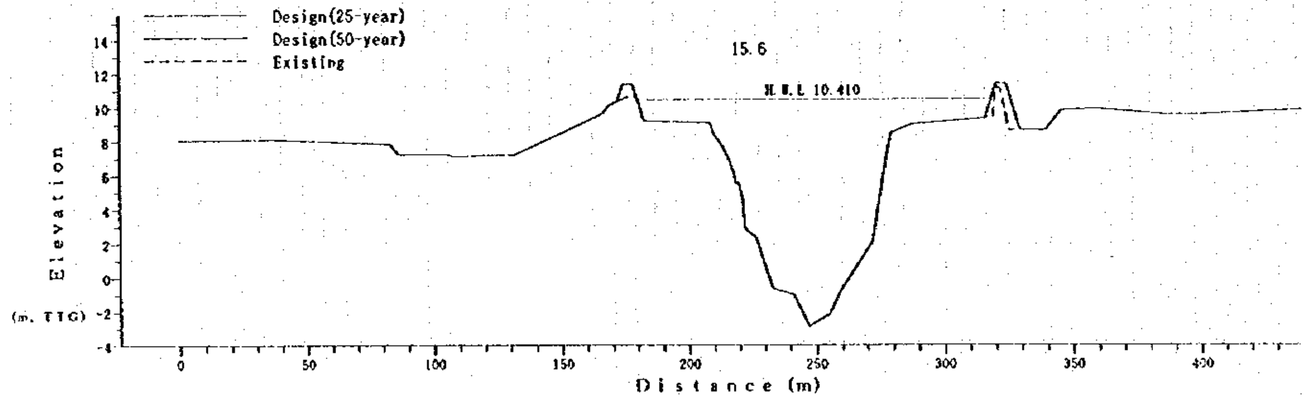
Design(25-year)
Design(50-year)
Existing
14.4
H.W.L 9.590
Elevation
(m, TTG)
Distance (m)



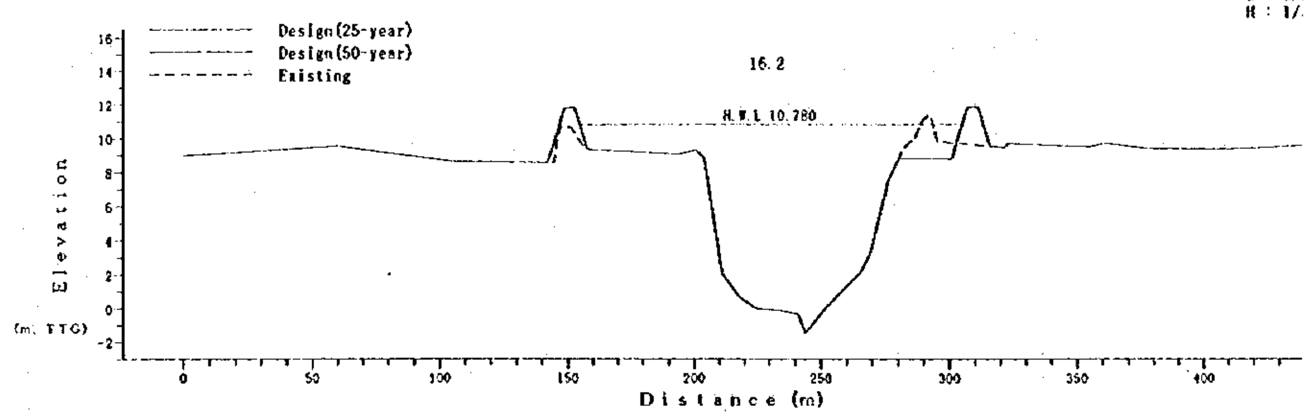
Design(25-year)
Design(50-year)
Existing
14.8
H.W.L 9.890
Elevation
(m, TTG)
Distance (m)

