(3) Water Supply Capacity
to be Developed

Total (1) - Total (2) : 10.37 m^3/s

In accordance with the possible water supplying draft by each scheme, Scheme 3 is adopted as the Water Resources Development Master Plan.

3.6 Optimum Water Supply Plan

Water Supply Plan

The public water demand of 12.12 m^3/s in Semarang City in 2015 will be fully supplied by the surface water of Babon River, Garang River and Blorong River, to coincide with the water supply programme of the Jratunseluna River Basin Development Project.

For ranking among the four reservoirs, cost efficiency is examined as shown in Table VII.3.6 (refer to CHAPTER 4 of SECTOR XII, PROJECT COST ESTIMATE). From the estimated cost efficiency among the reservoirs and the anticipated social impact such as compensation for assets and relocation, Jatibarang Reservoir can be proposed as a first priority project. Furthermore, interbasin transfer should be implemented after the completion of Mundingan Reservoir, because the purpose of the facilities is to supplement refilling the reservoir storage with surplus water of Blorong River. Accordingly, the priority of each facility is set up as follows:

(1) Jatibarang Reservoir
(2) Mundingan Reservoir
(3) Interbasin Transfer
(4) Kedung Suren Reservoir
(5) Babon Reservoir

With the said five facilities, the future water demand in Semarang City at the target year 2015 will be fully met. As estimated in Section 3.5, the possible amount of supplied water is 10.9 m^3/s. On the other hand, the target water demand to be supplied by this project is 10.37 m^3/s. As the results, the surplus is estimated at 0.53 m^3/s. This surplus storage can be utilized as a firm discharge for hydropower generation, concentrated to Jatibarang and Mundingan reservoirs, because both reservoirs are inadequate for hydropower generation in case of no storage of firm discharge due to the relatively small catchment area in comparison with the whole basin area.

The study procedures on hydropower generation development and water supply differ as follows:

(1) The control point to be developed for hydropower generation is the dam site, while that for water supply is the intake site, i.e., Simongan Weir; and

(2) Firm dicharge for hydropower generation is to be released from the dam during the period with small or no water release for water supply.

Being different as stated above, the firm discharge can be estimated through water balance analysis as follows:

Stage 1: Jatibarang Reservoir

The surplus water of 0.08 m^3/s can be changed to the firm discharge of 0.60 m^3/s.

Stage 2: Jatibarang Reservoir and Mundingan Reservoir

The surplus water of 0.18 m^3/s can be changed to the firm discharge of 0.6 m^3/s in the same way as Stage 1.

Stage 3: Jatibarang Reservoir, Mundingan Reservoir and Interbasin Transfer

To utilize the storage equivalent to the surplus water supply of 0.53 m^3/s, the firm discharge is approximately estimated at 1.80 m^3/s.

Maintenance flow in Garang River shall be secured by stepwisely, because the public water supply has higher priority than the maintenance flow. Both reservoirs shall ensure the maintenance flow of 0.5 m^3/s, respectively.

Computer simulation of water balance is executed for settling the optimum storage in each reservoir. In accordance with the priority of the Master Plan, the staged water development programme is given as follows:

Optimum Water Development Programme

Unit: m^3/s

Stage	Water Development Programme	Public Water	River Maintenance Flow	Irrigation Water	Firm Discharge for Hydropower
1-1	Jatibarang Res.	0.92	0.50	-	0.60
1-2	Jatibarang Res. & Mundingan Res.	2.02	1.00	-	0.60
1-3	Jatibarang Res., Mundingan Res. & Interbasin Trans.	2.62	1.00	-	1.80
2	Kedung Suren Res.	1.70	0.60	2.61	-
3	Babon Res.	1.30	0.50	0.10	-
	Total	5.62	2.10	2.71	1.80

The results of water balance computation during critical period in a 10-year drought cycle are shown in Fig. VII.3.8, and principal features of reservoirs for water resources development are summarized in Table VII.3.7. The public water supply programme is proposed, as shown in Figs. VII.3.9 and VII.3.10, so that the future water demand could be ensured at any stage.

Economic Evaluation

The economic evaluation of the Water Resources Development Master Plan was made in cooperation with the water resources development planner/dam planner, the construction planner/cost estimator and the project economist assigned in this study.

For the economic evaluation of water resources development, the estimation of annual benefit of public water supply plays an important role. Therefore, the reason to set up the raw water rate is described below, and then the results of economic evaluation are summarized.

(1) Raw Water Rate

Since the Water Resources Development Master Plan for public water supply does not contain construction of treatment plant and distribution system, the benefit on the economic evaluation is considered as the incremental water supply at the point of water intake facilities. The evaluation of public water supply benefits has been done on the assumption that benefits equal the costs of the most likely alternative sources of producing comparable quantity and quality of water.

Through the data collection, analysis of information and discussion with officials of the Indonesian government, the following two study results can be considered as the most likely alternatives:

(a) Previous Study in 1980

The Jratunseluna Basin Updated Development Plan published in May 1980 established the raw water rate of US$78.67/1000 m^3 for the economic evaluation. Converting this figure into the current rate in 1992 with the annual inflation rate of 6% and the exchange rate of Rp. 2,033/US$, the raw water rate is estimated at Rp. 320/m^3.

(b) Eastern Semarang Water Supply Project

The Water Supply Plan for Demak and Eastern Semarang Areas published by Jratunseluna Project in November 1992 estimated the construction cost of Dolok Dam including the sub-canal to convey water to the main canal at Rp. 43,875 million. Considering the alternative cost of Rp. 43,875 million to be amortized and the water supply capacity of 1.0 m^3/s by Dolok Reservoir, the raw water rate is estimated at Rp. 260/m^3.

Based on the results of the investigation mentioned above, the annual benefit of public water supply can be set at about Rp. 300/m^3 as the rate of raw water to produce alternative water supply of equal quantity and quality.

(2) Economic Evaluation

According to CHAPTER 2 of SECTOR XIV, ECONOMIC EVALUATION, the Water Resources Development Master Plan is evaluated by figuring out the economic validity in terms of the economic internal rate of return (EIRR). The estimated figures of EIRR are as follows:

	Project	EIRR (%)
(a	Jatibarang Reservoir, Mundingan Reservoir and Interbasin Transfer	16.1
(b)	Kedung Suren Reservoir	9.5
(c)	Babon Reservoir	4.9
	Total Project	10.8

3.7 Selection of Priority Project

The Water Resources Development Master Plan is composed of four dams and one interbasin transfer. Through the prioritization and implementation schedule discussed in the foregoing sections, the highest priority is placed on Jatibarang Dam because of the highest cost efficiency as well as EIRR and minimum social impact, especially the non-existence of residential houses. Therefore, Jatibarang Dam is selected as the first priority project for water supply source.

CHAPTER 4 FEASIBILITY STUDY ON PRIORITY PROJECT

4.1 Background and Planning Criteria

The priority project was identified among the water resources development components proposed in the Master Plan study considering the cost efficiency and the magnitude of social impact. The identified priority project is Jatibarang Dam Project as a multipurpose development for public water supply, hydropower generation, river maintenance flow and flood control. The main objective of the Feasibility Study is to clarify the viability of the proposed project.

In Master Plan study, topographical information of the reservoir area such as the relationship among reservoir elevation, impounding area and storage capacity, was estimated using the topographical map of 1:50,000 edited in 1942. In the Feasibility Study, on the other hand, the information around the reservoir area was obtained from the map of 1:2,500 newly developed during the study period from the aero-photographs taken in 1991. Based on the latest and detailed information, water supply capacity is elaborated through the analyses in the following sections.

Feasibility Study for Water Resouces Development in the Jatibarang reservoir shall conform to the following criteria:

(1) Priority for Allocation of Reservoir Storage

The effective storage capacity of the Jatibarang reservoir will be allocated for flood control, public water supply including river maintenance flow, and hydropower generation. Among the allocated purposes, the flood control to regulate the design flood in line with the design discharge in the river improvement plan ought to be indispensable so as to avoid the extensive relocation of many houses located along the river improvement portion (refer to CHAPTER 4 of SECTOR V, FLOOD CONTROL PLAN). Regarding the public water supply capacity, however, the deficit in the water supply from the Jatibarang reservoir could be supplemented by the Mundingan reservoir as planned in the Master Plan. The storage capacity for hydropower generation could also be compensated by other alternative thermal power plants. In due consideration of these conditions, the priority order to allocate reservoir storage will be placed on (1) flood control, (2) water supply and (3) hydropower generation.

Thus, the allocation for public water supply capacity has the second priority next to the flood control capacity. Nevertheless, the deficit in the public water supply is going to be more serious in Semarang City. Therefore, the public water supply capacity to be allocated for the Jatibarang reservoir in the Master Plan should be ensured, at least, so as to cope with the water shortage working together with the public water supply from the Mundingan reservoir.

(2) Other Criteria

Other criteria such as planning drought, control point for water supply, dead storage, and so on, will be the same as those set up in the Master Plan.

4.2 Alternative Plan

Allocated Reservoir Storage for Water Supply

As described in the planning criteria, flood control is placed on the first priority to allocate the reservoir storage to each purpose. According to the results of the comparative study to determine the optimum dam height and allocated storage described in CHAPTER 4 of SECTOR V, FLOOD CONTROL PLAN, the storage of 16.7 MCM which is located between LWL of EL. 136.6 m and NWL of EL. 155.3 m, is allocated for water supply including hydropower generation. This storage volume increases from 12.2 MCM estimated in the Master Plan, so that the ratio of increase is approximately 37%. Additionally, the portion between NWL and the dam crest at EL. 164.0 m is utilized as freeboard, PMF release and flood control (refer to Fig. IX.3.5 in SECTOR IX, DAM ENGINEERING).

Alternatives for Water Supply and Hydropower Generation

Considering the above-mentioned conditions, the objective to allocate the storage for water supply of 16.7 MCM is to seek the optimum allocation of the storage between the purposes of water supply and hydropower generation, through the water balance analysis as shown the model in Fig. VII.4.1. To compare the economic efficiency between water supply and hydropower generation, three alternatives are set up as follows:

(1) Alternative 1

According to the Master Plan, water supply capacity is planned at 2.00 m^3/s, and the firm discharge for hydropower generation is estimated at 1.18 m^3/s to fully utilize the remaining storage.

(2) Alternative 2

This case is situated between Alternative 1 and Alternative 3. Water supply capacity is planned at 2.30 m^3/s, and the firm discharge is estimated at 1.03 m^3/s in the same way.

(3) Alternative 3

This case fully utilizes the additional effective storage for water supply purpose, and hydropower energy is additionally generated only by the water released for water supply. Water supply capacity is estimated at 2.54 m^3/s.

These three alternatives are summarized below:

	Alternatives 1	2	3
Water Supply Capacity	2.00 m^3/s	2.30 m^3/s	2.54 m^3/s
- Newly Developed	1.42 m^3/s	1.72 m^3/s	1.96 m^3/s
- Existing Supply	0.58 m^3/s	0.58 m^3/s	0.58 m^3/s
Hydropower Generation			
Maximum Dicharge	3.09 m^3/s	3.03 m^3/s	2.87 m^3/S
Firm Discharge	1.18 m^3/s	1.03 m^3/s	-
Installed Capacity	1,610 kW	1,580 kW	1,500 kW
Annual Energy Production	7,470 MWh	5,820 MWh	6,710 MWh

Note: NWL: EL.155.3 m
Tailrace Water Level: EL.90.0 m
Head Loss: 2.0 m
Maximum Effective Head: 63.3 m
Combined Efficiency of Turbine and Generator: 0.838

The detailed method of estimation of installed capacity and annual energy production is the same, as described in CHAPTER 3 of SECTOR XIII, HYDROPOWER GENERATION PLAN. The notable factors are as follows:

(1) Maximum Discharge

Maximum discharge for hydropower which is the basic data to design installed capacity, is determined with reference to the average for 30 years equivalent to the annual water utilization factor of 60% on the flow-duration curves of reservoir release water.

(2) Ineffectual Release

Turbines and generators shall not be operated under the conditions of both small discharge and low head to avoid cavitation and adverse vibration. Ineffectual release for hydropower generation which is not introduced into the turbine, is defined as the discharge with which energy output is less than 30% of installed capacity. These ineffectually released water will thereby pass through the outlet pipe.

Comparison Among the Alternatives

With reference to the construction cost of the hydropower generation plant for each alternative, it can be regarded as approximately the same because the difference in cost among the alternatives is only 5%. Comparison among the alternatives can then be evaluated on the annual benefit.

According to the rate of benefit in CHAPTER 3 of this SECTOR and CHAPTER 3 of SECTOR XIV, ECONOMIC EVALUATION, the annual benefit of water supply and hydropower generation can be estimated for each alternative as follows:

Annual Benefit Estimation

Unit: million Rp.

	Alternatives 1	2	3
Water Supply	13,430	16,270	18,540
Hydropower	1,230	960	1,110
Total	14,660	17,230	19,650

Note: Raw Water Rate : Rp 300/m^3
Hydropower Energy Rate : Rp 165/kWh

As a result of the annual benefit estimation, annual benefit of water supply is a dominant source compared with hydropower generation in this case, so that Alternative 3 is identified as the optimum plan based on the benefit maximization principle.

4.3 Optimum Plan

As studied in Section 4.2, the principal features of the optimum plan in the Jatibarang reservoir are proposed as follows (refer to Fig. VII.4.2):

<u>Principal Features of Jatibarang Reservoir for Water Resources Development</u>

Normal Water Level	EL. 155.3 m
Gross Storage Capacity	27.8 MCM
Flood Control Capacity	4.3 MCM
Water Conservation Storage	16.7 MCM
Low Water Level	EL. 136.6 m
Dead Storage	6.8 MCM

Water Supply Capacity, Total	2.54 m^3/s
- Public Water	1.46 m^3/s
- Existing Public Water	0.58 m^3/s
- River Maintenance Flow	0.50 m^3/s
Hydropower Generation, Max. Dis.	2.87 m^3/s
- Installed Capacity	1,500 kW
- Annual Energy Production	6,710 MWh

As a study result of the optimum plan, public water supply capacity of the Jatibarang reservoir will increase from 0.92 m^3/s to 1.46 m^3/s in comparison with the Master Plan. As studied in this Feasibility Study, the topographical information on other reservoirs can also differ from the one dealt with the Master Plan study if the newly detailed investigation is executed. Therefore, the increase of 0.54 m^3/s for water supply from Jatibarang reservoir should be maintained on the safe side for further water resources development.

The reservoir operation and flow condition at the control point, Simongan Weir, are illustrated through the water balance study for 30 years in Fig. VII.4.3.

TABLES

Table VII.2.1 PRESENT WATER SUPPLY SYSTEM IN THE STUDY AREA

No.	Name of Town	Administrative Status	Population in 1990	Supply Source	Status	Construction Status Up To 91/92		
						Capacity (l/s)	House Connection (Unit)	Public Hydrant (Unit)
1	Semarang	A/B	1,250,971	MAG/SG/SD	PDAM	1,580	27,120	755
	-Kab.Semarang-							
2	Ungaran	D	94,079	MAG	PDAM	60	3,847	59
3	Klepu	E	75,423	MAG	PDAM	5	360	18
	-Kab.Kendal-							
4	Kaliwungu	E	83,736	SD	PDAM	10	341	10
5	Brangsong	E	38,092			10	674	
6	Singorojo	E	42,181					
7	Limbangan	E	26,182	MAG			295	7
8	Boja	E	51,329					
9	Pegandon	E	61,577					

Source : Jawa Tengah Dalam Angka 1991, Kantor Statistik Prov. Jawa Tengah
Note : Administrative Status A : Capital of Province
B : City
C : Administration Town
D : Kecamatan (Capital of Kabupaten)
E : Kecamatan
PDAM : Perusahaan Daerah Air Minum (Water Supply Public Corporation)
Supply Source MAG : Gravitation Spring
SG : River Water with Treatment Plant
SD : Deep Well

Table VII.2.2 AVERAGE ANNUAL WATER SUPPLY IN SEMARANG CITY

Calender Year	Unit	Supply Source			Total
		Spring	Garang River	Deep Well	
1985	m^3/Yr	10,100,442	15,566,375	225,633	25,892,450
	(l/s)	(320.3)	(493.6)	(7.2)	(821.0)
1986	m^3/Yr	9,963,277	15,439,246	362,201	25,764,724
	(l/s)	(315.9)	(489.6)	(11.5)	(817.0)
1987	m^3/Ys	9,733,160	15,755,376	396,352	25,884,888
	(l/s)	(308.6)	(499.6)	(12.6)	(820.8)
1988	m^3/Yr	10,215,190	16,341,737	614,704	27,171,631
	(l/s)	(323.0)	(516.8)	(19.4)	(859.3)
1989	m^3/Yr	9,098,442	16,244,742	676,606	26,019,790
	(l/s)	(288.5)	(515.1)	(21.5)	(825.1)
1990	m^3/Yr	6,666,829	14,165,462	10,219,741	31,052,032
	(l/s)	(211.4)	(449.2)	(324.1)	(984.7)
1991	m^3/Yr	7,896,167	13,625,674	11,456,896	32,978,737
	(l/s)	(250.4)	(432.1)	(363.3)	(1045.7)

Source : PDAM Semarang City

Table VII.2.3 SPRING DATA OF WATER SOURCE SYSTEM IN SEMARANG CITY

No.	Spring	Distance from City (km)	Yield Capacity(l/s) Maximum	Minimum
1	Kalidoh Besar	20.7	50.00	38.50
2	Si Cepit	19.4	51.00	40.00
3	Mudal Besar & Ancar	14.4	164.15	125.00
4	Mudal Kecil	14.9	47.64	37.14
5	Lawang	14.8	40.38	36.69
6	Abimanyu	14.7	3.00	2.00
		Total	356.17	279.33

Source:PDAM Semarang City

Table VII.2.4 DEEP WELLS OF WATER SOURCE SYSTEM IN SEMARANG CITY

No.	Well	Distance from City (km)	Yield Capacity (l/s) Maximum	Minimum	Well Depth (m)
1	Kalidoh(E1)	20.2	100	80	120
2	Kandang Babi II(E2)	19.2	30	25	120
3	Si Cepit(E3)	19.4	50	40	120
4	Gowongan(E4)	18.4	60	50	50
5	Ngablak(E5)	19.4	30	20	120
6	Genuk(E6)	17.0	25	20	121
7	Blanten(E7)	18.1	10	6	120
8	Sembungan(E8)	17.3	15	10	119
9	Karang Bolo(E9)	16.3	23	20	117
10	Kretek(E10)	15.0	50	40	120
11	Kaligarang(E11)	14.0	10	6	120
12	Sumur Jurang(E12)	14.5	14	10	120
13	Karang Geneng(E13)	13.3	15	10	162
14	Jurang Dampit(E14)	11.8	24	17	91
15	Pengkol(E15)	9.5	25	20	144
16	Plalangan(E16)	9.0	14	10	120
17	Ngrajegan(W1)	21.3	40	30	153
18	Tampingan(W2)	20.7	25	20	174
19	Kalilongas(W3)	19.3	35	26	179
20	Campurejo(W4)	18.0	40	30	173
21	Kalilengko(W5)	17.6	30	20	172
22	Cangkiran II(W6)	17.0	32	25	141
23	Medini(W7)	19.1	30	24	167
24	Jati Kalangan(W8)	17.8	25	20	173
25	Cangkiran I(W9)	17.7	30	25	137
26	Bubakan(W10)	15.4	14	10	140
27	Rejosari(W11)	14.6	27	20	182
28	Kuncen(W12)	14.1	40	30	179
29	Paramasan(W13)	13.3	31	25	180
30	Ngabean(W14)	8.5	25	20	167
		Total	919	709	

Source : PDAM Semarang City

Table VII.2.5 DEEP WELLS
IN THE CITY AREA

No.	Location/ Name	Average Yield in 1991 (l/s)
1	Ngesrep Timur	3.93
2	Erowati	2.37
3	Tombro	2.50
4	Ronggowarsito	2.59
5	Raden Patah	1.52
6	Citandui	1.88
7	Blimbing	2.10
8	Pemali	1.62
9	Senjoyo	2.23
10	Kinibalu	0.15
11	Wot Gandul	1.02
12	Brumbungan	1.43
13	Manyaran	0.76
14	Bugangan I	0.49
15	Jangli	2.15
16	Mijen	0.37
17	Kenconowungu	1.29
18	Rejosari	0.83
19	Sadeng	0.64
20	Arjuna	0.27
21	Cendrawasih	1.44
	Total	31.58

Source : PDAM Semarang City

Table VII.2.6 WATER USE DATA IN SEMARANG CITY

Item	Unit	Calender Year						
		1985	1986	1987	1988	1989	1990	1991
Total Water Supplied	m^3	25,892,450	25,764,724	25,884,888	27,171,631	26,019,790	31,052,032	32,978,740
Metered Water	m^3	13,390,950	14,292,810	12,845,191	12,408,509	13,219,591	15,624,590	17,591,964
Unaccounted For Water	m^3	12,501,500	11,471,914	13,039,697	14,763,122	12,800,199	15,427,442	15,386,776
	%	48.28	44.53	50.38	54.33	49.19	49.68	46.66
Total Population		1,096,271	1,107,636	1,112,175	1,119,036	1,126,265	1,133,811	1,141,521
Number of Customers		31,180	31,936	32,459	29,480	35,964	48,000*	60,000*
Population supplied Water		214,116	240,825	257,199	236,525	264,747	376,921	451,800
Service Ratio	%	19.53	21.74	23.13	21.14	23.51	33.24	39.58
Usage per Capita	l/day	171	163	137	144	137	114	107

Source : PDAM Semarang City (including Total Population)
Note * : Approximate Value

Table VII.2.7 PRESENT WATER USE IN KAB. KENDAL

Item	Unit	Kecamatan Kaliwungu
Water Supply		
Source		Deep Well
Location/Name		Sekopek
Yield Capacity	l/s	15.00
Water Use as of March 1992		
Total Production	m^3	18,792
Metered Water	m^3	10,701
Unaccounted for Water	m^3	7,731
	%	41.14
Number of Customers		600

Source : PDAM Kab. Kendal

Table VII.2.8 WATER CONSUMPTION DATA IN KAB. KENDAL (AS OF MARCH 1992)

Consumer for Tariff	Kec. Kaliwungu	
	No. of Consumers	Consumption (m^3/month)
House Connection	558	8,833
Commercial	12	193
Industry	-	-
Social	4	80
Government Office	12	274
Special	14	1,321
Total	600	10,701

Source : PDAM Kab. Kendal

Table VII.2.9 WATER SUPPLY DATA IN KAB. SEMARANG

Kecamatan	Source	Location/ Name	Yeild Capacity (l/s)
Ungaran	Spring	Ngablak	23.57
		Sendang Putri	1.22
		Kalidoh Kecil	18.74
	Deep Well	Kandang Babi	2.50
	TK	Depan Polsek	10.00
		Taman Unyil	3.20
		Perumnas Mapagan	5.00
		(TOTAL)	64.23
Klepu	Spring	Pager Sari	5.00

Source : PDAM Kab. Semarang
Note TK : Support for Ungaran by Semarang City System