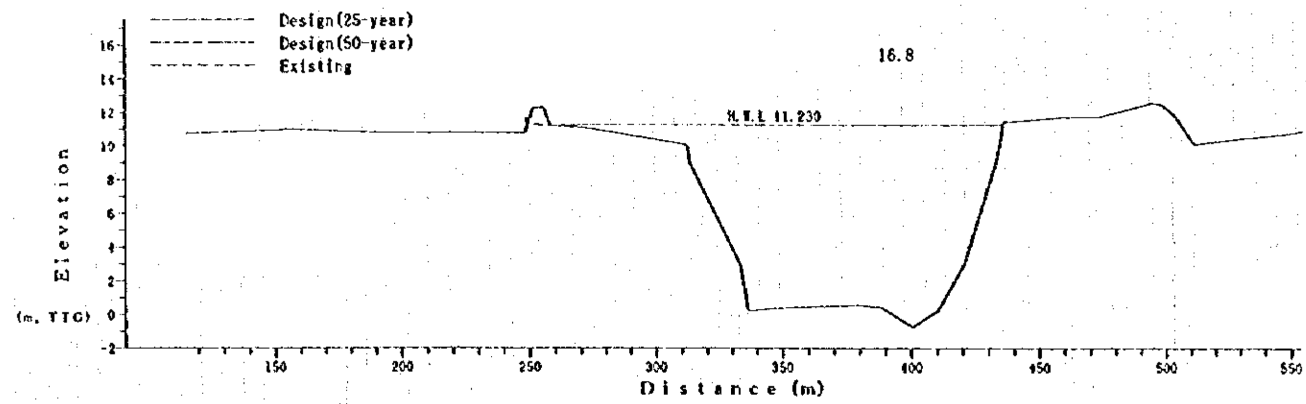
B : 1/
H : 1/

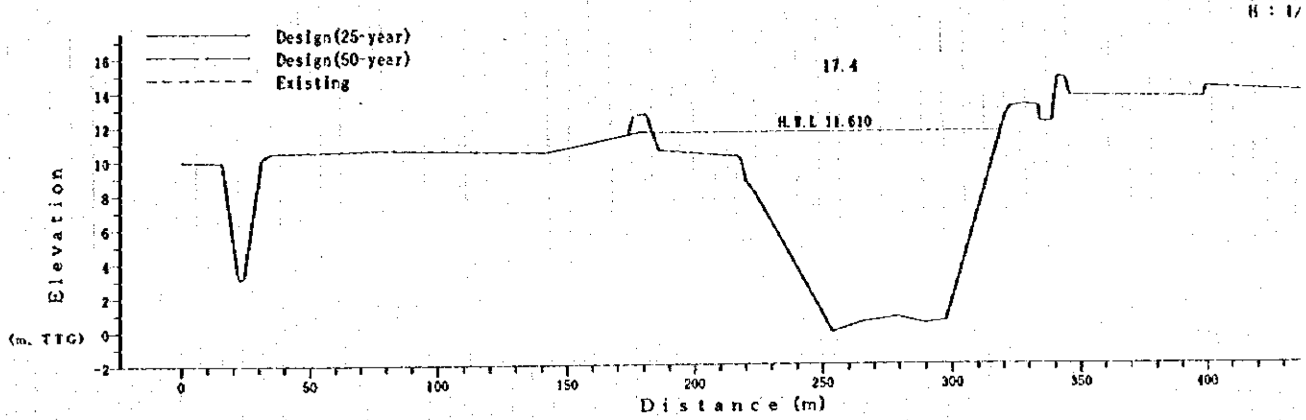

Design(25-year)
Design(50-year)
Existing
15.1
H.W.L 10.060
Elevation
(m, TTG)
Distance (m)

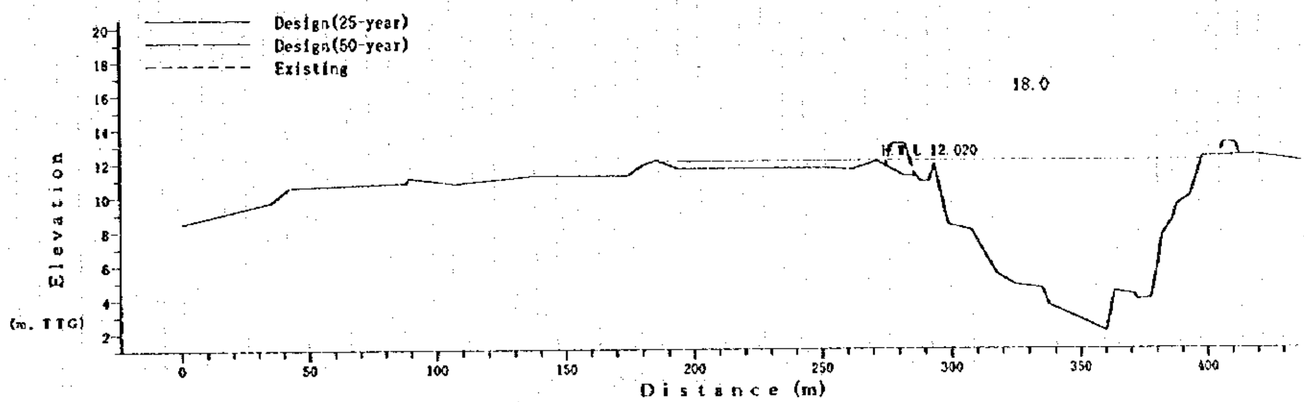

Design(25-year)
Design(50-year)
Existing
15.6
H.W.L 10.410
Elevation
(m, TTG)
Distance (m)

B : 1/
H : 1/

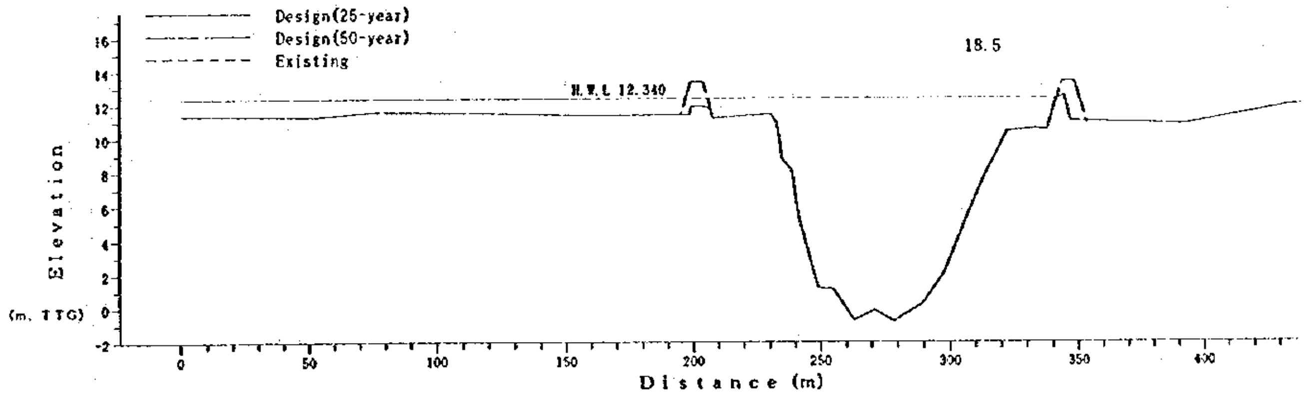

Design(25-year)
Design(50-year)
Existing
16.2
H.W.L 10.780
Elevation
(m, TTG)
Distance (m)

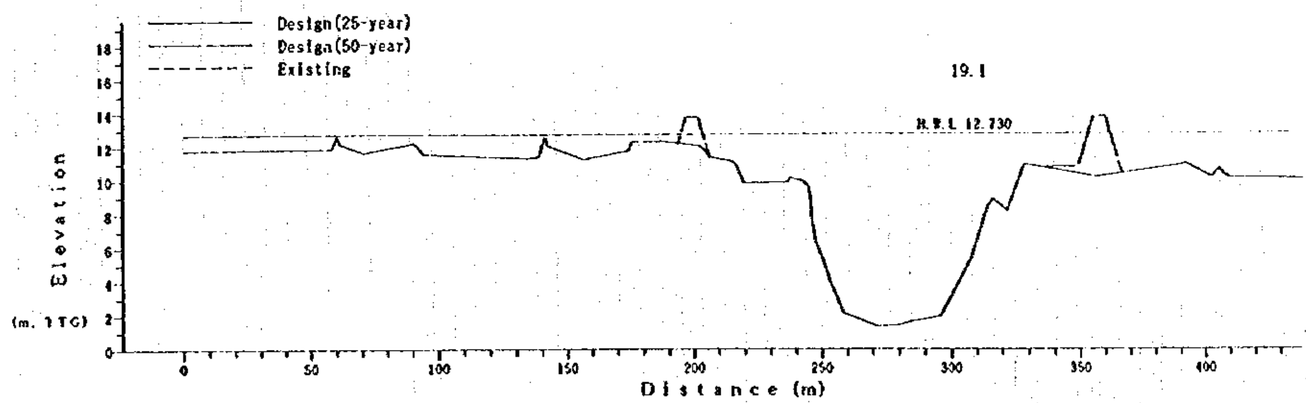

Design(25-year)
Design(50-year)
Existing
16.8
H.W.L 11.230
Elevation
(m, TTG)
Distance (m)