Table VII.2.10 EXISTING IRRIGATION AREA IN THE STUDY AREA

No. Name	Total Area (ha)	River	Kecamatan	Paddy Field (ha) Technical	Semi-Tech	Simple	Rainfed
Blorong River System							
1 Blorong Mojo	1,379	Blorong	Limbangan	0	0	325	0
			Boja	273	0	461	0
			Singorojo	90	0	90	0
			Kaliwungu	110	0	30	0
			(Total)	473	0	906	0
2 Blorong Tambangan	515	Blorong	Boja	0	0	257	0
			Limbangan	0	0	102	0
			Mijen	0	79	77	0
			(Total)	0	79	436	0
3 Kedung Pengilon	3,145	Blorong	Brangsong	1,450	0	0	0
			Kaliwungu	1,579	0	0	0
			Pegandon	116	0	0	0
			(Total)	3,145	0	0	0
(TOTAL)	5,039			3,618	79	1,342	0
Besole River System							
1 Plumbon	457	Besole	Kaliwungu	139	0	0	0
			Tugu	318	0	0	0
			(Total)	457	0	0	0
2 Plumbon Hulu	178	Besole	Mijen	99	0	0	0
			Tugu	79	0	0	0
			(Total)	178	0	0	0
(TOTAL)	635			635	0	0	0
Bringin River System							
1 Kedung Bringin	472	Bringin	Mijen	0	0	67	0
			Tugu	0	0	405	0
			(Total)	0	0	472	0
Garang River System 1 (Kreo River)							
1 Kedung Kreo	744	Kreo	Boja	0	0	317	0
			Limbangan	0	0	49	0
			Mijen	0	0	378	0
			(Total)	0	0	744	0
Garang River System 2 (Kripik River)							
1 Gandu Kripik	418	Kripik	Gunungpati	418	0	0	0
Garang River System 3 (Garang River)							
1 Sidopangus	756	Pangus	Ungaran	440	0	0	0
			Gunungpati	316	0	0	0
			(Total)	756	0	0	0
2 Sigotek	137	Tuan	Gunungpati	137	0	0	0
3 Sijambe	401	Garang	Ungaran	0	239	162	0
(TOTAL)	1,294			893	239	162	0
Babon & East Floodway River System							
1 Kedung Braholo	66	Penggaron	Genuk	10	0	0	0
			Semarang Selatan	35	0	0	0
			Semarang Timur	21	0	0	0
			(Total)	66	0	0	0
2 Penggaron Kiri	133	Penggaron	Genuk	115	0	0	0
			Semarang Timur	18	0	0	0
			(Total)	133	0	0	0
(TOTAL)	199			199	0	0	0

Source : Dinas Pekerjaan Umum Pengairan, Prop. Dati I Jawa Tengah

Table VII.2.11 BRACKISH WATER AQUACULTURE IN THE STUDY AREA

No	Name	Total Area (ha)		Production (ton/ha/4months)
		Gross	Operation	
Semarang City				
	Kec. Genuk			
1	Kaligawa	80	80	3-5
	Kec. Semarang Barat & Tugu			
2	Kalibanteng	100	100	3-5
Kab. Kendal				
	Kec. Kaliwungu			
3	Mororejo	536	536	2-8
4	Wonorejo	595	595	2-8
5	Nolokerto	14	14	2-8
6	Sumberejo	12	12	2-8
	Kec. Brangsong			
7	Purwokerto	61	61	2-8
8	Turunrejo	127	127	2-8
	Total	1,525	1,525	

Source : Dinas Pekerjaan Umum Pengairan, Prop. Dati I Jawa Tengah

Table VII.2.12 WATER QUALITY CRITERIA OF TYPICAL PARAMETER

Parameter	Unit	Max. Concentration by Category A	B	C	D
1.Physical					
Total Dissolved Solids	mg/l	1000	-	-	-
Dissolved Solids	mg/l	-	1000	1000	2000
2.Chemical					
pH	(RANGE)	6.5-8.5	5-9	6-9	5-9
Dissolved Oxygen (DO)	mg/l(MIN)	6.5	6	3	2
BOD5	mg/l	1	5	6	10
COD	mg/l	2	8	10	15
Nitrite	mg/l	1	1	0.06	-
Sulfide	mg/l	0.05	0.1	0.002	-
Phenol	mg/l	-	0.002	0.001	-
3.Metals					
Iron	mg/l	0.5	5	-	-
Chromium Hexavalent	mg/l	0.01	0.05	0.05	1
Lead	mg/l	0.05	0.1	0.03	1
Zinc	mg/l	5	5	0.02	2
4.Bacteriological					
Fecal Coliform	MPN/100ml	0	2000	-	-
Total Coliform	MPN/100ml	3	10000	-	-

Note; Categories of beneficial uses
A : drinking water not requiring treatment
B : raw drinking water requiring treatment
C : livestock watering and aquatic life
D : irrigation, industry, cities, hydro-power generation

Table VII.2.13 WATER QUALITY MONITORING DATA

Station	Parameter (YEAR) / (Season)	1989/1990 Dry	Wet	1990/1991 Dry	Wet	1991/1992 Dry	Wet
Tinjomoyo	DO	8.56	7.73	7.89	8.24	7.22	9.59
	BOD	0.59	1.64	2.17	1.12	5.25	2.34
Tugu Suharto	DO	7.52	8.80	7.95	8.24	8.14	7.06
	BOD	3.62	1.01	1.73	1.16	3.08	2.79
Simongan Weir	DO	7.80	7.54	5.97	7.04	6.10	7.18
	BOD	2.31	4.98	2.72	2.48	4.59	2.16
Railway Bridge	DO	6.01	4.13	4.80	7.17	6.88	7.10
	BOD	14.43	6.45	6.86	2.61	3.32	3.96

Note ; unit : mg/l
Dry Season : from May to Oct.
Wet Season : from Nov. to Apr.

Table VII.3.1 PROJECTION OF INDUSTRIAL AREA

Kotamadia /Kabupaten	Kecamatan	Industrial Area (ha) 1990	1995	2000	2005	2010	2015
	Year	1990	1995	2000	2005	2010	2015
Semarang	West/Tugu	90	270	450	720	900	1,080
	Central/North	116	231	385	385	385	385
	South	33	40	57	100	143	186
	East/Genuk	92	340	500	640	780	920
Demak	Sayung	90	270	720	1,217	1,800	1,800
Total		421	1,151	2,112	3,062	4,008	4,371

Table VII.3.2 FUTURE PUBLIC WATER DEMAND PROJECTION

WATER USE	unit	Year 1990	1995	2000	2005	2010	2015
Domestic Water							
Domestic Use	lcd	150	170	170	200	200	250
Population		1,250,971	1,325,882	1,405,284	1,489,441	1,578,637	1,673,173
Service Ratio	%	100	100	100	100	100	100
Water Demand	m3/d	187,646	225,400	238,898	297,888	315,727	418,293
	m3/s	2.172	2.609	2.765	3.448	3.654	4.841
Non-Domestic Water							
Industrial Use	l/s/ha	0.75	0.75	0.75	0.75	0.75	0.75
Industrial Area	ha	421	1,151	2,112	3,062	4,008	4,371
Water Demand	m3/s	0.316	0.863	1.584	2.297	3.006	3.278
Commercial Use of Domestic Water	%	8.5	15	20	20	20	20
Water Demand	m3/s	0.185	0.391	0.553	0.690	0.731	0.968
Unaccounted for Water	%	50	28	25	25	25	25
Total Water Demand	m3/s	5.34	5.37	6.54	8.58	9.85	12.12

Table VII.3.3 TYPICAL IRRIGATION WATER DEMAND FOR CROPS IN BLORONG AND BABON RIVER BASIN

Technical Irrigation Area : Kedung Pengilon (A=3,145 ha)

Month	Sub-Period	Design Channel Discharge (m3/s)	Specific Discharge (l/s/ha)	Month	Sub-Period	Design Channel Discharge (m3/s)	Specific Discharge (l/s/ha)
Jan	1	2.380	0.757	Jul	1	1.463	0.465
	2	2.518	0.801		2	1.327	0.422
Feb	1	2.549	0.810	Aug	1	0.716	0.228
	2	2.135	0.679		2	0.883	0.281
Mar	1	1.402	0.446	Sep	1	0.935	0.297
	2	1.563	0.497		2	0.826	0.263
Apr	1	2.068	0.658	Oct	1	0.016	0.005
	2	2.030	0.645		2	0.551	0.175
May	1	1.603	0.510	Nov	1	2.043	0.650
	2	1.488	0.473		2	3.230	1.027
Jun	1	1.749	0.556	Dec	1	3.067	0.975
	2	1.623	0.516		2	2.507	0.797
				Average		1.695	0.539

Technical Irrigation Area : Penggaron Kanan (A=858 ha)

Month	Sub-Period	Design Channel Discharge (m3/s)	Specific Discharge (l/s/ha)	Month	Sub-Period	Design Channel Discharge (m3/s)	Specific Discharge (l/s/ha)
Jan	1	0.838	0.977	Jul	1	0.429	0.500
	2	0.601	0.700		2	0.429	0.500
Feb	1	0.644	0.751	Aug	1	0.429	0.500
	2	0.686	0.800		2	0.429	0.500
Mar	1	0.566	0.660	Sep	1	0.429	0.500
	2	0.223	0.260		2	0.429	0.500
Apr	1	0.215	0.251	Oct	1	0.215	0.251
	2	0.429	0.500		2	0.000	0.000
May	1	0.429	0.500	Nov	1	0.000	0.000
	2	0.429	0.500		2	0.000	0.000
Jun	1	0.429	0.500	Dec	1	0.537	0.626
	2	0.429	0.500		2	1.073	1.251
				Average		0.430	0.501

Simple Irrigation Area : Blorong Tambangan (A=515 ha)

Month	Sub-Period	Design Channel Discharge (m3/s)	Specific Discharge (l/s/ha)	Month	Sub-Period	Design Channel Discharge (m3/s)	Specific Discharge (l/s/ha)
Jan	1	0.437	0.849	Jul	1	0.165	0.320
	2	0.470	0.913		2	0.124	0.241
Feb	1	0.402	0.781	Aug	1	0.161	0.313
	2	0.167	0.324		2	0.161	0.313
Mar	1	0.241	0.468	Sep	1	0.161	0.313
	2	0.529	1.027		2	0.115	0.223
Apr	1	0.431	0.837	Oct	1	0.000	0.000
	2	0.335	0.650		2	0.338	0.656
May	1	0.335	0.650	Nov	1	0.676	1.313
	2	0.358	0.695		2	0.540	1.049
Jun	1	0.381	0.740	Dec	1	0.945	1.835
	2	0.333	0.647		2	0.945	1.835
				Average		0.365	0.708

Technical Irrigation Area : Penggaron Kiri (A=133 ha)

Month	Sub-Period	Design Channel Discharge (m3/s)	Specific Discharge (l/s/ha)	Month	Sub-Period	Design Channel Discharge (m3/s)	Specific Discharge (l/s/ha)
Jan	1	0.108	0.812	Jul	1	0.067	0.504
	2	0.093	0.699		2	0.067	0.504
Feb	1	0.078	0.586	Aug	1	0.067	0.504
	2	0.081	0.609		2	0.067	0.504
Mar	1	0.083	0.624	Sep	1	0.067	0.504
	2	0.056	0.421		2	0.067	0.504
Apr	1	0.014	0.105	Oct	1	0.067	0.504
	2	0.034	0.256		2	0.034	0.256
May	1	0.067	0.504	Nov	1	0.000	0.000
	2	0.067	0.504		2	0.000	0.000
Jun	1	0.067	0.504	Dec	1	0.000	0.000
	2	0.067	0.504		2	0.054	0.406
				Average		0.057	0.430

Table VII.3.4 PRELIMINARY SCREENING OF POTENTIAL RESERVOIRS

Item	unit	<Babon> Babon	<Garang> Garang	Mundin-gan	Jatiba-rang	<Blorong> Blorong	Kedung Suren
Catchment Area (C.A)	km2	51.9	70.9	45.7	53.0	50.5	146.5
Gross Storage Capacity	MCM	45.9	13.4	35.9	19.4	4.8	72.1
Required Sediment Capacity (Vd)	MCM	10.2	13.0	7.4	6.8	7.8	19.7
Specific Sediment Capacity (Vd/C.A/50)	m3/km2/yr	3,900	3,700	3,200	2,600	3,100	2,700
Effective Capacity (Ve)	MCM	35.7	0.4	28.5	12.6	-	52.4
Specific Capacity (Ve/C.A)	mm	688	6	624	238	-	358
House Evacuation	house	1,330	-	470	-	-	1,470

Table VII.3.5(1/3) RELATIONSHIP BETWEEN SUPPLYING CONSTANT DRAFT AND STORAGE CAPACITY

unit: 1,000,000m3

Year	Babon Reservoir					Mundingan Reservoir							Mundingan Res. & Interbasin Transfer							
	0m3/s	0.5m3/s	1m3/s	1.5m3/s	2m3/s	0.5m3/s	1m3/s	1.5m3/s	2m3/s	2.5m3/s	3m3/s	3.5m3/s	0.5m3/s	1m3/s	1.5m3/s	2m3/s	2.5m3/s	3m3/s	3.5m3/s	4m3/s
1960 / 61	0.00	0.00	0.00	0.55	3.68	0.00	0.00	0.00	0.00	0.00	0.32	0.79	0.00	0.00	0.00	0.00	0.00	0.09	0.65	1.79
1961 / 62	0.00	1.36	6.29	12.75	20.98	0.86	2.62	5.42	8.97	13.32	19.11	25.57	0.86	2.58	5.38	8.85	13.05	18.27	24.49	31.16
1962 / 63	0.00	0.00	0.19	2.52	7.15	0.00	0.00	0.00	0.18	1.22	3.08	6.39	0.00	0.00	0.00	0.10	0.54	2.13	4.52	7.36
1963 / 64	0.00	1.73	6.80	13.91	22.41 *	1.16	3.82	7.12	11.35	16.21	22.44	29.46 *	0.81	2.77	6.07	10.25	15.01	20.24	26.22	33.48
1964 / 65	0.00	0.16	2.11	8.19	31.10 *	0.00	0.14	1.11	2.70	5.64	9.31	(20.15)*	0.00	0.07	0.92	2.51	5.35	8.64	12.71	17.32
1965 / 66	0.00	1.55	5.78	12.01	20.40	0.69	2.56	5.58	9.31	14.20	19.76	25.86	0.69	2.56	5.40	9.13	14.02	19.58	25.68	32.31
1966 / 67	0.00	0.19	2.27	7.31	15.36	0.00	0.40	1.84	4.03	6.77	9.99	14.66	0.00	0.40	1.84	4.03	6.77	9.99	13.75	18.88
1967 / 68	0.00	2.23	6.77	12.67	20.17	1.93	4.85	8.36	12.67	17.94	23.76	30.13	1.84	4.42	7.80	11.90	16.75	22.13	28.22	35.14
1968 / 69	0.00	0.00	0.00	0.45	4.06	0.00	0.00	0.00	0.00	0.00	0.10	0.93	0.00	0.00	0.00	0.00	0.00	0.01	0.64	1.86
1969 / 70	0.00	0.00	0.00	0.58	4.25	0.00	0.00	0.00	0.00	0.05	0.45	1.20	0.00	0.00	0.00	0.00	0.05	0.45	1.11	2.94
1970 / 71	0.00	0.00	0.00	0.54	2.61	0.00	0.00	0.00	0.00	0.06	0.60	1.77	0.00	0.00	0.00	0.00	0.06	0.49	1.57	2.81
1971 / 72	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22
1972 / 73	0.00	0.75	4.63	10.29	17.84 *	0.92	2.53	4.75	7.55	11.47	16.63	22.40	0.92	2.53	4.75	7.55	11.03	15.68	21.29	27.38
1973 / 74	0.00	0.00	1.36	4.70	20.28 *	0.00	0.00	0.10	1.23	3.73	6.82	10.65	0.00	0.00	0.00	0.82	2.63	4.87	8.35	12.20
1974 / 75	0.00	0.00	0.03	1.22	4.69	0.00	0.00	0.00	0.00	0.14	0.72	1.67	0.00	0.00	0.00	0.00	0.00	0.02	0.23	1.17
1975 / 76	0.00	0.00	0.00	0.47	3.10	0.00	0.00	0.00	0.00	0.00	0.19	1.07	0.00	0.00	0.00	0.00	0.00	0.06	0.73	1.90
1976 / 77	0.00	0.13	2.49	6.40	13.81	0.00	0.72	2.73	5.34	8.49	12.28	16.61	0.00	0.72	2.73	5.34	8.49	12.28	16.60	21.33
1977 / 78	0.00	1.97	6.20	12.67	20.63	1.30	4.00	7.38	11.35	16.28	21.72	27.70	1.30	3.38	6.76	10.73	15.66	21.10	27.07	33.33
1978 / 79	0.00	0.00	0.23	4.55	13.12	0.00	0.00	0.00	0.01	0.49	2.51	5.58	0.00	0.00	0.00	0.00	0.19	1.82	4.24	7.88
1979 / 80	0.00	0.00	0.17	1.59	8.05	0.00	0.00	0.00	0.00	0.38	1.08	2.86	0.00	0.00	0.00	0.00	0.16	0.96	1.87	2.97
1980 / 81	0.00	0.00	0.70	3.08	6.90	0.00	0.00	0.23	1.23	2.84	5.00	7.81	0.00	0.00	0.21	1.11	2.73	4.75	7.51	10.36
1981 / 82	0.00	2.04	5.93	11.22	19.34	1.88	4.42	7.55	11.42	15.89	20.91	26.27	0.80	2.79	5.23	8.40	12.41	16.97	21.91	26.97
1982 / 83	0.09	3.40	9.72	17.75 *	27.37 *	2.52	6.47	11.21	16.49	22.33	29.05 *	36.81 *	2.18	5.99	10.54	15.60	21.07	27.08	33.61	40.85
1983 / 84	0.08	1.66	5.26	19.97 *	46.50 *	1.04	2.73	5.34	8.63	12.53	(22.22)*	37.91 *	1.04	2.73	5.27	8.45	12.14	16.38	21.36	26.85
1984 / 85	0.00	0.31	2.56	(19.60)*	64.13 *	0.00	0.10	0.97	2.51	5.13	(11.90)*	38.19 *	0.00	0.04	0.77	2.12	4.13	7.04	10.24	16.44
1985 / 86	0.01	1.77	7.70	32.40 *	87.94 *	0.99	2.68	5.43	10.01	15.32	21.85	54.33 *	0.10	1.17	2.96	5.99	10.31	15.85	21.88	28.29
1986 / 87	0.00	0.07	1.57	(11.90)*	(82.93)*	0.00	0.00	0.03	0.57	1.57	4.73	(21.54)*	0.00	0.00	0.00	0.07	0.50	1.78	3.93	7.49
1987 / 88	0.00	2.21	6.09	11.73	(74.54)*	1.65	4.18	7.36	11.13	15.48	20.13	25.81	1.65	4.18	7.30	10.94	15.08	19.64	24.47	30.45
1988 / 89	0.00	0.00	0.56	3.33	(35.46)*	0.00	0.00	0.00	0.34	1.47	3.78	6.62	0.00	0.00	0.00	0.34	1.40	3.08	5.92	9.17
1989 / 90	0.00	0.00	0.00	0.00	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67
Required V	0.01	2.21	6.80	17.75	46.50	1.88	4.42	7.55	11.42	16.28	22.44	37.91	1.65	4.18	7.30	10.94	15.66	21.10	27.07	33.48

Note; *: Period during which storage utilization extends over years without refilling
( ): Negligible storage which depends on the antecedent drought events

Table VII.3.5(2/3) RELATIONSHIP BETWEEN SUPPLYING CONSTANT DRAFT AND STORAGE CAPACITY

unit: 1,000,000m3

Year	Jatibaran/Jatibaran & Mundingan Res.								Jatibaran/Jatibaran & Mundingan Res. & Interbasin Transfer									
	0.5m3/s	1m3/s	1.5m3/s	2m3/s	2.5m3/s	3m3/s	3.5m3/s	4m3/s	0.5m3/s	1m3/s	1.5m3/s	2m3/s	2.5m3/s	3m3/s	3.5m3/s	4m3/s	4.5m3/s	5m3/s
1960 / 61	0.00	0.00	0.00	0.00	0.00	0.32	0.79	2.39	0.00	0.00	0.00	0.00	0.00	0.09	0.65	1.79	4.40	7.67
1961 / 62	0.87	2.62	5.42	8.93	13.32	19.03	25.49	32.35	0.87	2.58	5.38	8.81	13.05	18.20	24.42	31.16	38.12	46.81
1962 / 63	0.00	0.00	0.00	0.18	1.22	3.06	6.23	10.15	0.00	0.00	0.00	0.10	0.54	2.13	4.52	7.36	10.96	14.94
1963 / 64	1.10	3.75	7.08	11.35	16.21	22.22	29.24 *	36.83 *	0.81	2.71	6.03	10.25	15.01	20.24	26.00	33.26	41.05 *	49.55 *
1964 / 65	0.00	0.14	1.11	2.64	5.58	9.24	(15.35)*	(32.71)*	0.00	0.07	0.92	2.45	5.29	8.58	12.71	17.32	(25.92)*	(44.47)*
1965 / 66	0.68	2.56	5.51	9.31	14.20	19.76	25.86	32.58	0.68	2.56	5.33	9.13	14.02	19.58	25.68	32.31	39.58	47.27
1966 / 67	0.00	0.40	1.84	4.03	6.78	9.99	14.25	20.37	0.00	0.40	1.84	4.03	6.78	9.99	13.75	18.54	25.05	31.95
1967 / 68	1.89	4.81	8.32	12.64	17.94	23.76	30.13	37.10	1.84	4.37	7.76	11.88	16.74	22.13	28.22	35.14	42.58	50.51
1968 / 69	0.00	0.00	0.00	0.00	0.00	0.10	0.93	2.42	0.00	0.00	0.00	0.00	0.00	0.01	0.63	1.86	3.41	5.79
1969 / 70	0.00	0.00	0.00	0.00	0.05	0.45	1.12	3.06	0.00	0.00	0.00	0.00	0.05	0.45	1.03	2.86	5.30	8.44
1970 / 71	0.00	0.00	0.00	0.00	0.06	0.60	1.77	3.06	0.00	0.00	0.00	0.00	0.06	0.49	1.57	2.81	4.12	7.09
1971 / 72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.65	1.92
1972 / 73	0.92	2.53	4.74	7.55	11.31	16.47	22.30	28.60 *	0.92	2.53	4.74	7.55	11.03	15.51	21.19	27.28	33.80	40.91 *
1973 / 74	0.00	0.00	0.10	1.22	3.74	6.68	10.50	(15.18)*	0.00	0.00	0.00	0.82	2.63	4.87	8.21	12.05	15.90	(20.38)*
1974 / 75	0.00	0.00	0.00	0.00	0.13	0.72	1.57	4.39	0.00	0.00	0.00	0.00	0.00	0.02	0.23	1.17	2.63	5.73
1975 / 76	0.00	0.00	0.00	0.00	0.00	0.20	1.07	2.50	0.00	0.00	0.00	0.00	0.00	0.06	0.73	1.90	3.62	5.83
1976 / 77	0.00	0.72	2.73	5.34	8.49	12.29	16.61	21.38	0.00	0.72	2.73	5.34	8.49	12.29	16.60	21.33	26.48	32.08
1977 / 78	1.30	3.92	7.30	11.31	16.28	21.72	27.70	34.23	1.30	3.30	6.68	10.69	15.66	21.09	27.07	33.33	39.76	46.24
1978 / 79	0.00	0.00	0.00	0.01	0.49	2.51	5.33	10.84	0.00	0.00	0.00	0.00	0.19	1.83	4.24	7.79	13.81	20.61
1979 / 80	0.00	0.00	0.00	0.00	0.38	1.08	2.86	6.12	0.00	0.00	0.00	0.00	0.16	0.96	1.87	2.91	7.10	11.85
1980 / 81	0.00	0.00	0.23	1.23	2.84	5.00	7.81	10.66	0.00	0.00	0.21	1.11	2.73	4.75	7.51	10.36	13.25	17.08
1981 / 82	1.88	4.42	7.55	11.42	15.89	20.91	26.27	31.67	0.80	2.79	5.23	8.40	12.41	16.97	21.91	26.97	32.36	37.76
1982 / 83	2.42	6.39	11.13	16.41	22.25	28.89 *	36.64 *	45.07 *	2.16	5.91	10.46	15.51	20.99	27.00	33.53	40.81	48.95 *	58.17 *
1983 / 84	1.04	2.73	5.28	8.57	12.47	(17.92)*	(33.86)*	51.08 *	1.04	2.73	5.20	8.39	12.08	16.33	21.36	26.85	(32.65)*	(50.90)*
1984 / 85	0.00	0.10	0.97	2.51	5.13	(8.62)*	(30.19)*	58.60 *	0.00	0.04	0.77	2.12	4.13	7.04	10.24	15.61	23.62	(49.19)*
1985 / 86	0.99	2.68	5.28	9.85	15.22	21.86	43.88 *	83.46 *	0.10	1.17	2.90	5.88	10.21	15.85	21.88	28.29	34.82	(54.45)*
1986 / 87	0.00	0.00	0.03	0.57	1.57	4.58	9.62	(54.16)*	0.00	0.00	0.00	0.07	0.50	1.78	3.93	7.40	13.15	20.26
1987 / 88	1.64	4.18	7.36	11.13	15.47	20.10	25.75	(41.28)*	1.64	4.18	7.30	10.94	15.08	19.64	24.41	30.45	37.36	44.77
1988 / 89	0.00	0.00	0.00	0.34	1.47	3.78	6.62	9.88	0.00	0.00	0.00	0.34	1.40	3.08	5.92	9.17	12.66	17.29
1989 / 90	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	1.53	2.67
Required V	1.88	4.42	7.55	11.42	16.28	22.22	30.13	51.08	1.64	4.18	7.30	10.94	15.66	21.09	27.07	33.33	41.05	49.55