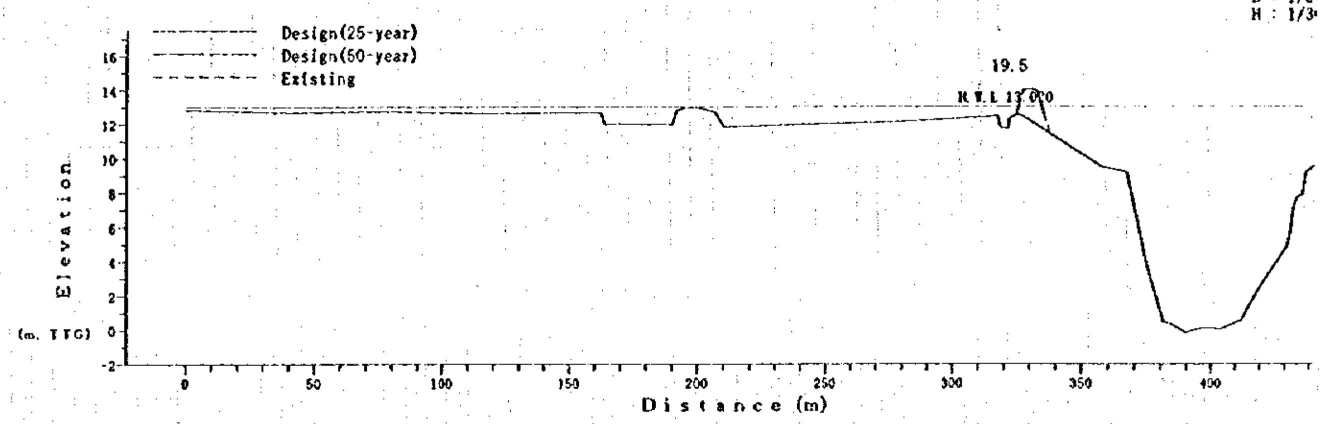

Design(25-year)
Design(50-year)
Existing
17.4
H.W.L 11.610
Elevation
(m. TTG)
Distance (m)

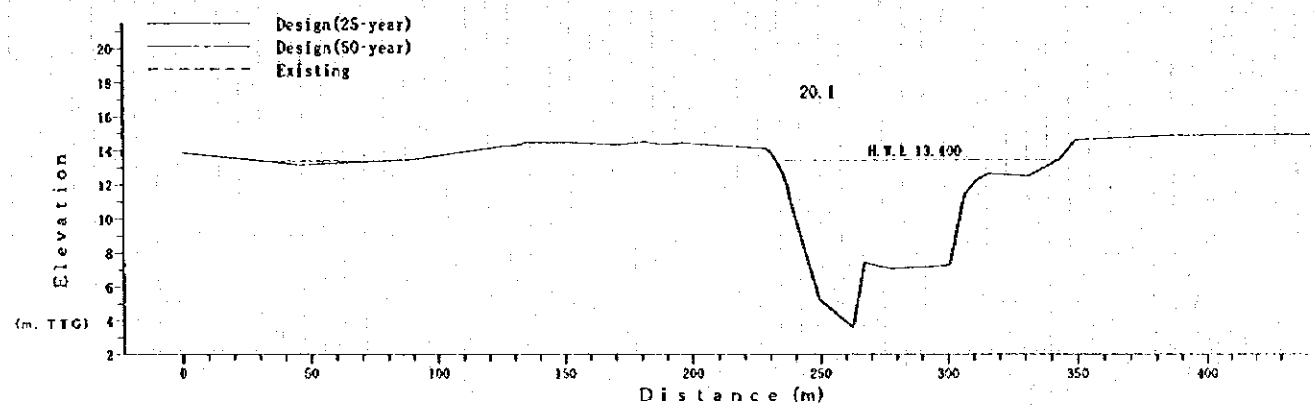

Design(25-year)
Design(50-year)
Existing
18.0
H.W.L 12.020
Elevation
(m. TTG)
Distance (m)

B : 1/
H : 1/


Design(25-year)
Design(50-year)
Existing
18.5
H.W.L 12.340
Elevation
(m. TTG)
Distance (m)


Design(25-year)
Design(50-year)
Existing
19.1
H.W.L 12.730
Elevation
(m. TTG)
Distance (m)


Design(25-year)
Design(50-year)
Existing
19.5
H.W.L 13.000
Elevation
(m. TTG)
Distance (m)


Design(25-year)
Design(50-year)
Existing
20.1
H.W.L 13.400
Elevation
(m. TTG)
Distance (m)