Note; *: Period during which storage utilization extends over years without refilling
( ): Negligible storage which depends on the antecedent drought events

Table VII.3.5(3/3) RELATIONSHIP BETWEEN SUPPLYING CONSTANT DRAFT AND STORAGE CAPACITY

unit: 1,000,000m3

Year	Kedung Suren Reservoir							Kedung Suren Res. & Interbasin Transfer					
	0m3/s	0.5m3/s	1m3/s	1.5m3/s	2m3/s	2.5m3/s	3m3/s	0m3/s	0.5m3/s	1m3/s	1.5m3/s	2m3/s	2.5m3/s
1960 / 61	0.00	0.00	0.18	0.39	0.61	1.46	6.22	0.00	0.06	0.28	0.49	0.77	2.86
1961 / 62	6.92	9.19	11.64	14.68	19.89	26.85	35.59	7.22	9.59	12.05	15.08	20.96	29.66
1962 / 63	1.76	2.62	3.49	4.35	5.22	6.43	7.72	2.22	3.08	3.94	4.98	6.23	7.52
1963 / 64	4.15	4.99	6.73	9.15	14.39	23.37 *	32.36 *	4.17	5.99	8.41	10.83	18.62 *	27.60 *
1964 / 65	2.64	4.19	5.92	7.64	9.37	(18.35)*	38.70 *	3.31	4.96	6.69	8.41	(15.65)*	36.00 *
1965 / 66	9.20	12.83	20.53	30.56	40.78	51.12 *	61.74 *	9.47	13.10	21.26	31.36	41.80 *	52.26 *
1966 / 67	0.91	4.74	11.71	19.24	27.75	(45.00)*	70.74 *	0.91	5.48	12.65	20.71	(36.46)*	62.04 *
1967 / 68	3.04	5.29	12.42	20.04	28.08	36.63	(52.18)*	3.04	5.29	12.69	20.40	28.44	(40.15)*
1968 / 69	0.00	0.00	0.22	0.43	0.65	0.86	1.73	0.00	0.07	0.28	0.50	0.71	1.12
1969 / 70	0.46	0.81	1.73	2.91	4.92	7.12	9.32	0.55	1.55	3.11	4.88	6.88	9.09
1970 / 71	0.00	0.00	0.00	0.28	1.27	5.64	11.30	0.00	0.00	0.00	0.29	1.41	6.29
1971 / 72	0.00	0.00	0.00	0.00	0.50	1.91	4.07	0.00	0.00	0.00	0.00	0.75	2.29
1972 / 73	6.26	7.99	10.76	14.69	20.53	29.32	38.48	6.55	8.95	11.82	15.77	22.94	31.75
1973 / 74	0.08	0.46	1.15	1.99	3.41	6.86	10.37	0.08	0.65	1.50	2.40	4.25	7.80
1974 / 75	0.00	0.00	0.22	0.79	2.37	4.80	7.48	0.00	0.09	0.53	1.29	3.12	5.54
1975 / 76	0.00	0.00	0.00	0.00	0.21	3.36	7.32	0.00	0.00	0.00	0.00	0.96	4.70
1976 / 77	2.23	3.09	4.81	10.54	17.96 *	25.91 *	39.32 *	2.43	3.29	5.01	11.04 *	19.65 *	32.99 *
1977 / 78	6.00	9.92	17.18	24.79	34.37 *	59.86 *	85.48 *	6.63	11.51	18.78	26.39 *	48.40 *	73.89 *
1978 / 79	3.07	4.19	5.70	7.21	(20.31)*	(57.59)*	97.85 *	3.29	4.59	6.10	(13.29)*	(44.79)*	84.93 *
1979 / 80	0.44	0.65	0.87	1.09	1.65	5.73	(41.16)*	0.56	0.78	1.00	1.52	2.23	(22.38)*
1980 / 81	0.00	0.00	0.02	0.25	1.63	6.55	13.29	0.00	0.00	0.15	0.48	2.94	9.05
1981 / 82	0.60	1.19	2.44	3.74	5.04	6.33	7.68	1.04	1.96	3.26	4.56	5.85	7.15
1982 / 83	4.12	5.63	7.20	9.45	13.49	20.12	28.51	4.44	5.95	7.72	10.32	15.42	23.85
1983 / 84	0.01	0.37	1.02	2.94	7.85	13.29	19.07	0.20	0.85	1.49	3.89	8.87	14.50
1984 / 85	0.85	1.54	2.62	3.70	4.82	6.11	8.11	1.03	2.01	3.09	4.38	5.68	6.98
1985 / 86	0.00	0.19	0.48	1.13	1.77	2.42	4.22	0.20	0.66	1.31	1.96	2.61	3.26
1986 / 87	0.06	0.28	0.50	0.71	1.05	1.48	1.92	0.24	0.46	0.73	1.16	1.59	2.07
1987 / 88	2.53	3.40	4.26	5.50	9.00	15.14	22.94	2.53	3.46	4.54	5.82	10.63	18.71
1988 / 89	0.67	1.73	3.24	8.75	16.52	27.04	37.71	1.52	2.60	3.68	9.27	19.64	30.16
1989 / 90	0.25	0.47	0.68	1.06	2.39	6.49	10.59	0.25	0.47	0.78	1.21	2.39	6.49
Required V	6.26	9.19	12.42	20.04	28.08	36.63	70.74	6.63	9.59	12.69	20.71	28.44	62.04

Note; *: Period during which storage utilization extends over years without refilling
( ): Negligible storage which depends on the antecedent drought events

Table VII.3.6 COST EFFICIENCY OF PROPOSED RESERVOIRS AS MAXIMUM DEVELOPMENT

Reservoir		Babon	Jatibarang	Mundingan	Kedung Suren
Normal Water Level (EL. m)		69.4	153.0	224.6	69.9
Required Storage Volume(mill.m3)		35.7	12.6	27.6	53.2
Public Water					
-Newly Developed (m3/s)		1.3	0.5	1.6	2.0
-Existing Supply (m3/s)		-	0.6	0.6	-
Existing Irrigation(m3/s)		0.1	-	-	2.6
River Maintenance Flow(m3/s)		0.5	1.0	1.0	0.6
Annual Yield (mill.m3/Yr.)*1	[A]	41.0	15.8	50.5	63.1
Total Annual Yield(mill.m3/Yr.)*2	[B]	59.9	66.2	100.9	164.0
Estimated Construction Cost(mill.Rp)	[C]	286,000	57,100	113,600	248,100
Cost Efficiency(Rp/m3/Yr.)					
-vs. Annual Yield	[C/A]	6,980	3,610	2,250	3,930
-vs. Total Annual Yield	[C/B]	4,770	860	1,130	1,510

Note:

*1 Annual Yield is estimated by using newly developed public water.

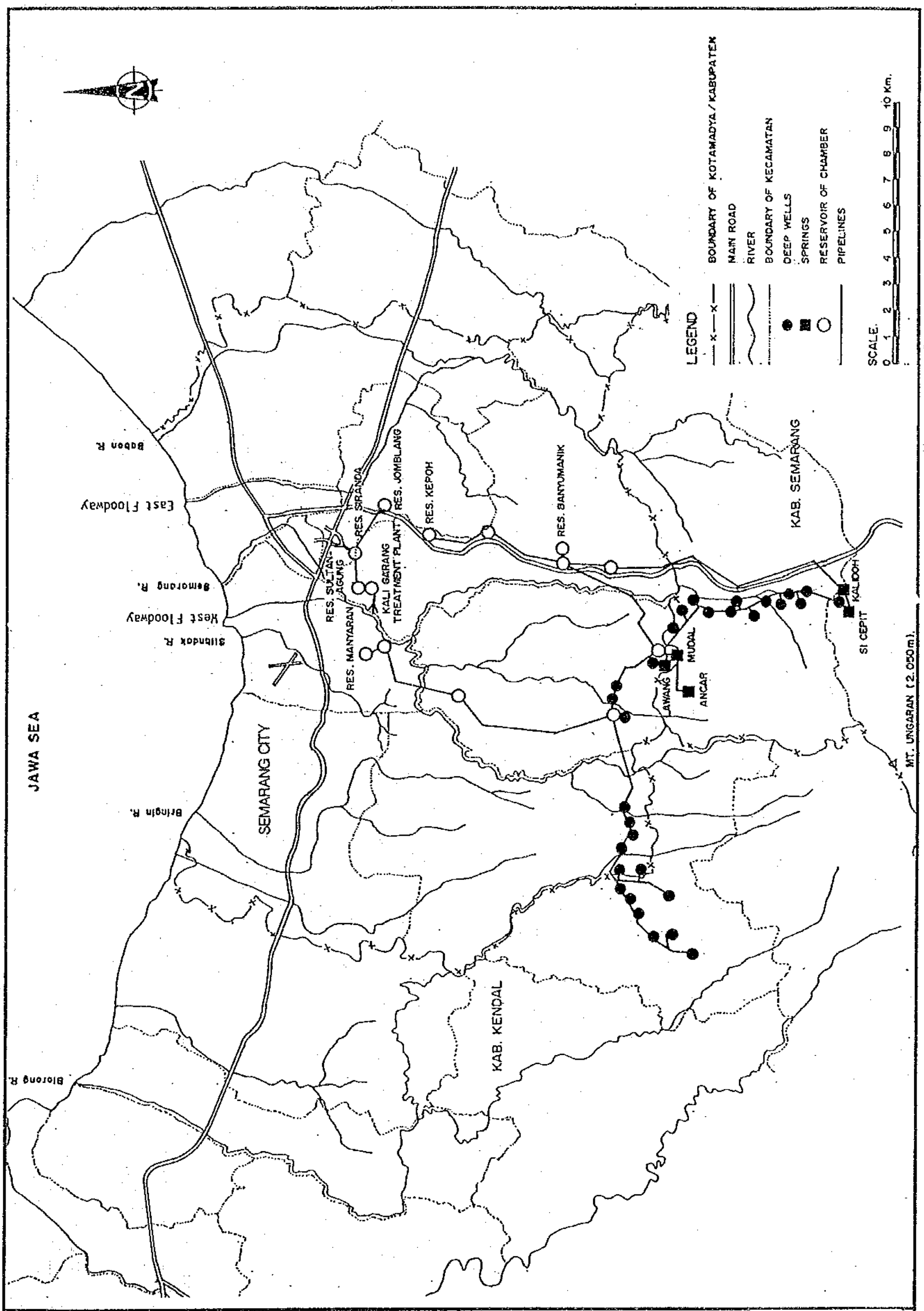
*2 Total Annual Yield is estimated by using total of whole public water, existing irrigation and river maintenance flow.

Table VII.3.7 PRINCIPAL FEATURES OF RESERVOIRS FOR WATER RESOURCES DEVELOPMENT MASTER PLAN

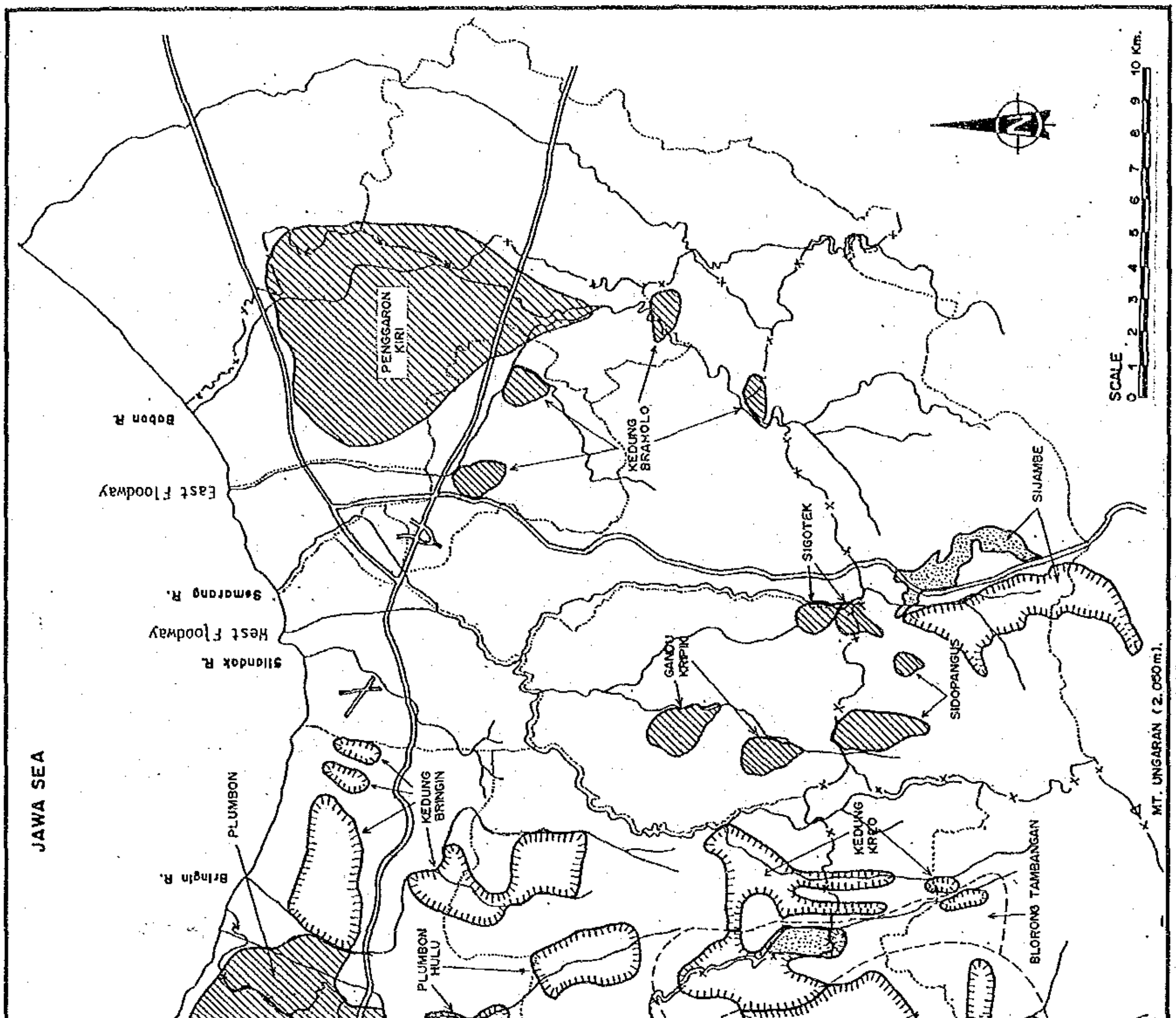
Reservoir	Jatibarang			Mundingan		Kedung Suren	Babon
	Stage I	Stage II	Stage III	Stage II	Stage III		
Normal Water Level	EL.153.0m	EL.153.0m	EL.153.0m	EL.224.6m	EL.224.6m	EL. 69.7m	EL. 69.4m
Water Conservation Storage							
-Firm Discharge for Hydropower	0.4 MCM	1.0 MCM	1.0 MCM	12.4 MCM	7.6 MCM	-	-
-Water Supply	12.2 MCM	16.3 MCM	16.3 MCM	15.2 MCM	20.0 MCM	52.4 MCM	35.7 MCM
-Total	12.6 MCM	17.3 MCM	17.3 MCM	27.6 MCM	27.6 MCM	52.4 MCM	35.7 MCM
Low Water Level	EL.138.2m	EL.128.1m	EL.128.1m	EL.207.9m	EL.207.9m	EL. 60.3m	EL. 55.7m
Dead Storage	6.8 MCM	2.1 MCM	2.1 MCM	7.4 MCM	7.4 MCM	19.7 MCM	10.2 MCM
Dam Foundation	EL. 90.0m	EL. 90.0m	EL. 90.0m	EL.185.0m	EL.185.0m	EL. 40.0m	EL. 40.0m
Supplying Draft							
-Firm Discharge for Hydropower	0.6 m3/s	0.6 m3/s	1.8 m3/s	Equivalent to		-	-
-Public Water	0.9 m3/s	2.0 m3/s	2.6 m3/s		Jatibarang	1.7 m3/s	1.3 m3/s
-Existing Public Water	0.6 m3/s	0.6 m3/s	0.6 m3/s	on Stage I		-	-
-River Maintenance Flow	0.5 m3/s	1.0 m3/s	1.0 m3/s		on Stage II	0.6 m3/s	0.5 m3/s
-Existing Irrigation	-	-	-			2.6 m3/s	0.1 m3/s

Note : Stage I ; Operation with Jatibarang reservoir only
Stage II ; Operation as a series reservoirs with Jatibarang and Mundingan reservoirs
Stage III ; Operation as a series reservoirs and receiving water through interbasin transfer from Blorong River

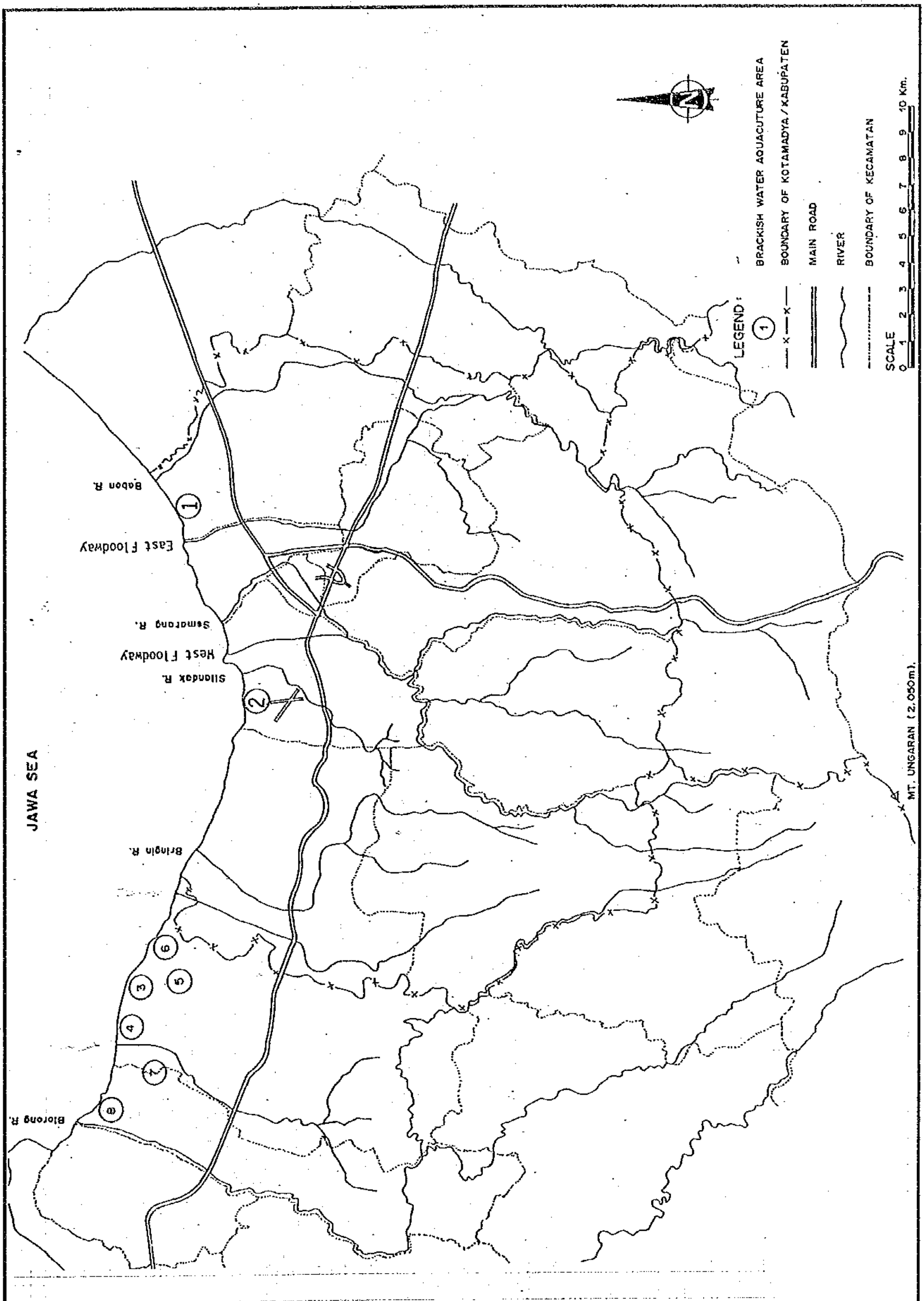
FIGURES



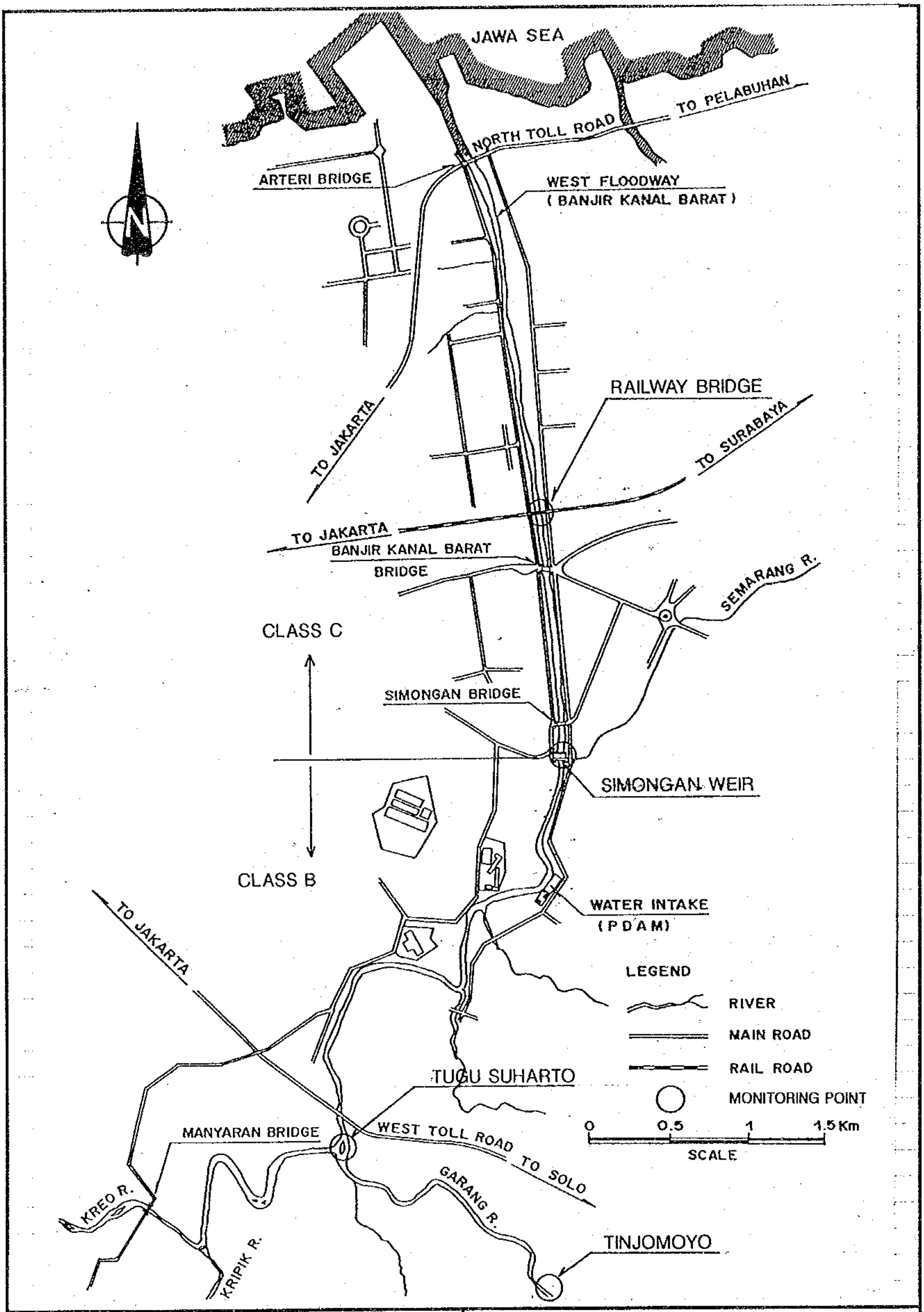
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VII.2.1 WATER SOURCES AND TRANSPORTATION SYSTEM OF PDAM SEMARANG CITY



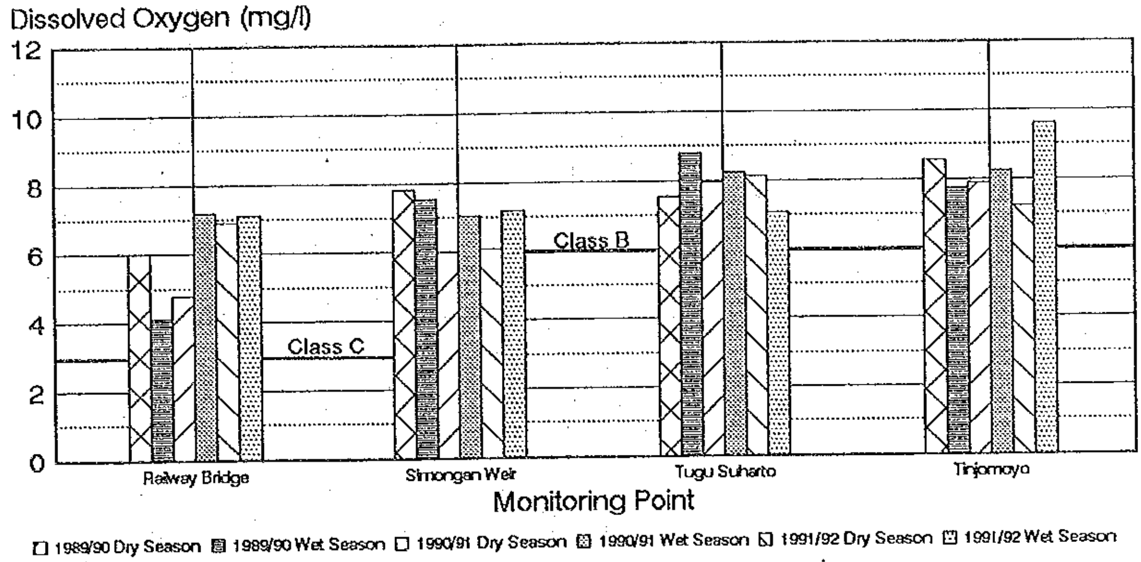
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.2.2 IRRIGATION AREA
JAPAN INTERNATIONAL COOPERATION AGENCY	

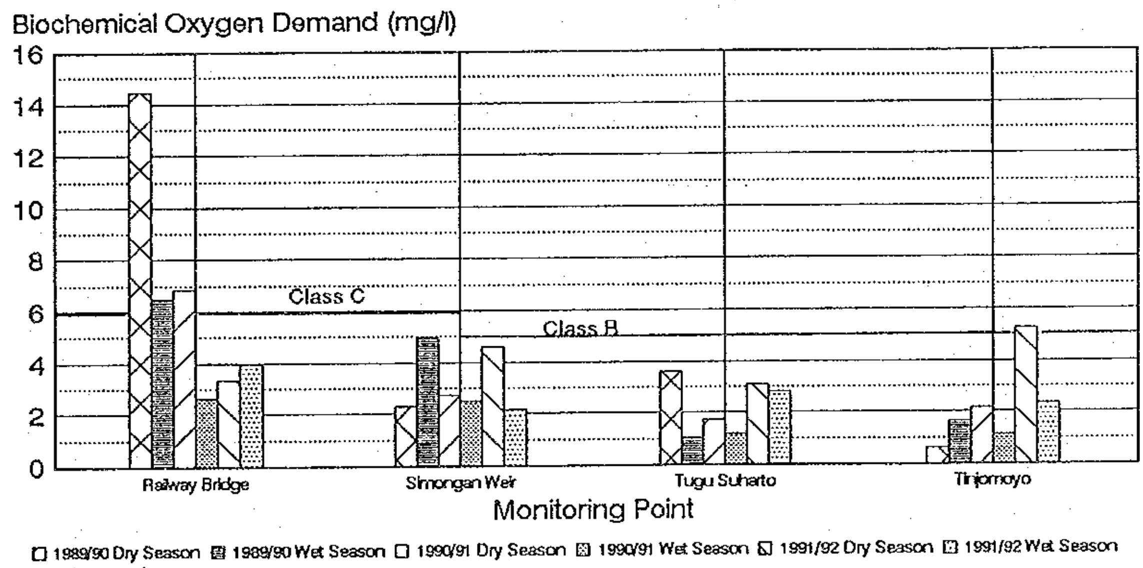


MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.2.3 LOCATION OF BRACKISH WATER AQUACULTURE
JAPAN INTERNATIONAL COOPERATION AGENCY	

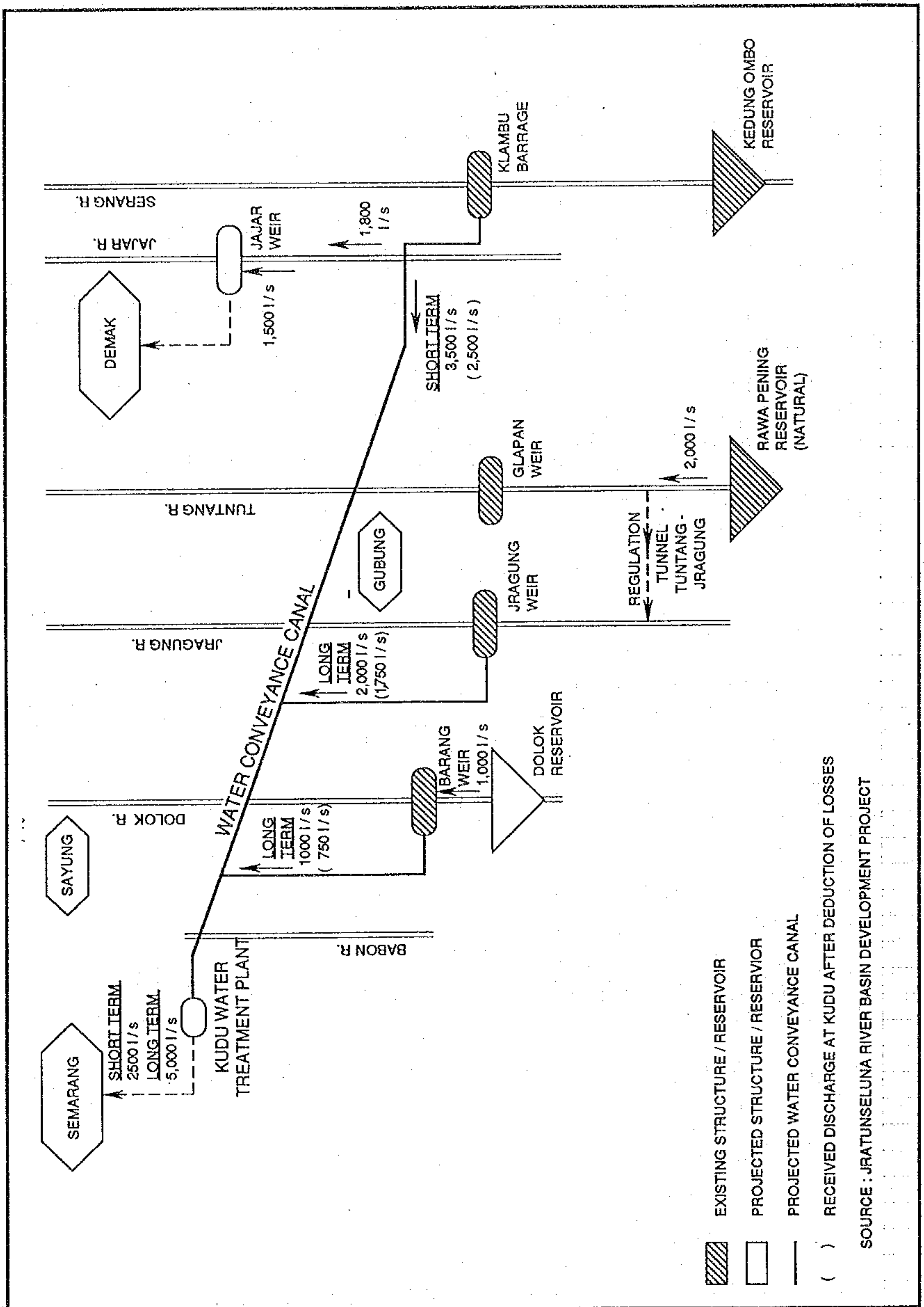


MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.2.4 WATER QUALITY CLASSIFICATION AND MONITORING POINTS
JAPAN INTERNATIONAL COOPERATION AGENCY	

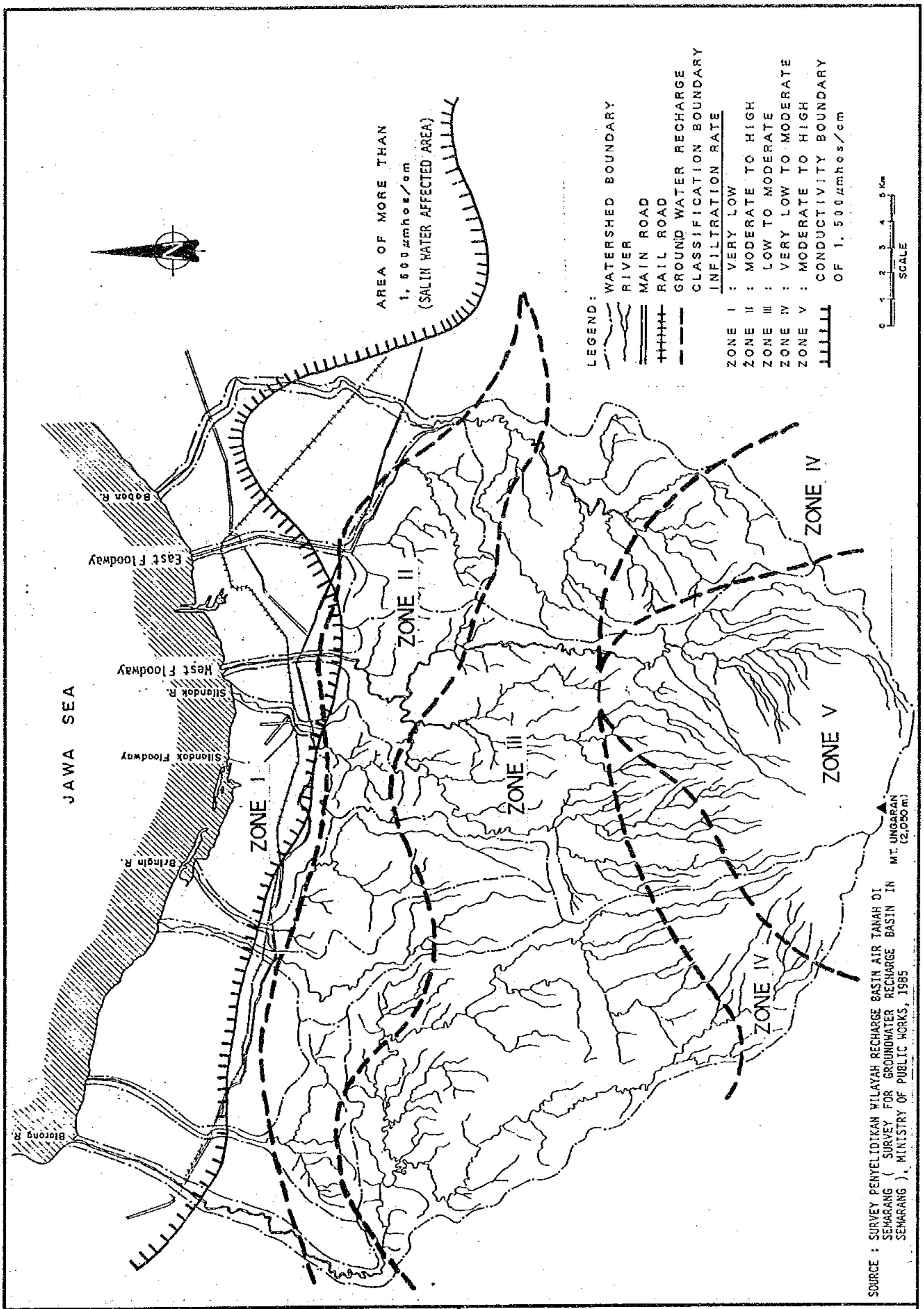




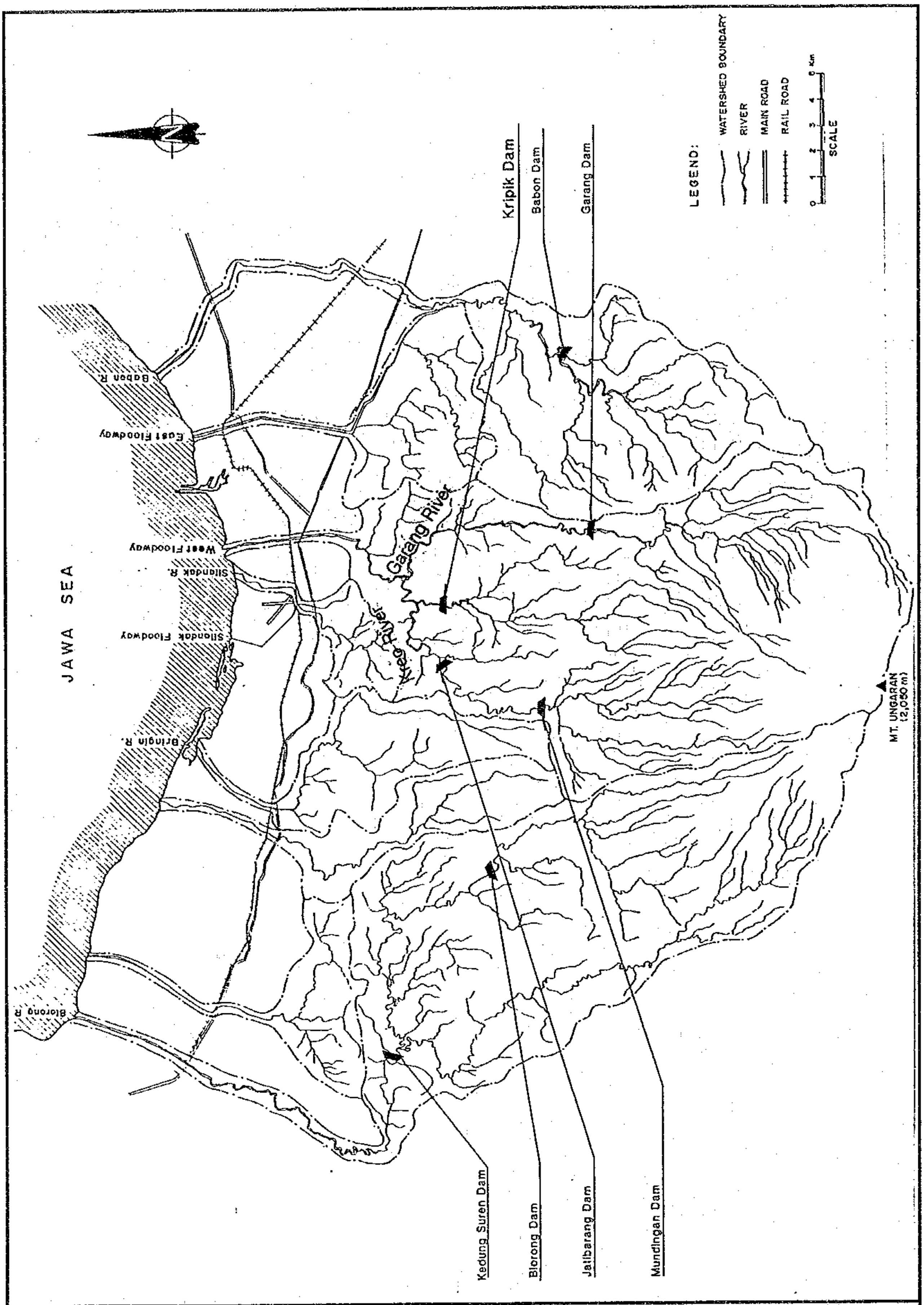
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.2.5 WATER QUALITY IN GARANG RIVER
JAPAN INTERNATIONAL COOPERATION AGENCY	



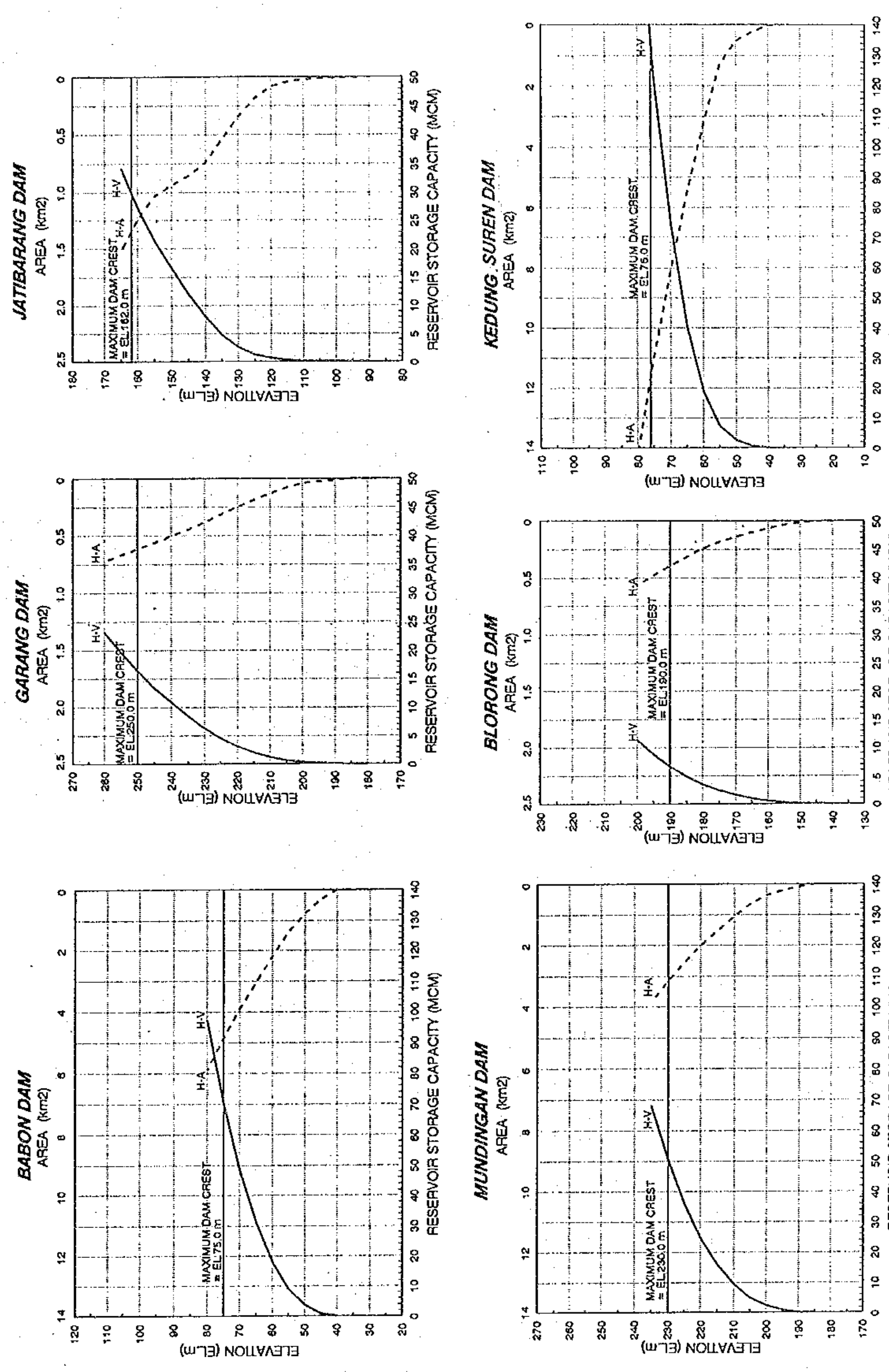
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.3.1 SCHEMATIC DIAGRAM OF WATER SUPPLY PLAN FOR DEMAK AND EASTERN SEMARANG AREAS
JAPAN INTERNATIONAL COOPERATION AGENCY	



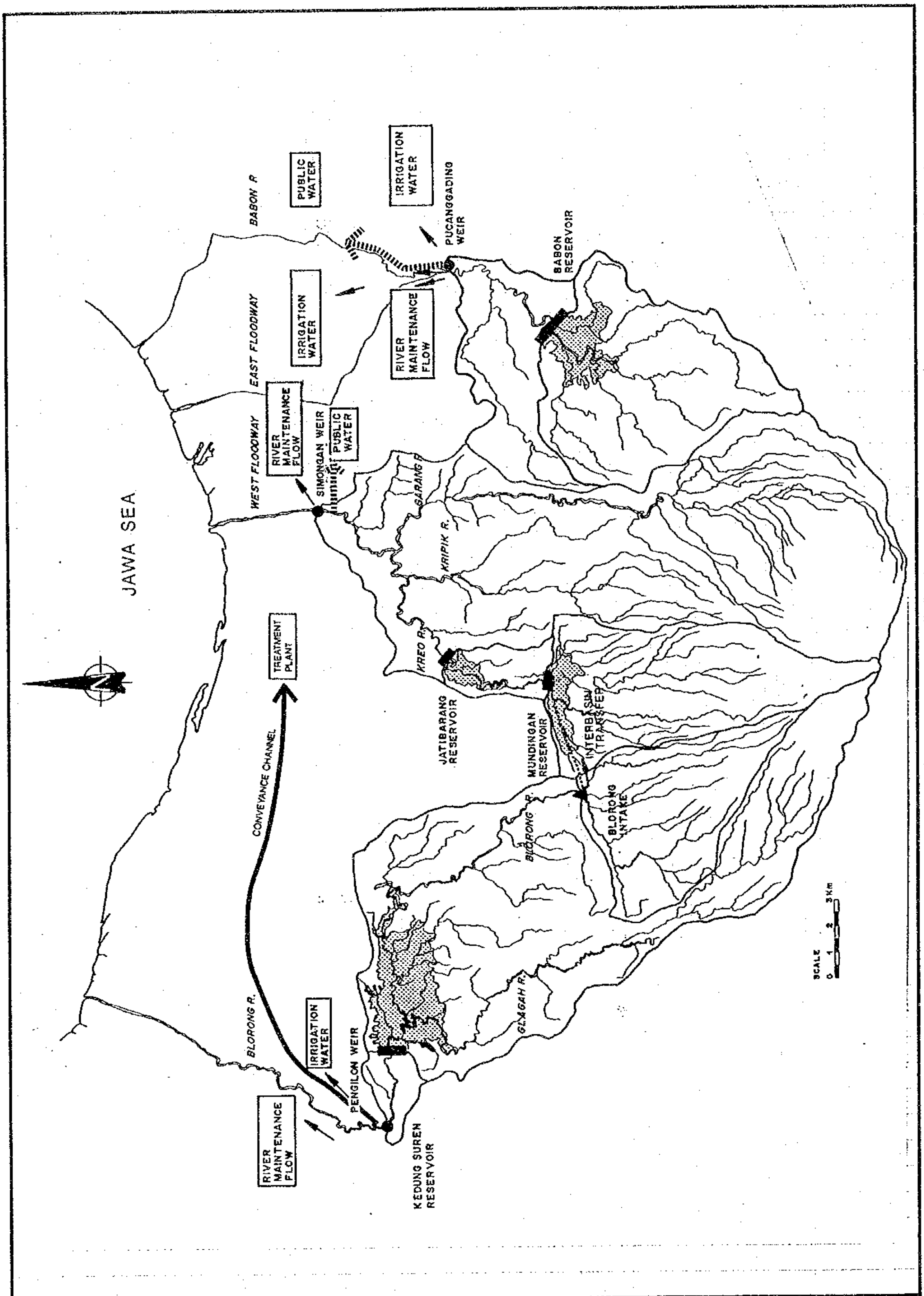
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.3.2 PRESENT CONDITION OF GROUNDWATER
JAPAN INTERNATIONAL COOPERATION AGENCY	