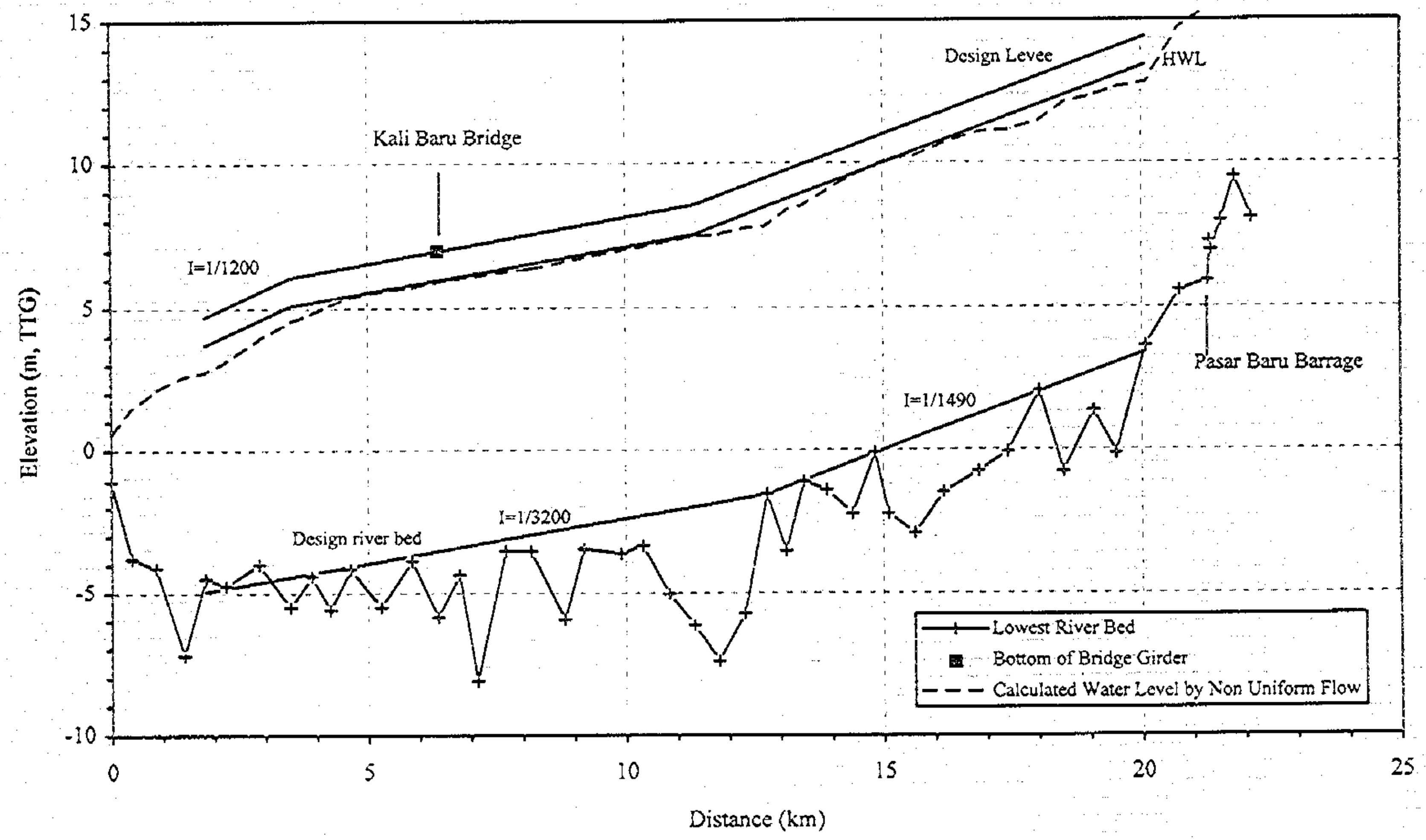


Figure HIGH WATER LEVEL AND NON UNIFORM FLOW WATER LEVEL (Master Plan)

Table - WORK QUANTITIES OF CISADANE RIVER

Work Item (additional works from 25-year to 50-year)	Unit	Quantity
1. Land Aquisition and Compensation		
Land aquisition	ha	3.4
House	nos.	60
2. Channel Improvement		
Preparatory	ls	1
Excavation and dredging	m^3	1,271,000
Embankment	m^3	98,000
Low water channel revetment	m^2	0
Drop structure	nos.	0
Construction of new drainage structure	nos.	0
Improvement of existing drainage structure	nos.	0
Reconstruction of bridge	nos.	0