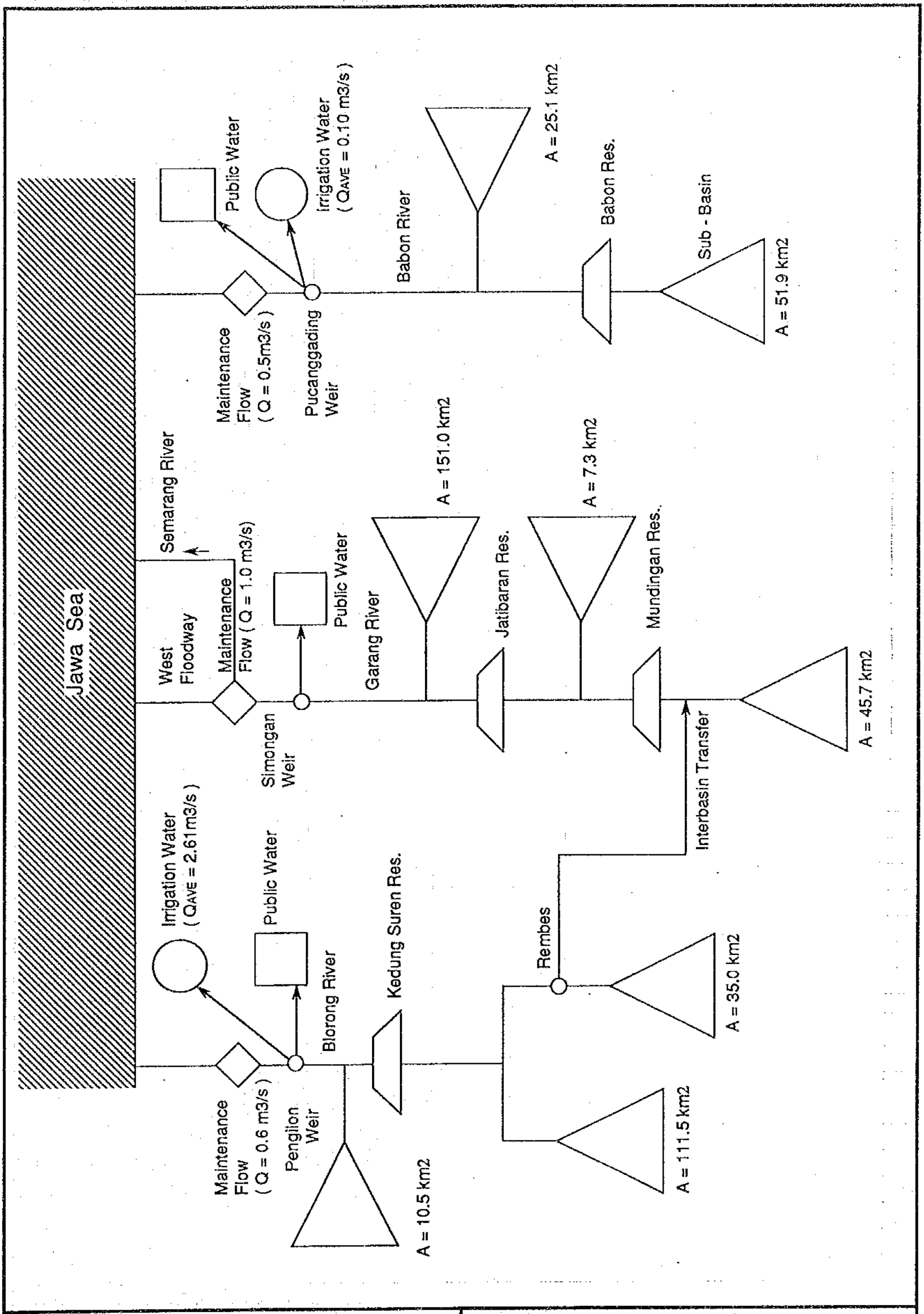
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VII.3.3 LOCATION OF POTENTIAL DAM SITES



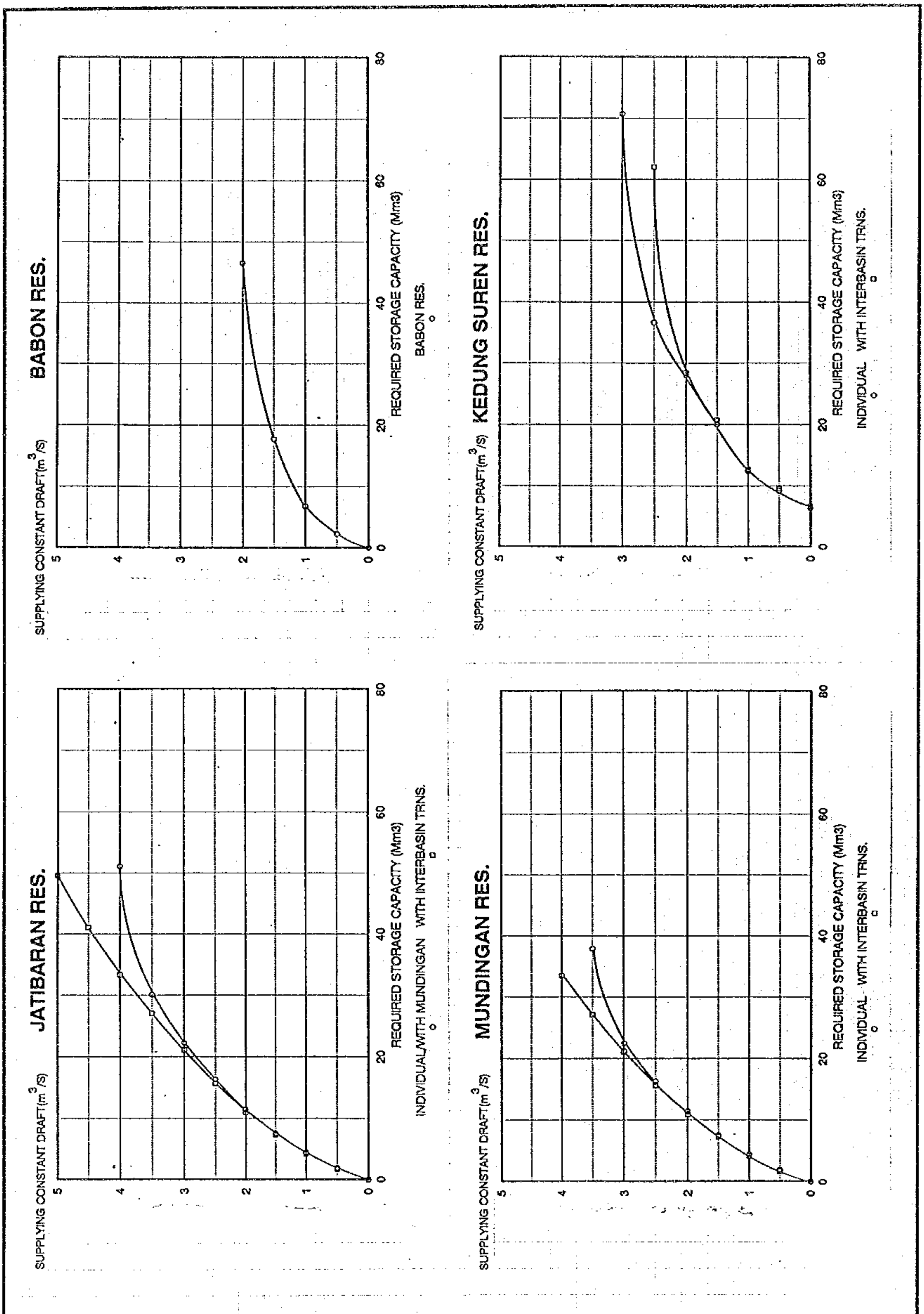
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.3.4 RESERVOIR STORAGE CURVES
JAPAN INTERNATIONAL COOPERATION AGENCY	



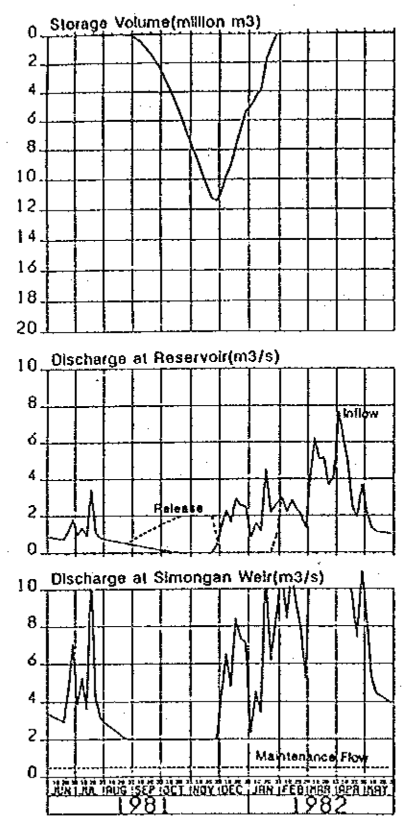
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.3.5 SCHEMATIC DIAGRAM OF WATER RESOURCES DEVELOPMENT PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY	



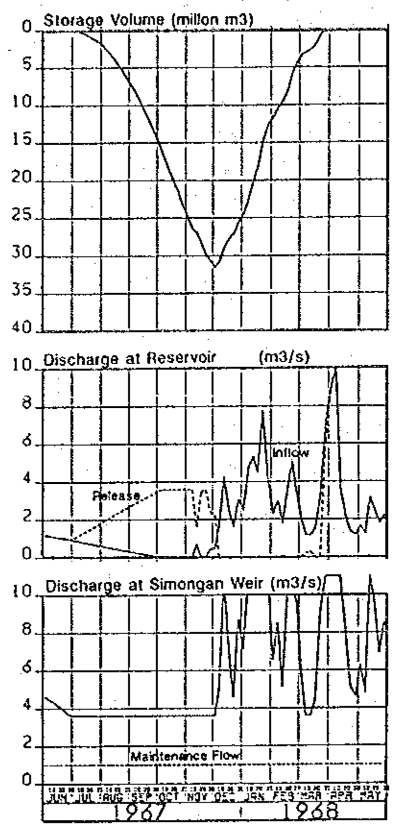
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.3.6 SCHEMATIC DIAGRAM OF WATER BALANCE MODEL
JAPAN INTERNATIONAL COOPERATION AGENCY	



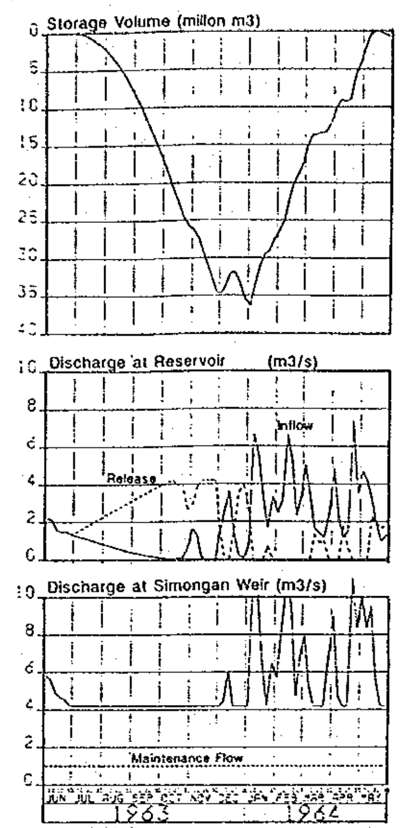
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VII.3.7 STORAGE-DRAFT CURVE



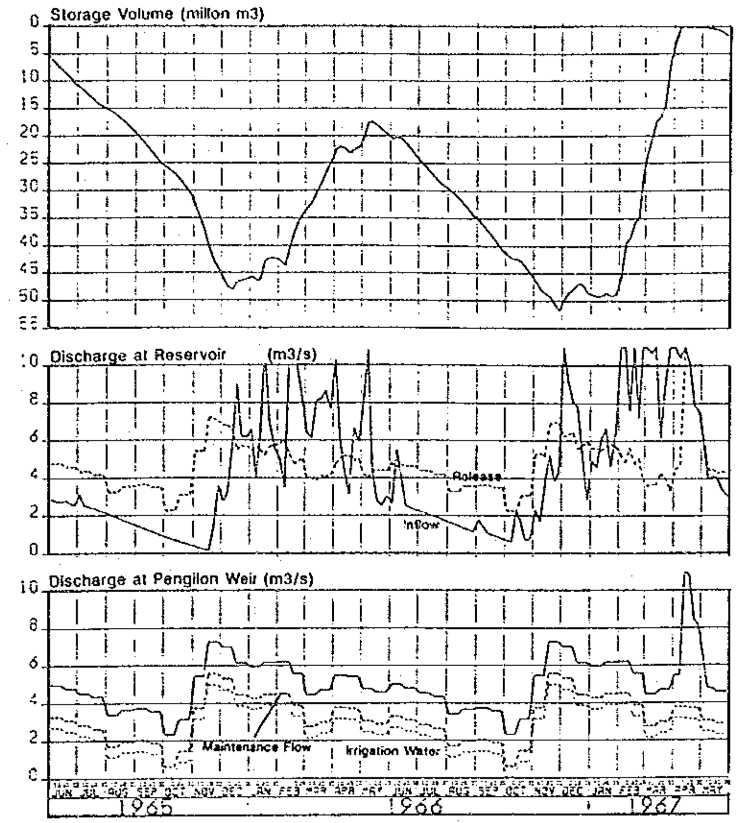
Jatibarang Res.



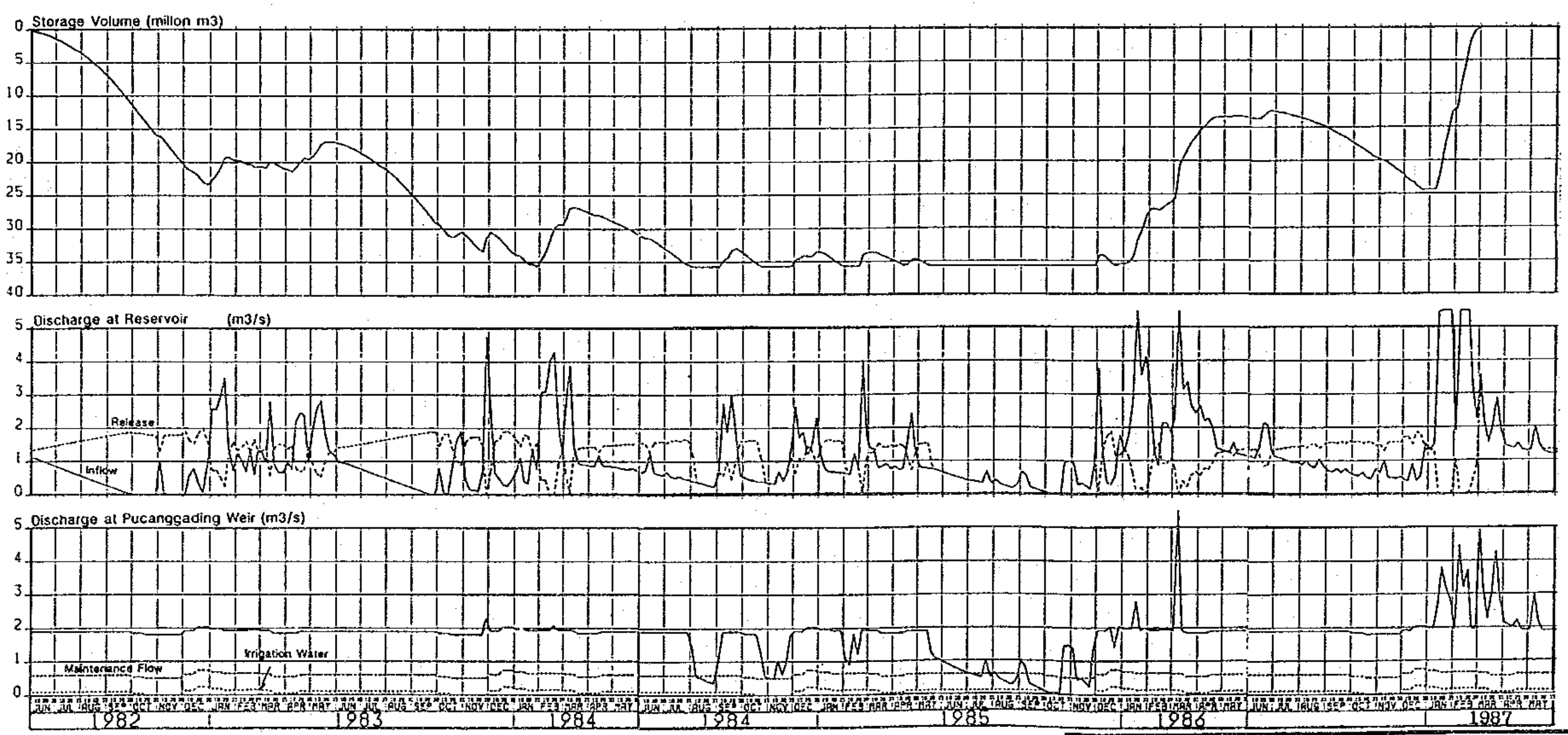
Series Res.
(Jatibarang & Mundingan)



Series Res. &
Interbasin Transfer

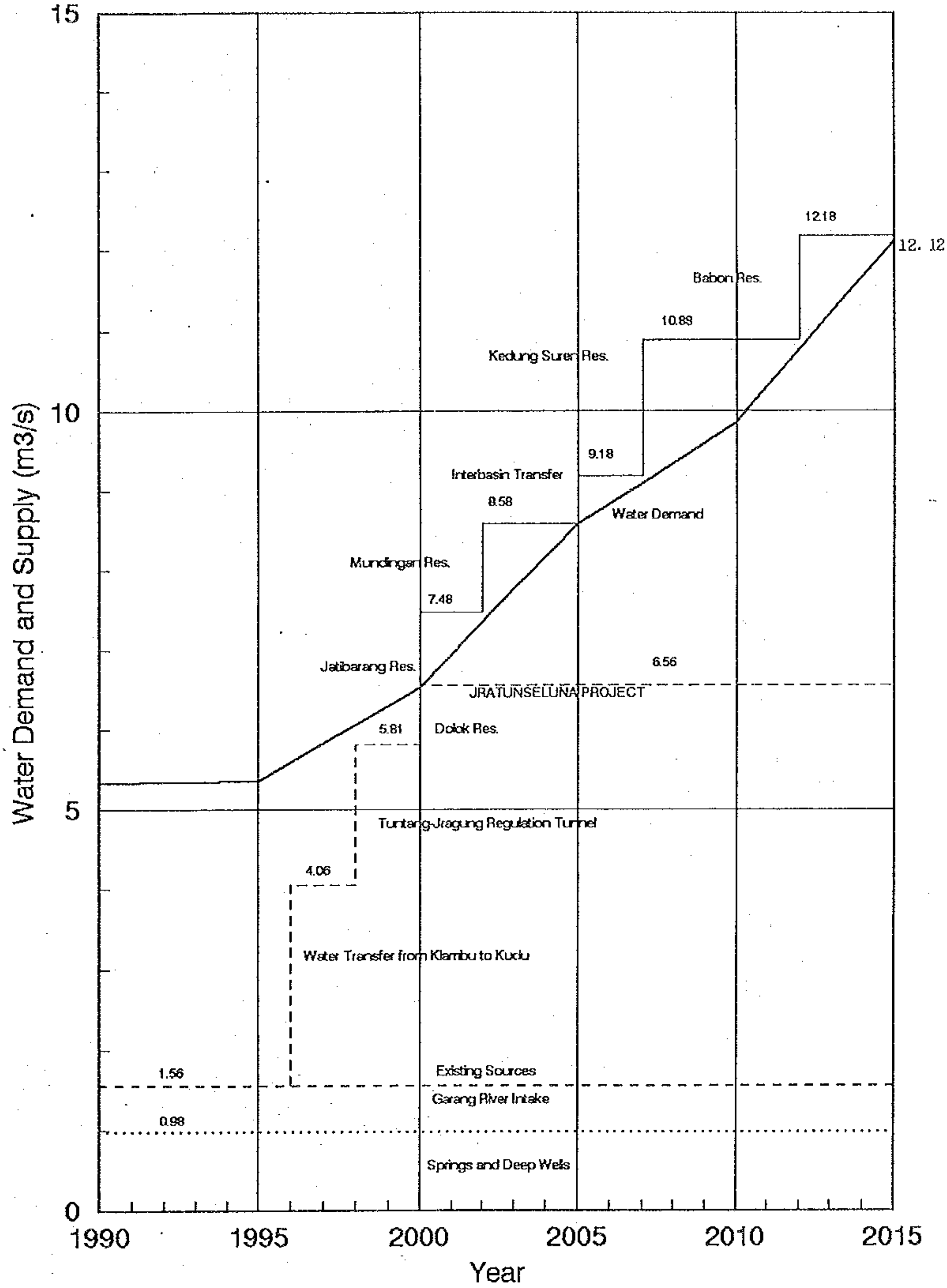


Kedung Suren Res.

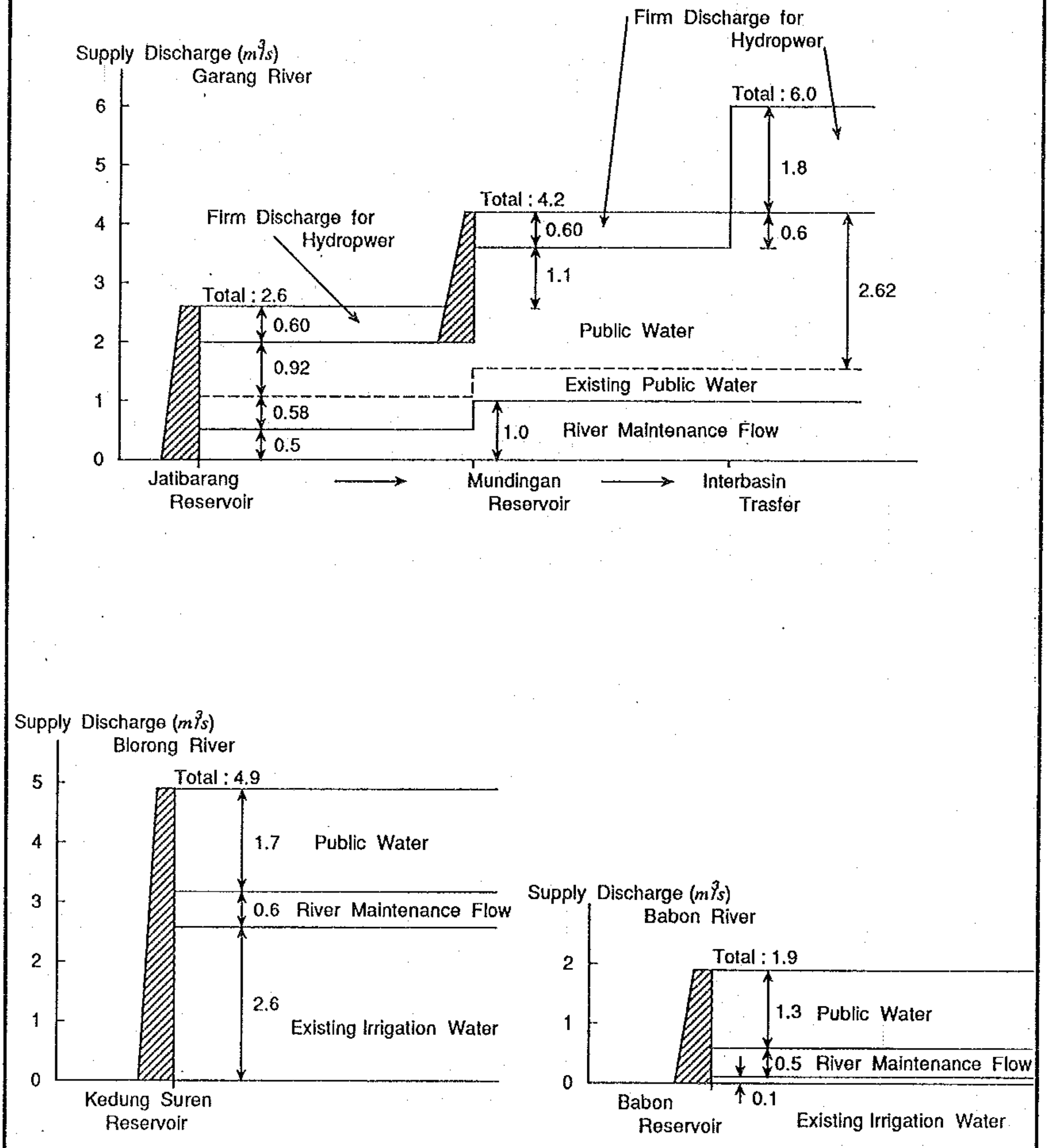


Babon Res.

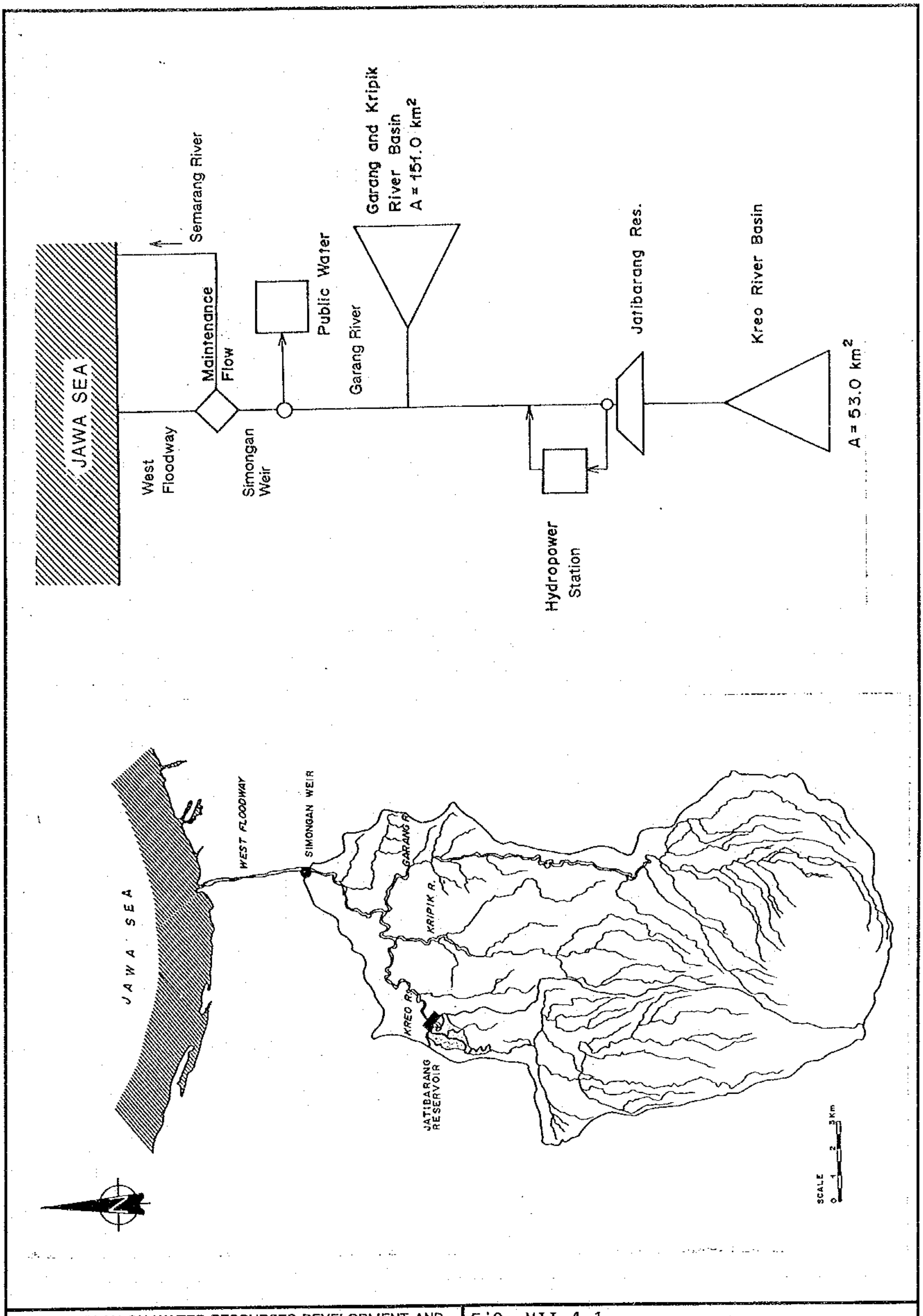
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VII.3.8 WATER BALANCE OF CRITICAL PERIOD IN A 10-YEAR DROUGHT CYCLE



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.3.9 PUBLIC WATER SUPPLY PROGRAMME
JAPAN INTERNATIONAL COOPERATION AGENCY	

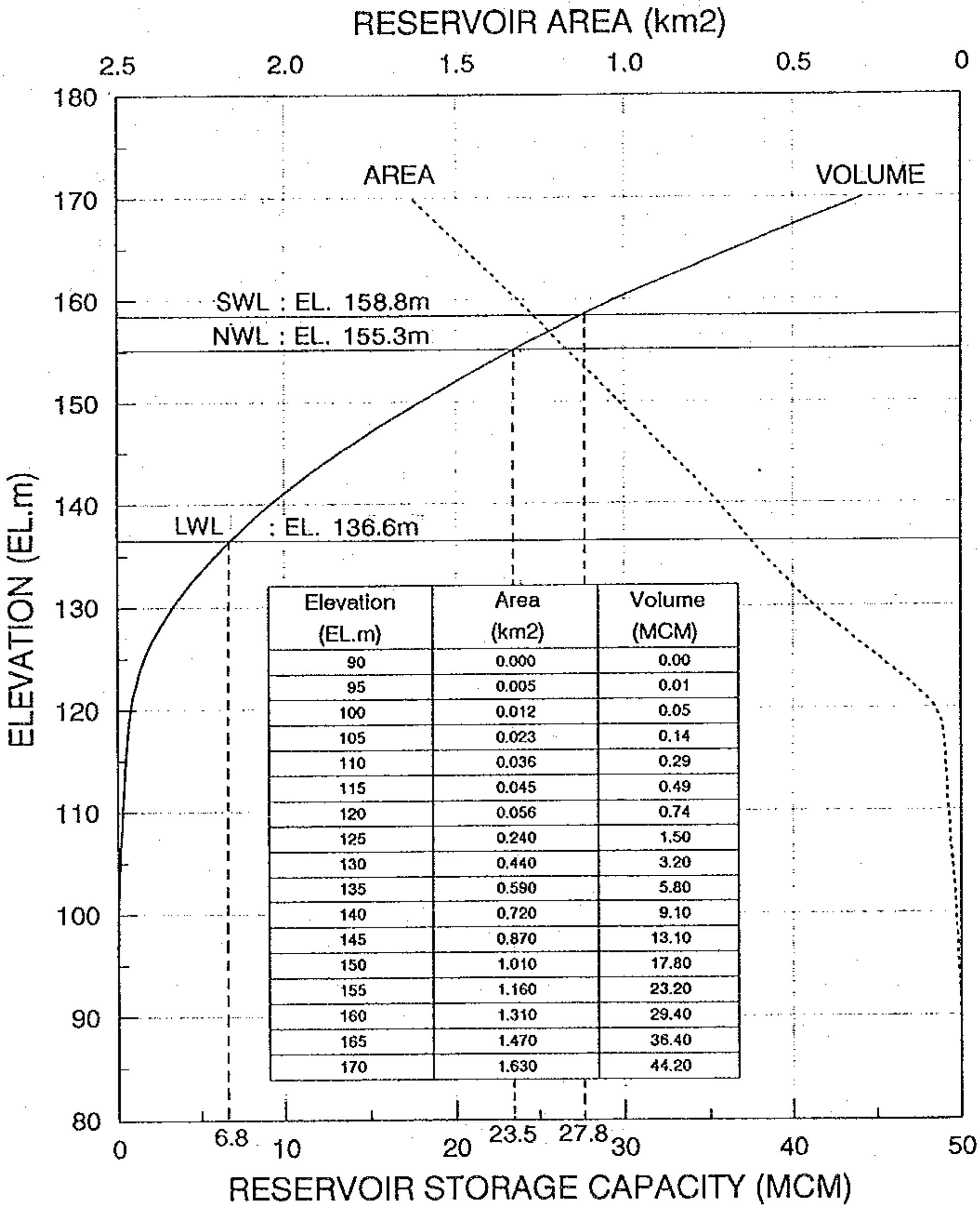


MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.3.10
JAPAN INTERNATIONAL COOPERATION AGENCY	WATER RESOURCES DEVELOPMENT PLAN BY RIVER SYSTEM



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	FIG. VII.4.1
JAPAN INTERNATIONAL COOPERATION AGENCY	LOCATION OF JATIBARANG RESERVOIR AND SCHEMATIC DIAGRAM OF WATER BALANCE MODEL

JATIBARANG DAM



Elevation (EL.m)	Area (km2)	Volume (MCM)
90	0.000	0.00
95	0.005	0.01
100	0.012	0.05
105	0.023	0.14
110	0.036	0.29
115	0.045	0.49
120	0.056	0.74
125	0.240	1.50
130	0.440	3.20
135	0.590	5.80
140	0.720	9.10
145	0.870	13.10
150	1.010	17.80
155	1.160	23.20
160	1.310	29.40
165	1.470	36.40
170	1.630	44.20

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

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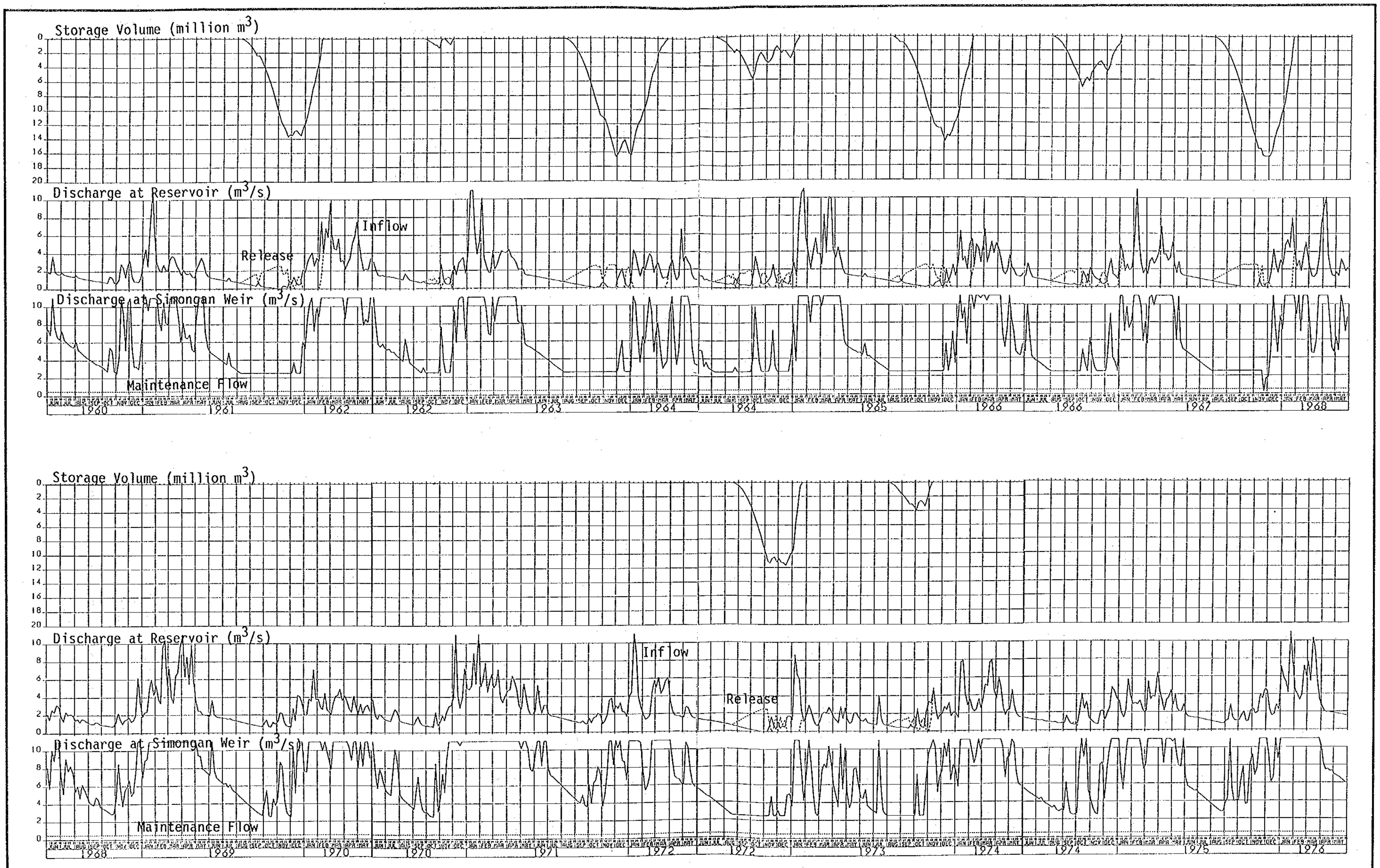
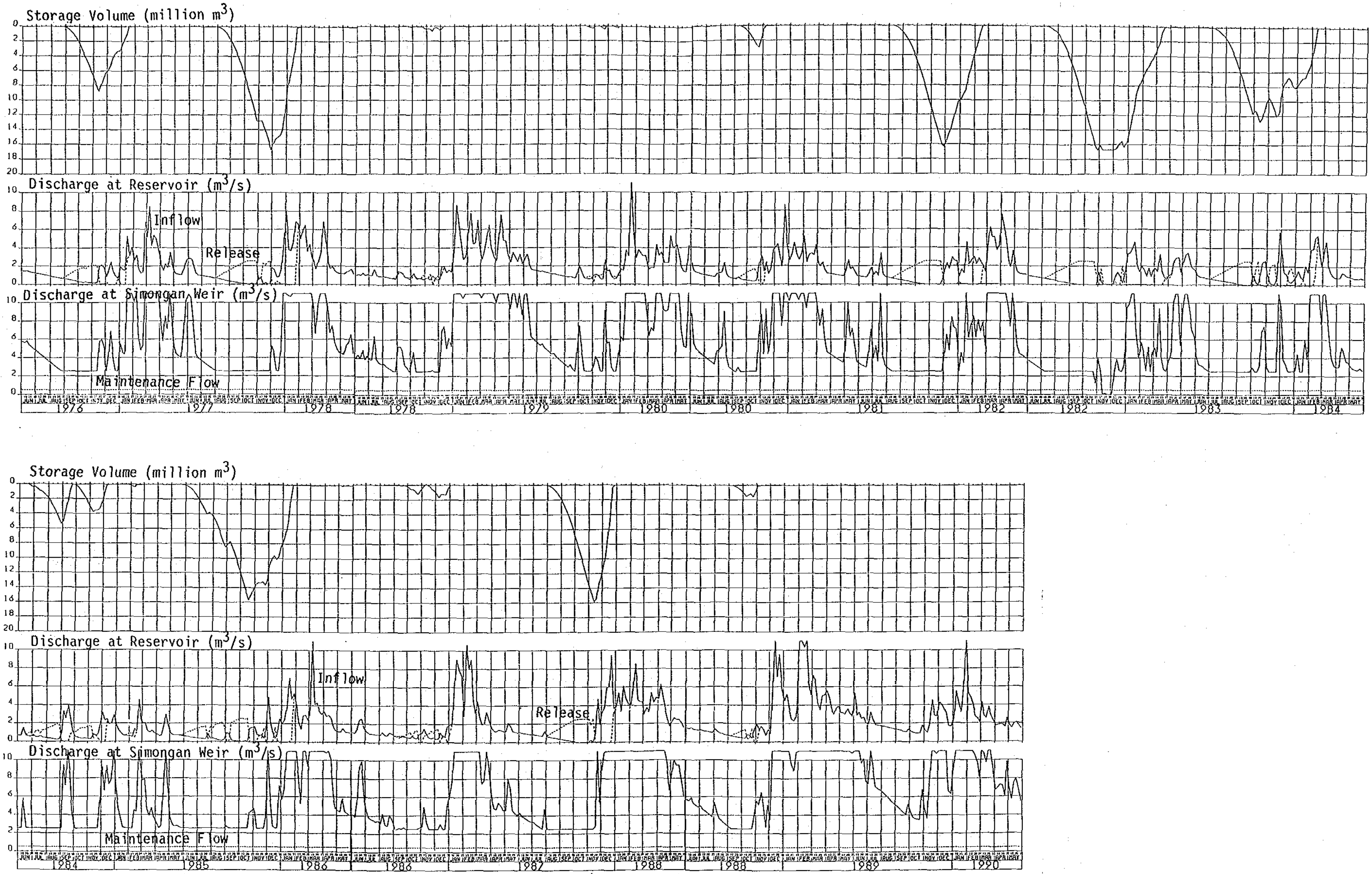
Fig. VII.4.2
STORAGE CURVE OF JATIBARANG RESERVOIR



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.4.3(1/2) JATIBARANG RESERVOIR OPERATION AND FLOW CONDITIONS
JAPAN INTERNATIONAL COOPERATION AGENCY	



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VII.4.3(2/2) JATIBARANG RESERVOIR OPERATION AND FLOW CONDITIONS
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VIII SEDIMENT CONTROL PLAN

VIII SEDIMENT CONTROL PLAN

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CHAPTER 1 GENERAL

As in other tropical countries, rivers in Indonesia discharge a great deal of sediment, especially during floods. Sediments usually settle on the alluvial plain downstream, or washed out into the sea.

The flow capacity of some rivers in the study area has decreased due to riverbed aggradation by heavy siltation which results in floods. On the other hand, heavy sedimentation causes degradation of reservoir storage functions.

This sector of the supporting report presents the results of the study on sedimentation in the study area, identifies the rivers with sedimentation problems, and proposes the basic concepts of the sediment control measures.

The present condition of sedimentation in the study area is discussed in CHAPTER 2, based on the results of the field investigation and riverbed material survey in the six target rivers conducted in the master plan study stage. Sediment yield is estimated in CHAPTER 3, in accordance with the mechanism of sediment production, and sediment balance in each river basin is also analyzed from the headwaters to the rivermouths.

CHAPTER 4 clarifies the sedimentation problems studied and analyzed in CHAPTER 3, and presents the basic concept of sediment control measures for watershed conservation where reservoirs are proposed in the Water Resources Development Plan, as well as the control measures for river channel siltation in Silandak River.

CHAPTER 2 SEDIMENT CONDITION

2.1 Present Sediment Condition in the Study Area

Field investigations and data collection had been executed to clarify the present condition of sedimentation in the study area. The results are summarized below, while the basin map and longitudinal profile of the respective rivers are presented in Fig. VIII.2.1.

(1) On the steep slope in the headwaters of the objective river basins, no new sediment yield due to large-scale collapse has been recognized.

(2) In the upper reaches of the respective rivers, deepening is a dominant function of streamflow; however, the riverbeds seem to be stable because of the armor with boulders.

(3) Sediment yield due to bank erosion with small collapse has been observed along the river bank in the middle and down stream, especially at the bending portion. The amount of sediment by bank erosion is, however, small.

(4) A great deal of sediment yield due to sheet erosion on upland cultivation areas has been observed and the sheet erosion seems to be a dominant source of sediment load. On the plantation land, there is only a little amount of sediment yield during heavy rains because of canopy interception and undergrowth cover by forests.

(5) Remarkable amounts of sediment deposit have been observed in the main courses of Silandak River and East Floodway at intersections and mild portions of the riverbed on the alluvial plains due to erosion in the developed land in the Silandak river basin and the transport of sediment from the upper reaches of Babon River to East Floodway.

(6) River mouth clogging has occurred in Bringin River due to the formation of a coastal sand dune by littoral current.

2.2 Present Condition of Riverbed Materials

According to the results of the river material survey as shown in Figs. VIII.2.2 and VIII.2.3, the characteristics of riverbed materials related to sedimentation are summarized as follows:

(1) In the lower part of rivers, i.e., the alluvial plain portion with a gentle gradient, the riverbed is formed mainly of silt and clay that have been transported as wash load.

(2) In the middle part of rivers on the hilly areas, the riverbed consists mainly of silt and clay; the biggest size seems to be coarse sand.

(3) In the upper reaches of rivers, the riverbed is formed only of gravel and sand.

On the above-mentioned situation, wash load having the particle diameter of less than 0.1 mm, a dominant source of sediment, do not exist in the riverbeds of the upper reaches. This fact shows that once the wash load, which is produced mainly by sheet erosion, flows into the river streams, these small particles are directly drained out into the middle and lower reaches and settle there or are washed out into the coastal areas.

CHAPTER 3 ANALYSIS ON SEDIMENT YIELD AND BALANCE

3.1 Analysis on Sediment Yield

Sediment yield in the study area is classified into two modes; namely, wash load from the drainage basins and bed material load from the river channels. Based on the field investigation, the main mechanism of production of each load is schematically shown below. Sheet erosion is a dominant source of sediment yield in the study area.

- Sediment Yield
  - Wash Load
    - Sheet Erosion
    - Bank Erosion
  - Bed Load
    - Bed Load Transport

Sediment yield is estimated in line with the above three categories.

(1) Sheet Erosion

The Universal Soil Loss Equation (USLE) which is broadly applied, is adopted to the estimation of sheet erosion volume. Table VIII.3.1 and Fig. VIII.3.1 show the results of sheet erosion estimation for each 1-km mesh, converting the unit from ton to m^3 and using the specific soil gravity of 2.65 tons/m^3. The USLE formula is expressed as follows, and the details of each factors are also described below:

$$E = R*K*LS*C*P$$

where,

E = *average annual soil loss in ton/ha*

R = *rainfall factor*
K = *soil erodibility factor*
LS = *slope gradient-length factor*
C = *cropping management factor*
P = *supporting conservation practice factor*

Rainfall Factor *R*

Rainfall factor *R* is derived from the summation of individual storm products of kinetic energy of rainfall multiplied by the maximum 30-min rainfall intensity, for all significant storms with a total depth of more than 13 mm. Rainfall factor and kinetic energy of rainfall are expressed by:

$$R = \Sigma Ek * I_{30}$$

$$Ek = [916 + 331 \log (I/25.4)] * 0.0296r$$

where,

Ek = *kinetic energy in mt/ha*
I_{30} = *maximum 30-min rainfall intensity in mm/hr*
I = *average rainfall intensity in mm/hr*
r = *rainfall amount in mm*

The rainfall station in the study area where rainfall data have been observed on the minute basis is only the Semarang Meteorological Station. The rainfall factor *R* of 3,214 is derived through the above-mentioned methodology from the rainfall records in 1989, as an average year in comparison with the latest 10 year's rainfall amount. The process of estimation is shown in Table VIII.3.2.

Soil Erodibility Factor *K*

The soil condition of the study area is divided into six categories, and in line with each category the following *K* values are applied on the basis of previous studies executed by the Ministry of Forest. The distribution of soil cover is shown in Fig. VIII.3.2.

Soil Erodibility Factor K

	Soil Cover	K value
1.	Gray Alluvium	0.05
2.	Brown Mediteron	0.26
3.	Brown Latosol	0.26
4.	Red Brown Latosol	0.26
5.	Regosol Complex	0.50
6.	Brown Andosol	0.38

Slope Gradient-Length Factor *LS*

The slope gradient of the study area is clarified on 1-km meshes on the basis of previous studies, as shown in Fig. VIII.3.3. The factor *LS* is derived from Taneda's formula which is expressed by:

$$LS = L^{1/2} (0.067S + 0.952S^2)$$

where,

L = *length of slope in m*
S = *land gradient measured as tangent*

Cropping Management Factor *C*

Land use condition of the study area is divided into five categories, and the following *C* values are applied for each category on the basis of previous studies and field investigation. The distribution of land use is shown in Fig. VIII.3.4.

Cropping Management Factor C

	Land Use	C value	Remarks
1.	Forest	0.001	
2.	Upland Cultivation	0.50	including mixed plantation
3.	Paddy Field	0.01	
4.	Plantation	0.01	
5.	Village	0.15	30% of upland cultivation's value

Supporting Conservation Practice Factor P

In accordance with the land use pattern, the following P values are applied on the basis of previous studies and field investigation.

Supporting Conservation Practice Factor P

Land Use		P value
1.	Forest	0.5
2.	Upland Cultivation	0.4
3.	Paddy Field	0.04
4.	Plantation	0.5
5.	Village	0.4

(2) Bank Erosion

Sediment yield due to bank erosion, riverbed erosion (including secondary erosion of deposits) and collapse of river bank are estimated based on the valley order analysis of the Holton's Law using topographical maps of 1:50,000 scale. The following sediment yield by bank erosion per unit length of river channel, which is set up based on the field survey, are applied to each river to estimate the annual sediment volume by valley order.