Work Item (from present condition to 50-year)	Unit	Quantity
1. Land Aquisition and Compensation		
Land aquisition	ha	48.7
House	nos.	520
2. Channel Improvement		
Preparatory	ls	1
Excavation and dredging	m^3	2,096,000
Embankment	m^3	1,011,000
Low water channel revetment	m^2	8,400
Drop structure	nos.	0
Construction of new drainage structure	nos.	3
Improvement of existing drainage structure	nos.	2
Reconstruction of bridge	nos.	0

Table EARTH WORKS AND LAND AQUISITION OF CISADANE RIVER (Master Plan, 50-year)

Section No.	Distance (km)	Accumulative Distance (km)	Channel Improvement: Area Excavation (m^2)	Channel Improvement: Area Embankment (m^2)	Channel Improvement: Volume Excavation (m^3)	Channel Improvement: Volume Embankment (m^3)	Land Aquisition: Extension (m)	Land Aquisition: Area (ha)
0.0	0.000	0.000	0.0	0.0	0	0	0	0.00
0.4	0.400	0.400	0.0	0.0	0	0	0	0.00
0.9	0.465	0.865	0.0	0.0	0	0	0	0.00
1.4	0.545	1.410	0.0	0.0	0	0	0	0.00
1.8	0.417	1.827	0.0	108.0	0	21,600	87	1.74
2.2	0.400	2.227	0.0	119.9	0	62,937	105	5.51
2.9	0.650	2.877	0.0	116.8	0	73,559	122	7.69
3.5	0.610	3.487	0.0	58.0	0	29,618	28	1.43
3.9	0.412	3.899	12.5	163.7	4,799	62,935	20	0.77
4.3	0.357	4.256	70.2	83.9	26,465	31,623	24	0.90
4.7	0.397	4.653	259.9	125.8	129,310	62,566	44	2.19
5.3	0.598	5.251	233.0	118.9	140,174	71,530	55	3.31
5.9	0.605	5.856	333.5	65.4	185,081	36,297	18	1.00
6.4	0.505	6.361	132.6	17.6	60,996	8,114	0	0.00
6.8	0.415	6.776	195.6	56.0	74,817	21,435	44	1.68
7.1	0.350	7.126	130.4	94.4	58,046	42,026	20	0.89
7.7	0.540	7.666	486.4	69.7	252,421	36,185	13	0.67
8.2	0.498	8.164	364.4	44.4	209,189	25,486	25	1.44
8.8	0.650	8.814	282.5	52.9	143,217	26,830	23	1.17
9.2	0.364	9.178	371.9	33.7	202,675	47,177	0	0.00
9.9	0.726	9.904	264.0	107.9	151,668	61,977	45	2.59
10.3	0.423	10.327	299.8	4.0	139,838	1,847	5	0.23
10.8	0.510	10.837	257.8	46.9	129,138	23,507	21	1.05
11.3	0.492	11.329	31.8	54.8	15,375	26,515	38	1.84
11.8	0.475	11.804	242.6	6.8	118,894	3,352	0	0.00
12.3	0.505	12.309	0.0	13.3	0	6,294	12	0.57
12.7	0.440	12.749	7.8	37.1	3,120	14,832	37	1.48
13.1	0.360	13.109	0.0	14.2	0	5,027	12	0.43
13.5	0.350	13.459	0.0	5.2	0	2,033	5	0.20
13.9	0.438	13.897	0.0	2.9	0	1,344	5	0.23
14.4	0.495	14.392	0.0	15.8	0	7,453	0	0.00
14.8	0.446	14.838	76.6	152.4	26,834	53,416	38	1.33
15.1	0.255	15.093	7.2	20.6	2,790	7,998	52	2.02
15.6	0.520	15.613	0.0	20.8	0	11,221	14	0.76
16.2	0.561	16.174	33.8	38.4	20,795	23,597	33	2.03
16.8	0.668	16.842	0.7	7.4	446	4,605	5	0.31
17.4	0.570	17.412	0.0	8.9	0	5,239	0	0.00
18.0	0.610	18.022	0.0	22.7	0	12,191	20	1.08
18.5	0.465	18.487	0.0	33.6	0	17,590	23	1.20
19.1	0.582	19.069	0.0	70.8	0	36,002	5	0.25
19.5	0.435	19.504	0.0	50.4	0	25,326	14	0.70
20.1	0.570	20.074	0.0	0.0	0	0	0	0.00
				Total	2,096,000	1,011,000		48.7

JKA