Sediment Yield by Bank Erosion
Per Unit Channel Length

Valley Order	Bank Erosion Rate (m^3/km/yr)
1st	15
2nd	25
3rd	30
4th	120
5th	135

Results of the estimation of sediment yield by bank erosion are shown in Table VIII.3.3.

(3) Wash Load

The summary of wash load due to sheet and bank erosion is given as follows:

Summary of Wash Load
(Unit: 1000 m^3/year)

River Basin	Sheet Erosion	Bank Erosion	Total
Babon	384.2	6.2	390.4
East Floodway	84.1	2.2	86.3
Garang	930.3	16.5	946.8
Silandak	77.5	0.9	78.4
Bringin	109.7	1.6	111.3
Blorong	545.1	11.0	556.1

(4) Bed Load Transport

The volume of bed load transport can be estimated by the sediment transportability between stream power and riverbed materials. Bed load transport is generated by the tractive force of water running toward the downstream direction against the riverbed material. To estimate the volume of bed load transport, Ashida and Michiue's Formula is employed and the following basic factors are applied:

- Riverbed Material: adopted from the results of riverbed material survey

- Flow Discharge : adopted from the average flow regime (refer to CHAPTER 6 of SECTOR I, METEOROLOGY AND HYDROLOGY)

- Channel Width : Regime Theory, $B = aQ^{1/2}$
  where,
  B = flow width in m
  a = constant (0.7)
  Q = flow discharge in m^3/s

The results of estimation of bed load transport are given in Table VIII.3.4.

3.2 Analysis on Sediment Balance

(1) Sediment Balance

Sediment balance was studied from the upstream to the downstream. The sediment balance analysis in each river basin was conducted using the amounts of wash load and bed load obtained in the preceding section. The results of sediment balance study in the study area are shown in Table VIII.3.5 and Fig. VIII.3.5.

Based on the results, net quantities of sediment discharge into the lower reaches of the respective rivers and sediment inflow into the potential reservoirs which are proposed in CHAPTER 3 of SECTOR VII, WATER RESOURCES DEVELOPMENT PLAN, are summarized below.

Sediment Discharge into Lower Reaches

River Basin	Catchment Area (km^2)	Annual Sediment Discharge ($1000m^3/yr$)	Specific Sediment Discharge ($m^3/km^2/yr$)
Babon	77.0	109.7	1,425
East Floodway	29.7	40.1	1,351
Garang	204.0	240.2	1,177
Silandak	8.5	22.3	2,624
Bringin	32.1	29.5	919
Blorong	157.0	171.6	1,093

Sediment Inflow into Potential Reservoirs

Reservoir	Catchment Area (km^2)	Annual Sediment Discharge ($1000m^3/yr$)	Specific Sediment Discharge ($m^3/km^2/yr$)
Babon River			
- Babon	51.9	83.9	1,619
Garang River			
- Garang	70.9	112.7	1,590
- Mundingan	45.7	60.4	1,321
- Jatibarang	53.0	56.3	1,062
Blorong River			
- Blorong	50.5	67.7	1,340
- Kedung Suren	146.5	165.5	1,130

According to these results, the specific sediment discharge in Silandak River is quite high in relation to the present conditions observed as described in Section 2.1. On the other hand, the specific sediment discharge in

East Floodway from its own drainage basin is on the average in comparison with other rivers, showing that the heavy siltation in the channel has been caused by floodwaters from the upper reaches of Babon River.

(2) Study Procedure

The following procedure was applied to estimate sediment balance:

(a) Wash Load

Transportability of wash load was commonly determined so as to apply the sediment-rating curves derived from the sediment-discharge relationship through the sampling of suspended sediments, especially during floods. Since sediment-rating curves have not been established in the target rivers, the following sediment delivery ratio (refer to Sedimentation Engineering prepared by ASCE) is applied to the sediment discharge of sheet erosion out of the subbasins.

Wash load discharge by sheet erosion from the subbasin is calculated by multiplying the sediment yield of sheet erosion by the delivery ratio, and the remaining amount means the deposit within the subbasin.

Sediment Delivery Ratio

Catchment Area (km^2)	Delivery Ratio
A < 5	30%
5 < A < 10	25%
10 < A < 20	20%

Sediment yield by bank erosion and sediment discharge of sheet erosion washed out of the subbasin are assumed to be carried to the downstream without depositing in the river channel on the basis of the investigation on riverbed material survey.

(b) Bed Load

Bed load balance can be simply estimated by striking a balance between inflow and transportability. In case sediment inflow exceeds sediment transportability, the difference between the two values means the quantity of deposit.

CHAPTER 4 SEDIMENT CONTROL PLAN

4.1 Sedimentation Problems

As described in Section 2.1, considering the Flood Control Plan and the Water Resources Development Plan, the problems on sedimentation in the study area can be pointed out as follows:

(1) Excess Design Sediment Inflow into Reservoirs

The dead storage of the reservoirs proposed in the Water Resources Development Master Plan is estimated from the results of sediment balance analysis. The amount of sediment inflow, however, has quite a great uncertainty because of the limited information, and the excess sediment inflow has sometimes occurred and damaged the reservoir function due to loss of the effective storage. Therefore, the sediment control plan over the reservoir watershed shall be established to ensure the effective storage against the potential excess sediment inflow.

(2) River Channel Siltation

Silandak River and East Floodway have the most serious problems of river channel siltation and flow capacity has been reduced by riverbed aggradation.

4.2 Sediment Control for Reservoir Watershed

As described in the foregoing section, the dominant sediment inflow consists of small particles produced by sheet erosion on the basin-wide fields. Based on the above-mentioned circumstances, the following measures are recommended.

(1) Forest Conservation

Only a small forest reserve area is to be designated to preserve plants in the watershed of the proposed reservoirs. The forest areas, however, remain in the headwaters of each river basin. As described in Section 2.1, Present Sediment Condition in the Study Area, the forest area is effective in preventing sediment yield by sheet erosion. From this point of view, the forest and plantation areas to be densely covered by trees shall be conserved continuously as a forest conservation area (refer to Fig. VIII.4.1). These efforts will affect water conservation as well as soil conservation by the increase in low flow discharge in streams and groundwater recharge.

(2) Small-Scale Level Terraces

Upland cultivation areas are divided into small lots in accordance with land ownership, so that large-scale land treatment measures such as contour strip-cropping and gradient terraces are inadequate for the study area. Where the soil is covered thickly, the slope of upland cultivation areas shall be reformed into small-scale level terraces. To complete this measure over the watershed, however, takes a long period.

4.3 Sediment Control for River Channel Siltation

As described in this section, heavy siltation has occurred in the middle reaches of East Floodway and the lower reaches of Silandak River. According to the Flood Control Plan of Babon River, the existing diversion gate of East Floodway is planned in the master plan stage to close during floods to divert floodwaters from the upper reaches of Babon River only into the lower Babon River and Babon Floodway at the Pecanggading Weir, so that East Floodway will not receive flood water anymore from Babon River in flood time. Considering this situation, the siltation problem in East Floodway will not develop further.

On the other hand, the situation of Silandak River is quite different. According to the Flood Control Plan of Silandak River, floodwaters will be drained only through the Silandak Floodway in the lower reaches. At present, heavy siltation has occurred at just the lower portion of the diversion point between Silandak River and Silandak Floodway. Therefore, sediment control measures are needed to be introduced in the Silandak river basin to keep the design channel cross section. The detailed basin condition and the proposed sediment control measures are as follows:

(1) Identification of Devastated Areas

If the devastated area can be identified, especially in the small basins such as the Silandak river basin, sediment control measures become more effective as urgent countermeasures. Through the field and aerophotographic investigations, two devastated areas are identified in the basin. One is the bare land in the headwaters having an area of approximately 20 ha. The other is the quarry at just the down part of the hilly area of approximately 40 ha. These areas are shown in Fig. VIII.4.2.

(2) Proposed Countermeasures

In the upper reaches of Silandak River, stepped gabion dams are proposed to trap the wash load by utilizing their permeability. The gabion dams have the advantage of low cost and flexibility to riverbed variation in comparison with the concrete type dams. Fig. VIII.4.3 illustrates the standard features of the proposed gabion dam.

Sedimentation basin is proposed at the quarry to settle down the eroded materials by raindrop. This facility shall be placed on the downmost part of the quarry area and designed as an excavated type in accordance with the site conditions. According to the guideline for disaster prevention works in Japan, the specific sediment inflow is estimated at 300 m^3/ha/year to 500 m^3/ha/year. The capacity of the sedimentation basin is designed in a half-year or one-year sediment inflow, on the premise that excavation works in the sedimentation basin shall be carried out with those intervals. The standard features of the proposed sedimentation basin is presented in Fig. VIII.4.4.

To prevent disaster by storm water and heavy sedimentation during the construction of land development works in Japan, many related works have been dealt with such as the disaster prevention ponds, sedimentation basins and small-scale ring levees. Fig. VIII.4.5 illustrates the typical types of these facilities according to the guideline in Japan.

TABLES

Table VIII.3.1(1/7) AVERAGE ANNUAL SOIL LOSS BY SHEET EROSION

BABON RIVER BASIN

Sub Basin	Mesh No.	Soil Erodibility Class	Soil Erodibility K	Slope LS	Land Use Pattern Class	Land Use Pattern C	P	Average Annual Soil Loss (m3/ha/yr)	Sub Basin Total (1000m3/yr)
BA-1	E-28	4	0.26	0.13	3	0.010	0.040	0.0	
	E-29	4	0.26	0.13	4	0.001	0.500	0.0	
	F-29	4	0.26	0.13	2	0.500	0.400	8.4	
	F-30	4	0.26	0.13	4	0.001	0.500	0.0	
	G-29	4	0.26	0.13	2	0.500	0.400	8.4	
	G-30	4	0.26	0.13	1	0.001	0.500	0.0	
	G-31	4	0.26	0.13	4	0.001	0.500	0.0	
	H-31	4	0.26	0.13	1	0.001	0.500	0.0	
	H-32	4	0.26	0.13	4	0.001	0.500	0.0	
	I-31	4	0.26	1.63	1	0.001	0.500	0.3	
	I-32	4	0.26	4.43	2	0.500	0.400	279.3	
	J-31	2	0.26	1.63	2	0.500	0.400	102.7	
	J-32	4	0.26	4.43	2	0.500	0.400	279.3	
	K-31	2	0.26	0.13	2	0.500	0.400	8.4	68.7
BA-2	G-28	4	0.26	1.63	2	0.500	0.400	102.7	
	H-27	4	0.26	4.43	1	0.001	0.500	0.7	
	H-28	4	0.26	0.13	1	0.001	0.500	0.0	
	H-29	2	0.26	1.63	1	0.001	0.500	0.3	
	H-30	4	0.26	1.63	1	0.001	0.500	0.3	
	I-27	2	0.26	4.43	1	0.001	0.500	0.7	
	I-28	2	0.26	1.63	1	0.001	0.500	0.3	
	I-29	2	0.26	1.63	1	0.001	0.500	0.3	
	I-30	2	0.26	1.63	1	0.001	0.500	0.3	
	J-28	2	0.26	1.63	1	0.001	0.500	0.3	
	J-29	2	0.26	1.63	2	0.500	0.400	102.7	
	J-30	2	0.26	1.63	2	0.500	0.400	102.7	
	K-30	2	0.26	0.13	2	0.500	0.400	8.4	31.9
BA-3	J-26	4	0.26	0.13	2	0.500	0.400	8.4	
	J-27	2	0.26	4.43	2	0.500	0.400	279.3	
	K-27	2	0.26	1.63	2	0.500	0.400	102.7	
	K-28	2	0.26	1.63	2	0.500	0.400	102.7	
	K-29	2	0.26	1.63	2	0.500	0.400	102.7	
	L-29	2	0.26	1.63	2	0.500	0.400	102.7	
	L-30	2	0.26	0.13	2	0.500	0.400	8.4	70.7
BA-4	K-26	4	0.26	0.13	5	0.150	0.400	2.5	
	L-26	4	0.26	0.78	2	0.500	0.400	49.5	
	L-27	4	0.26	0.78	2	0.500	0.400	49.5	
	L-28	2	0.26	1.63	2	0.500	0.400	102.7	
	M-26	4	0.26	0.13	2	0.500	0.400	8.4	
	M-27	4	0.26	0.78	2	0.500	0.400	49.5	
	M-28	2	0.26	0.78	2	0.500	0.400	49.5	
	M-29	2	0.26	1.63	2	0.500	0.400	102.7	
	M-30	2	0.26	0.13	3	0.010	0.040	0.0	
	N-28	2	0.26	0.78	2	0.500	0.400	49.5	
	N-29	2	0.26	4.43	2	0.500	0.400	279.3	
	N-30	2	0.26	1.63	2	0.500	0.400	102.7	84.5
BA-5	M-31	2	0.26	0.13	3	0.010	0.040	0.0	
	N-31	2	0.26	1.63	2	0.500	0.400	102.7	10.3
BA-6	K-32	2	0.26	4.43	2	0.500	0.400	279.3	
	K-33	4	0.26	0.78	2	0.500	0.400	49.5	
	L-31	2	0.26	0.13	2	0.500	0.400	8.4	
	L-32	2	0.26	1.63	3	0.010	0.040	0.2	
	L-33	2	0.26	1.63	2	0.500	0.400	102.7	
	L-34	2	0.26	0.13	2	0.500	0.400	8.4	
	M-32	2	0.26	1.63	2	0.500	0.400	102.7	55.1
BA-7	M-33	2	0.26	1.63	2	0.500	0.400	102.7	
	N-32	2	0.26	0.13	3	0.010	0.040	0.0	
	N-33	2	0.26	0.13	2	0.500	0.400	8.4	
	O-33	2	0.26	0.13	2	0.500	0.400	8.4	
	O-34	2	0.26	0.13	2	0.500	0.400	8.4	12.8
BA-8	N-26	4	0.26	0.13	2	0.500	0.400	8.4	
	N-27	4	0.26	0.13	2	0.500	0.400	8.4	
	O-26	4	0.26	0.13	5	0.150	0.400	2.5	
	O-27	4	0.26	0.13	2	0.500	0.400	8.4	
BA-8	O-28	2	0.26	0.13	3	0.010	0.040	0.0	
	P-27	4	0.26	0.13	2	0.500	0.400	8.4	
	P-28	4	0.26	0.13	3	0.010	0.040	0.0	
	P-29	2	0.26	0.13	3	0.010	0.040	0.0	
	Q-27	4	0.26	0.13	2	0.500	0.400	8.4	4.4
BA-9	O-29	2	0.26	0.13	5	0.150	0.400	2.5	
	O-30	2	0.26	0.13	2	0.500	0.400	8.4	
	O-31	2	0.26	1.63	2	0.500	0.400	102.7	
	O-32	2	0.26	0.13	3	0.010	0.040	0.0	
	P-30	2	0.26	0.13	2	0.500	0.400	8.4	
	P-31	2	0.26	1.63	2	0.500	0.400	102.7	
	P-32	2	0.26	0.78	3	0.010	0.040	0.1	
	P-33	2	0.26	0.13	3	0.010	0.040	0.0	
	Q-30	2	0.26	1.63	2	0.500	0.400	102.7	
	Q-31	2	0.26	1.63	2	0.500	0.400	102.7	43.0
BA-10	P-34	2	0.26	0.13	2	0.500	0.400	8.4	
	Q-33	2	0.26	0.13	5	0.150	0.400	2.5	
	Q-34	5	0.50	0.13	2	0.500	0.400	16.1	2.7
					Basin Average Annual Soil Loss :			46.8	384.2

Table VIII.3.1(2/7) AVERAGE ANNUAL SOIL LOSS BY SHEET EROSION

EAST FLOODWAY BASIN

Sub Basin	Mesh No.	Soil Erodibility Class	K	LS	Land Use Pattern Class	C	P	Average Annual Soil Loss (m3/ha/yr)	Sub Basin Total (1000m3/yr)
EA-1	R-33	5	0.50	0.13	2	0.500	0.400	16.1	
	S-33	1	0.05	0.78	2	0.500	0.400	9.5	2.6
EA-2	Q-28	2	0.26	1.63	2	0.500	0.400	102.7	
	Q-29	2	0.26	1.63	2	0.500	0.400	102.7	
	R-27	2	0.26	0.13	2	0.500	0.400	8.4	
	R-28	2	0.26	0.13	2	0.500	0.400	8.4	
	R-29	2	0.26	1.63	2	0.500	0.400	102.7	
	R-30	2	0.26	1.63	2	0.500	0.400	102.7	
	S-27	2	0.26	0.13	5	0.150	0.400	2.5	
	S-31	2	0.26	0.78	2	0.500	0.400	49.5	47.9
EA-3	Q-32	2	0.26	0.78	2	0.500	0.400	49.5	
	R-31	2	0.26	0.78	2	0.500	0.400	49.5	
	R-32	2	0.26	0.78	3	0.010	0.040	0.1	
	S-32	1	0.05	0.13	3	0.010	0.040	0.0	
	T-31	1	0.05	0.78	2	0.500	0.400	9.5	
	T-32	1	0.05	0.13	2	0.500	0.400	1.6	11.0
EA-4	S-28	2	0.26	0.13	2	0.500	0.400	8.4	
	S-29	2	0.26	0.78	2	0.500	0.400	49.5	
	S-30	2	0.26	0.78	2	0.500	0.400	49.5	
	T-27	2	0.26	0.13	5	0.150	0.400	2.5	
	T-28	2	0.26	0.78	2	0.500	0.400	49.5	
	T-29	2	0.26	0.78	2	0.500	0.400	49.5	
	T-30	1	0.05	0.78	2	0.500	0.400	9.5	
	U-29	1	0.05	0.13	5	0.150	0.400	0.5	21.9
EA-5	U-30	1	0.05	0.13	5	0.150	0.400	0.5	
	U-31	1	0.05	0.13	5	0.150	0.400	0.5	0.1
EA-6	U-27	1	0.05	0.78	5	0.150	0.400	2.9	
	U-28	1	0.05	0.78	5	0.150	0.400	2.9	0.6
				Basin Average Annual Soil Loss :				30.0	84.1

GARANG RIVER BASIN (1/3)

Sub Basin	Mesh No.	Soil Erodibility Class	K	LS	Land Use Pattern Class	C	P	Average Annual Soil Loss (m3/ha/yr)	Sub Basin Total (1000m3/yr)
GA-1	A-20	3	0.26	0.13	1	0.001	0.500	0.0	
	A-21	6	0.38	7.05	1	0.001	0.500	1.6	
	A-22	4	0.26	1.63	3	0.010	0.040	0.2	
	A-23	4	0.26	1.63	3	0.010	0.040	0.2	
	A-24	4	0.26	1.63	3	0.010	0.040	0.2	
	B-20	6	0.38	7.05	1	0.001	0.500	1.6	
	B-21	6	0.38	7.05	1	0.001	0.500	1.6	
	B-22	4	0.26	7.05	4	0.001	0.500	1.1	
	B-23	4	0.26	4.43	4	0.001	0.500	0.7	
	B-24	4	0.26	1.63	3	0.010	0.040	0.2	
	C-21	6	0.38	7.05	1	0.001	0.500	1.6	
	C-22	3	0.26	4.43	1	0.001	0.500	0.7	
	C-23	3	0.26	4.43	4	0.001	0.500	0.7	
	C-24	3	0.26	1.63	3	0.010	0.040	0.2	
	C-25	3	0.26	0.78	3	0.010	0.040	0.1	
	D-24	4	0.26	0.78	2	0.500	0.400	49.5	
	D-25	4	0.26	0.13	3	0.010	0.040	0.0	
	E-25	4	0.26	0.13	3	0.010	0.040	0.0	6.0
GA-2	D-21	6	0.38	7.05	1	0.001	0.500	1.6	
	D-22	4	0.26	4.43	1	0.001	0.500	0.7	
	D-23	4	0.26	1.63	4	0.001	0.500	0.3	
	E-22	3	0.26	4.43	2	0.500	0.400	279.3	
	E-23	3	0.26	1.63	2	0.500	0.400	102.7	
	E-24	3	0.26	0.78	2	0.500	0.400	49.5	
	F-22	4	0.26	4.43	2	0.500	0.400	279.3	
	F-23	4	0.26	1.63	2	0.500	0.400	102.7	
	F-24	4	0.26	0.13	3	0.010	0.040	0.0	
	F-25	4	0.26	0.13	3	0.010	0.040	0.0	
	G-23	4	0.26	1.63	2	0.500	0.400	102.7	
	G-24	4	0.26	0.78	2	0.500	0.400	49.5	
	H-24	4	0.26	0.78	3	0.010	0.040	0.1	
	H-25	4	0.26	0.13	3	0.010	0.040	0.0	
	I-25	4	0.26	0.13	3	0.010	0.040	0.0	96.8
GA-3	A-25	4	0.26	0.78	3	0.010	0.040	0.1	
	B-25	4	0.26	0.78	3	0.010	0.040	0.1	
	B-26	3	0.26	0.78	3	0.010	0.040	0.1	
	C-26	3	0.26	0.13	3	0.010	0.040	0.0	
	C-27	4	0.26	0.13	2	0.500	0.400	8.4	
	D-26	4	0.26	0.13	3	0.010	0.040	0.0	
	D-27	4	0.26	0.13	3	0.010	0.040	0.0	
	D-28	4	0.26	0.13	3	0.010	0.040	0.0	
	E-26	4	0.26	0.13	3	0.010	0.040	0.0	
	E-27	4	0.26	0.13	3	0.010	0.040	0.0	

Table VIII.3.1(3/7) AVERAGE ANNUAL SOIL LOSS BY SHEET EROSION
GARANG RIVER BASIN (2/3)

Sub Basin	Mesh No.	Soil Erodibility Class	Soil Erodibility K	LS	Land Use Pattern Class	Land Use Pattern C	P	Average Annual Soil Loss (m3/ha/yr)	Sub Basin Total (1000m3/yr)
	F-26	4	0.26	1.63	3	0.010	0.040	0.2	
	F-27	4	0.26	0.13	1	0.001	0.500	0.0	
	F-28	4	0.26	1.63	3	0.010	0.040	0.2	
	G-25	4	0.26	0.13	3	0.010	0.040	0.0	
	G-26	4	0.26	0.13	3	0.010	0.040	0.0	
	G-27	4	0.26	0.13	3	0.010	0.040	0.0	
	H-26	4	0.26	0.13	3	0.010	0.040	0.0	
	I-26	4	0.26	0.13	2	0.500	0.400	8.4	1.8
GA-4	B-19	6	0.38	7.05	4	0.001	0.500	1.6	
	C-19	6	0.38	7.05	1	0.001	0.500	1.6	
	C-20	6	0.38	7.05	1	0.001	0.500	1.6	
	D-19	6	0.38	7.05	4	0.001	0.500	1.6	
	D-20	6	0.38	7.05	1	0.001	0.500	1.6	
	E-20	4	0.26	4.43	1	0.001	0.500	0.7	
	E-21	3	0.26	4.43	2	0.500	0.400	279.3	
	F-20	3	0.26	4.43	4	0.001	0.500	0.7	
	F-21	4	0.26	4.43	2	0.500	0.400	279.3	
	G-22	4	0.26	1.63	3	0.010	0.040	0.2	
	H-23	4	0.26	1.63	3	0.010	0.040	0.2	
	I-24	4	0.26	0.13	3	0.010	0.040	0.0	
	J-24	4	0.26	0.13	2	0.500	0.400	8.4	57.7
GA-5	G-21	3	0.26	1.63	2	0.500	0.400	102.7	
	H-22	4	0.26	1.63	2	0.500	0.400	102.7	
	I-23	4	0.26	0.78	2	0.500	0.400	49.5	
	J-23	4	0.26	0.78	2	0.500	0.400	49.5	
	K-24	4	0.26	0.78	2	0.500	0.400	49.5	35.4
GA-6	J-25	4	0.26	0.13	2	0.500	0.400	8.4	
	K-25	4	0.26	4.43	2	0.500	0.400	279.3	
	L-25	4	0.26	1.63	2	0.500	0.400	102.7	
	M-25	4	0.26	7.05	2	0.500	0.400	444.6	83.5
GA-7	N-25	4	0.26	7.05	2	0.500	0.400	444.6	
	O-25	4	0.26	7.05	2	0.500	0.400	444.6	
	P-24	2	0.26	0.13	5	0.150	0.400	2.5	
	P-25	2	0.26	7.05	2	0.500	0.400	444.6	
	P-26	4	0.26	0.13	2	0.500	0.400	8.4	
	Q-24	2	0.26	1.63	5	0.150	0.400	30.8	
	Q-25	2	0.26	0.78	2	0.500	0.400	49.5	142.5
GA-8	Q-26	4	0.26	4.43	2	0.500	0.400	279.3	
	R-24	2	0.26	1.63	2	0.500	0.400	102.7	
	R-25	2	0.26	4.43	2	0.500	0.400	279.3	
	R-26	2	0.26	1.63	2	0.500	0.400	102.7	
	S-24	2	0.26	0.13	2	0.500	0.400	8.4	
	S-25	2	0.26	4.43	2	0.500	0.400	279.3	
	T-24	2	0.26	4.43	2	0.500	0.400	279.3	133.1
GA-9	H-21	3	0.26	1.63	2	0.500	0.400	102.7	
	I-21	3	0.26	0.78	2	0.500	0.400	49.5	
	J-20	3	0.26	0.78	3	0.010	0.040	0.1	
	J-21	3	0.26	0.78	3	0.010	0.040	0.1	
	K-21	3	0.26	0.78	2	0.500	0.400	49.5	
	L-21	4	0.26	0.78	2	0.500	0.400	49.5	
	M-21	4	0.26	0.13	3	0.010	0.040	0.0	25.1
GA-10	I-22	3	0.26	1.63	2	0.500	0.400	102.7	
	J-22	3	0.26	0.78	2	0.500	0.400	49.5	
	K-22	4	0.26	0.78	2	0.500	0.400	49.5	
	K-23	4	0.26	0.78	3	0.010	0.040	0.1	
	L-22	4	0.26	0.13	3	0.010	0.040	0.0	
	M-22	4	0.26	0.13	3	0.010	0.040	0.0	20.2
GA-11	L-23	4	0.26	0.13	2	0.500	0.400	8.4	
	M-23	4	0.26	0.13	3	0.010	0.040	0.0	
	N-21	4	0.26	0.13	2	0.500	0.400	8.4	
	N-22	4	0.26	0.13	2	0.500	0.400	8.4	
	N-23	4	0.26	0.13	3	0.010	0.040	0.0	
	O-21	2	0.26	0.13	3	0.010	0.040	0.0	
	O-22	2	0.26	1.63	2	0.500	0.400	102.7	
	O-23	2	0.26	0.13	2	0.500	0.400	8.4	
	P-22	2	0.26	1.63	2	0.500	0.400	102.7	23.9
GA-12	L-24	4	0.26	0.13	2	0.500	0.400	8.4	
	M-24	4	0.26	0.13	2	0.500	0.400	8.4	
	N-24	4	0.26	0.13	2	0.500	0.400	8.4	
	O-24	4	0.26	0.13	2	0.500	0.400	8.4	
	P-21	2	0.26	1.63	2	0.500	0.400	102.7	
	P-23	2	0.26	1.63	2	0.500	0.400	102.7	
	Q-21	2	0.26	1.63	2	0.500	0.400	102.7	
	Q-22	2	0.26	0.13	2	0.500	0.400	8.4	
	Q-23	2	0.26	1.63	2	0.500	0.400	102.7	45.3
GA-13	R-22	2	0.26	1.63	2	0.500	0.400	102.7	
	R-23	2	0.26	1.63	2	0.500	0.400	102.7	
	S-22	2	0.26	0.13	2	0.500	0.400	8.4	
	S-23	2	0.26	0.13	2	0.500	0.400	8.4	22.2
GA-14	E-19	6	0.38	7.05	4	0.001	0.500	1.6	
	F-18	4	0.26	4.43	2	0.500	0.400	279.3	
	F-19	3	0.26	4.43	4	0.001	0.500	0.7	
	G-18	4	0.26	1.63	2	0.500	0.400	102.7	
	G-19	3	0.26	1.63	2	0.500	0.400	102.7	

Table VIII.3.1(4/7) AVERAGE ANNUAL SOIL LOSS BY SHEET EROSION
GARANG RIVER BASIN (3/3)

Sub Basin	Mesh No.	Soil Erodibility Class	Soil Erodibility K	LS	Land Use Pattern Class	Land Use Pattern C	P	Average Annual Soil Loss (m3/ha/yr)	Sub Basin Total (1000m3/yr)
	G-20	3	0.26	1.63	2	0.500	0.400	102.7	
GA-14	H-19	3	0.26	1.63	3	0.010	0.040	0.2	
	H-20	3	0.26	1.63	3	0.010	0.040	0.2	
	I-18	4	0.26	1.63	3	0.010	0.040	0.2	
	I-19	3	0.26	1.63	3	0.010	0.040	0.2	
	I-20	3	0.26	1.63	3	0.010	0.040	0.2	
	J-19	3	0.26	0.78	2	0.500	0.400	49.5	
	K-18	4	0.26	0.78	3	0.010	0.040	0.1	
	L-18	4	0.26	0.13	3	0.010	0.040	0.0	64.0
GA-15	H-18	4	0.26	1.63	3	0.010	0.040	0.2	
	J-17	4	0.26	0.78	3	0.010	0.040	0.1	
	J-18	4	0.26	0.78	3	0.010	0.040	0.1	
	K-17	4	0.26	0.13	3	0.010	0.040	0.0	0.0
GA-16	K-19	3	0.26	0.78	2	0.500	0.400	49.5	
	L-19	4	0.26	0.13	3	0.010	0.040	0.0	
	M-18	4	0.26	0.13	3	0.010	0.040	0.0	
	M-19	4	0.26	0.13	3	0.010	0.040	0.0	5.0
GA-17	B-18	6	0.38	7.05	4	0.001	0.500	1.6	
	C-18	6	0.38	7.05	1	0.001	0.500	1.6	
	D-18	6	0.38	7.05	1	0.001	0.500	1.6	
	E-17	4	0.26	7.05	1	0.001	0.500	1.1	
	E-18	4	0.26	7.05	1	0.001	0.500	1.1	
	F-17	4	0.26	1.63	2	0.500	0.400	102.7	
	G-17	4	0.26	1.63	2	0.500	0.400	102.7	
	H-16	3	0.26	1.63	3	0.010	0.040	0.2	
	H-17	4	0.26	1.63	3	0.010	0.040	0.2	
	I-16	3	0.26	1.63	3	0.010	0.040	0.2	
	I-17	4	0.26	1.63	2	0.500	0.400	102.7	
	J-16	3	0.26	0.13	3	0.010	0.040	0.0	
	K-16	3	0.26	0.13	3	0.010	0.040	0.0	
	L-16	3	0.26	0.13	1	0.001	0.500	0.0	
	L-17	4	0.26	0.13	3	0.010	0.040	0.0	
	M-17	4	0.26	0.13	3	0.010	0.040	0.0	31.6
GA-18	M-15	3	0.26	0.13	3	0.010	0.040	0.0	
	M-16	3	0.26	0.13	3	0.010	0.040	0.0	
	N-16	4	0.26	0.13	1	0.001	0.500	0.0	
	N-17	4	0.26	0.13	3	0.010	0.040	0.0	
	N-18	2	0.26	0.13	3	0.010	0.040	0.0	0.0
GA-19	K-20	3	0.26	0.78	2	0.500	0.400	49.5	
	L-20	3	0.26	0.13	2	0.500	0.400	8.4	
	M-20	4	0.26	0.13	3	0.010	0.040	0.0	
	N-19	4	0.26	0.13	3	0.010	0.040	0.0	5.8
GA-20	O-18	2	0.26	0.13	2	0.500	0.400	8.4	
	O-19	4	0.26	0.13	2	0.500	0.400	8.4	
	P-18	2	0.26	1.63	2	0.500	0.400	102.7	
	P-19	2	0.26	0.13	2	0.500	0.400	8.4	
	Q-18	2	0.26	0.13	2	0.500	0.400	8.4	
	Q-19	2	0.26	0.13	2	0.500	0.400	8.4	
	R-19	2	0.26	1.63	2	0.500	0.400	102.7	24.7
GA-21	N-20	4	0.26	0.13	2	0.500	0.400	8.4	
	O-20	4	0.26	0.13	2	0.500	0.400	8.4	
	P-20	2	0.26	0.13	3	0.010	0.040	0.0	
	Q-20	2	0.26	1.63	3	0.010	0.040	0.2	
	R-20	2	0.26	1.63	2	0.500	0.400	102.7	
	R-21	2	0.26	1.63	2	0.500	0.400	102.7	
	S-19	4	0.26	0.13	2	0.500	0.400	8.4	
	S-20	2	0.26	1.63	2	0.500	0.400	102.7	
	S-21	2	0.26	1.63	2	0.500	0.400	102.7	
	T-19	4	0.26	0.13	2	0.500	0.400	8.4	
	T-20	2	0.26	1.63	2	0.500	0.400	102.7	
	T-21	2	0.26	0.13	2	0.500	0.400	8.4	55.5
GA-22	T-22	2	0.26	1.63	2	0.500	0.400	102.7	
	T-23	2	0.26	0.13	2	0.500	0.400	8.4	
	U-22	2	0.26	0.13	2	0.500	0.400	8.4	11.9
GA-23	S-26	2	0.26	0.13	5	0.150	0.400	2.5	
	T-25	2	0.26	4.43	2	0.500	0.400	279.3	
	T-26	2	0.26	0.78	5	0.150	0.400	14.8	
	U-23	2	0.26	0.13	2	0.500	0.400	8.4	
	U-24	2	0.26	0.13	2	0.500	0.400	8.4	
	U-25	2	0.26	0.78	2	0.500	0.400	49.5	
	U-26	2	0.26	0.78	5	0.150	0.400	14.8	
	V-24	2	0.26	0.13	5	0.150	0.400	2.5	
	V-25	2	0.26	0.13	5	0.150	0.400	2.5	38.3
				Basin Average Annual Soil Loss :				46.5	930.3

Table VIII.3.1(5/7) AVERAGE ANNUAL SOIL LOSS BY SHEET EROSION

SILANDAK RIVER BASIN

Sub Basin	Mesh No.	Soil Erodibility Class	K	LS	Land Use Pattern Class	C	P	Average Annual Soil Loss (m3/ha/yr)	Sub Basin Total (1000m3/yr)
SI-1	U-19	4	0.26	1.63	2	0.500	0.400	102.7	
	U-20	2	0.26	1.63	2	0.500	0.400	102.7	
	U-21	2	0.26	1.63	2	0.500	0.400	102.7	
	V-19	2	0.26	1.63	2	0.500	0.400	102.7	
	V-20	2	0.26	1.63	2	0.500	0.400	102.7	
	V-21	2	0.26	1.63	2	0.500	0.400	102.7	
	W-19	2	0.26	1.63	2	0.500	0.400	102.7	71.9
SI-2	V-22	2	0.26	1.63	5	0.150	0.400	30.8	
	V-23	2	0.26	0.78	5	0.150	0.400	14.8	
	W-21	2	0.26	0.13	2	0.500	0.400	8.4	
	W-22	1	0.05	0.78	5	0.150	0.400	2.9	5.7
						Basin Average Annual Soil Loss :		70.5	77.5

BRINGIN RIVER BASIN

Sub Basin	Mesh No.	Soil Erodibility Class	K	LS	Land Use Pattern Class	C	P	Average Annual Soil Loss (m3/ha/yr)	Sub Basin Total (1000m3/yr)
BR-1	O-17	4	0.26	0.13	2	0.500	0.400	8.4	
	P-17	4	0.26	0.13	2	0.500	0.400	8.4	
	Q-17	4	0.26	0.13	2	0.500	0.400	8.4	
	R-17	4	0.26	0.13	4	0.001	0.500	0.0	
	R-18	4	0.26	0.13	2	0.500	0.400	8.4	
	S-18	4	0.26	0.13	4	0.001	0.500	0.0	
	T-18	4	0.26	0.13	2	0.500	0.400	8.4	
	U-17	4	0.26	0.13	2	0.500	0.400	8.4	
	U-18	4	0.26	1.63	2	0.500	0.400	102.7	
	V-17	2	0.26	1.63	2	0.500	0.400	102.7	
	V-18	2	0.26	1.63	2	0.500	0.400	102.7	35.8
BR-2	R-16	4	0.26	0.13	4	0.001	0.500	0.0	
	S-16	4	0.26	0.13	4	0.001	0.500	0.0	
	S-17	4	0.26	0.13	4	0.001	0.500	0.0	
	T-16	4	0.26	0.13	4	0.001	0.500	0.0	
	T-17	4	0.26	0.13	4	0.001	0.500	0.0	
	U-14	4	0.26	0.13	4	0.001	0.500	0.0	
	U-15	4	0.26	0.13	4	0.001	0.500	0.0	
	U-16	4	0.26	0.13	4	0.001	0.500	0.0	
	V-14	4	0.26	0.78	4	0.001	0.500	0.1	
	V-15	4	0.26	0.13	4	0.001	0.500	0.0	
	V-16	2	0.26	1.63	2	0.500	0.400	102.7	10.3
BR-3	W-14	2	0.26	1.63	2	0.500	0.400	102.7	
	W-15	2	0.26	1.63	2	0.500	0.400	102.7	
	W-16	2	0.26	1.63	2	0.500	0.400	102.7	
	W-17	2	0.26	1.63	2	0.500	0.400	102.7	
	X-14	2	0.26	1.63	2	0.500	0.400	102.7	
	X-15	2	0.26	1.63	2	0.500	0.400	102.7	
	X-16	1	0.05	1.63	2	0.500	0.400	19.7	
	Y-14	1	0.05	0.13	5	0.150	0.400	0.5	63.6
						Basin Average Annual Soil Loss :		36.6	109.7

Table VIII.3.1(6/7) AVERAGE ANNUAL SOIL LOSS BY SHEET EROSION
BLORONG RIVER BASIN (1/2)

Sub Basin	Mesh No.	Soil Erodibility Class	Soil Erodibility K	LS	Land Use Pattern Class	Land Use Pattern C	P	Average Annual Soil Loss (m3/ha/yr)	Sub Basin Total (1000m3/yr)
BL-1	G-14	4	0.26	1.63	3	0.010	0.040	0.2	
	H-11	4	0.26	0.13	3	0.010	0.040	0.0	
	H-12	4	0.26	0.13	3	0.010	0.040	0.0	
	H-13	4	0.26	0.13	3	0.010	0.040	0.0	
	I-10	3	0.26	0.13	3	0.010	0.040	0.0	
	I-11	3	0.26	0.13	3	0.010	0.040	0.0	
	I-12	3	0.26	0.13	3	0.010	0.040	0.0	
	J-10	3	0.26	0.13	5	0.150	0.400	2.5	
	J-11	3	0.26	0.13	3	0.010	0.040	0.0	
	J-12	3	0.26	0.13	3	0.010	0.040	0.0	
	K- 9	3	0.26	0.13	3	0.010	0.040	0.0	
	K-10	3	0.26	0.13	3	0.010	0.040	0.0	
	K-11	3	0.26	0.13	3	0.010	0.040	0.0	0.3
BL-2	I-13	3	0.26	0.13	3	0.010	0.040	0.0	
	J-13	3	0.26	0.13	3	0.010	0.040	0.0	
	K-12	3	0.26	0.13	3	0.010	0.040	0.0	
	L-12	3	0.26	0.13	3	0.010	0.040	0.0	
	M-13	4	0.26	0.13	2	0.500	0.400	8.4	0.8
BL-3	F-15	4	0.26	4.43	2	0.500	0.400	279.3	
	G-15	4	0.26	1.63	2	0.500	0.400	102.7	
	H-14	4	0.26	1.63	5	0.150	0.400	30.8	
	H-15	4	0.26	1.63	3	0.010	0.040	0.2	
	I-14	3	0.26	0.13	3	0.010	0.040	0.0	
	J-14	3	0.26	0.13	3	0.010	0.040	0.0	
	K-13	3	0.26	0.13	3	0.010	0.040	0.0	
	K-14	3	0.26	0.13	3	0.010	0.040	0.0	
	L-13	3	0.26	0.13	3	0.010	0.040	0.0	41.3
BL-4	F-16	4	0.26	4.43	2	0.500	0.400	279.3	
	G-16	4	0.26	1.63	2	0.500	0.400	102.7	
	I-15	3	0.26	0.13	3	0.010	0.040	0.0	
	J-15	3	0.26	0.13	3	0.010	0.040	0.0	
	K-15	3	0.26	0.13	3	0.010	0.040	0.0	
	L-14	3	0.26	0.13	3	0.010	0.040	0.0	
	L-15	3	0.26	0.13	3	0.010	0.040	0.0	
	M-14	3	0.26	0.13	3	0.010	0.040	0.0	38.2
BL-5	L- 9	4	0.26	0.13	4	0.001	0.500	0.0	
	L-10	4	0.26	0.13	1	0.001	0.500	0.0	
	L-11	3	0.26	0.13	3	0.010	0.040	0.0	
	M- 9	4	0.26	0.13	4	0.001	0.500	0.0	
	M-10	4	0.26	0.13	2	0.500	0.400	8.4	
	M-11	4	0.26	0.13	2	0.500	0.400	8.4	
	M-12	4	0.26	0.13	2	0.500	0.400	8.4	
	N- 9	4	0.26	0.13	4	0.001	0.500	0.0	
	N-11	4	0.26	0.13	2	0.500	0.400	8.4	
	N-12	4	0.26	0.13	2	0.500	0.400	8.4	
	O-11	4	0.26	0.13	4	0.001	0.500	0.0	
	O-12	4	0.26	0.13	2	0.500	0.400	8.4	
	P-12	4	0.26	1.63	4	0.001	0.500	0.3	5.1
BL-6	N-13	4	0.26	0.13	2	0.500	0.400	8.4	
	N-14	3	0.26	0.13	3	0.010	0.040	0.0	
	O-13	4	0.26	1.63	2	0.500	0.400	102.7	
	O-14	3	0.26	1.63	3	0.010	0.040	0.2	
	P-13	4	0.26	1.63	1	0.001	0.500	0.3	11.2
BL-7	N-10	4	0.26	0.13	4	0.001	0.500	0.0	
	O- 9	4	0.26	0.13	2	0.500	0.400	8.4	
	O-10	4	0.26	0.78	4	0.001	0.500	0.1	
	P- 9	4	0.26	0.13	2	0.500	0.400	8.4	
	P-10	4	0.26	0.78	2	0.500	0.400	49.5	
	P-11	4	0.26	0.78	1	0.001	0.500	0.1	
	Q-10	4	0.26	0.78	4	0.001	0.500	0.1	
	Q-11	4	0.26	0.78	1	0.001	0.500	0.1	6.7
BL-8	Q-12	4	0.26	1.63	1	0.001	0.500	0.3	
	R-10	4	0.26	0.78	1	0.001	0.500	0.1	
	R-11	4	0.26	0.78	1	0.001	0.500	0.1	
	S-10	4	0.26	0.13	1	0.001	0.500	0.0	
	S-11	4	0.26	0.13	1	0.001	0.500	0.0	
	T-10	4	0.26	0.13	1	0.001	0.500	0.0	0.1
BL-9	Q-13	4	0.26	0.13	3	0.010	0.040	0.0	
	R-12	4	0.26	0.78	1	0.001	0.500	0.1	
	R-13	4	0.26	0.78	3	0.010	0.040	0.1	
	S-12	4	0.26	0.78	1	0.001	0.500	0.1	
	S-13	4	0.26	0.78	3	0.010	0.040	0.1	
	T-11	4	0.26	0.13	1	0.001	0.500	0.0	
	T-12	4	0.26	0.13	1	0.001	0.500	0.0	
	U-10	4	0.26	0.13	2	0.500	0.400	8.4	
	U-11	4	0.26	0.13	1	0.001	0.500	0.0	
	U-12	4	0.26	0.13	1	0.001	0.500	0.0	
	V-11	2	0.26	1.63	2	0.500	0.400	102.7	11.2
BL-10	S- 9	4	0.26	0.13	1	0.001	0.500	0.0	
	T- 8	4	0.26	0.13	1	0.001	0.500	0.0	
	T- 9	4	0.26	0.13	1	0.001	0.500	0.0	
	U- 7	2	0.26	0.13	2	0.500	0.400	8.4	
	U- 8	4	0.26	1.63	1	0.001	0.500	0.3	
	U- 9	4	0.26	0.13	1	0.001	0.500	0.0	0.9

Table VIII.3.1(7/7) AVERAGE ANNUAL SOIL LOSS BY SHEET EROSION
BLORONG RIVER BASIN (2/2)

Sub Basin	Mesh No.	Soil Erodibility Class	Soil Erodibility K	LS	Land Use Pattern Class	Land Use Pattern C	P	Average Annual Soil Loss (m3/ha/yr)	Sub Basin Total (1000m3/yr)
BL-11	O- 8	4	0.26	0.13	4	0.001	0.500	0.0	
	P- 8	4	0.26	0.13	2	0.500	0.400	8.4	
	Q- 8	4	0.26	4.43	2	0.500	0.400	279.3	
	Q- 9	4	0.26	4.43	2	0.500	0.400	279.3	
	R- 8	4	0.26	4.43	1	0.001	0.500	0.7	
	R- 9	4	0.26	4.43	1	0.001	0.500	0.7	
	S- 8	4	0.26	0.13	1	0.001	0.500	0.0	
	T- 7	2	0.26	0.13	3	0.010	0.040	0.0	56.8
BL-12	R- 7	4	0.26	4.43	1	0.001	0.500	0.7	
	S- 6	4	0.26	0.13	1	0.001	0.500	0.0	
	S- 7	4	0.26	0.13	1	0.001	0.500	0.0	
	T- 6	2	0.26	0.13	3	0.010	0.040	0.0	0.1
BL-13	B-17	4	0.26	7.05	4	0.001	0.500	1.1	
	C-17	4	0.26	4.43	4	0.001	0.500	0.7	
	D-16	4	0.26	7.05	1	0.001	0.500	1.1	
	D-17	4	0.26	7.05	1	0.001	0.500	1.1	
	E-16	4	0.26	4.43	2	0.500	0.400	279.3	
	F-14	4	0.26	1.63	3	0.010	0.040	0.2	
	G-12	4	0.26	0.13	3	0.010	0.040	0.0	
	G-13	4	0.26	1.63	3	0.010	0.040	0.2	28.4
BL-14	C-15	4	0.26	7.05	1	0.001	0.500	1.1	
	C-16	4	0.26	7.05	1	0.001	0.500	1.1	
	D-13	4	0.26	4.43	2	0.500	0.400	279.3	
	D-14	4	0.26	7.05	1	0.001	0.500	1.1	
	D-15	4	0.26	7.05	1	0.001	0.500	1.1	
	E-11	4	0.26	4.43	2	0.500	0.400	279.3	
	E-12	4	0.26	1.63	2	0.500	0.400	102.7	
	E-13	4	0.26	1.63	3	0.010	0.040	0.2	
	E-14	4	0.26	4.43	2	0.500	0.400	279.3	
	E-15	4	0.26	7.05	2	0.500	0.400	444.6	
	F-11	4	0.26	4.43	2	0.500	0.400	279.3	
	F-12	4	0.26	1.63	3	0.010	0.040	0.2	
	F-13	4	0.26	1.63	3	0.010	0.040	0.2	
	G-11	4	0.26	0.13	2	0.500	0.400	8.4	167.8
BL-15	H-10	4	0.26	1.63	3	0.010	0.040	0.2	0.0
BL-16	F-10	4	0.26	4.43	2	0.500	0.400	279.3	
	G- 9	4	0.26	1.63	2	0.500	0.400	102.7	
	G-10	4	0.26	1.63	4	0.001	0.500	0.3	
	H- 9	4	0.26	1.63	2	0.500	0.400	102.7	
	I- 9	4	0.26	0.13	3	0.010	0.040	0.0	48.5
BL-17	J- 8	4	0.26	0.13	4	0.001	0.500	0.0	
	J- 9	3	0.26	0.13	3	0.010	0.040	0.0	
	K- 7	4	0.26	0.13	1	0.001	0.500	0.0	
	K- 8	3	0.26	0.13	3	0.010	0.040	0.0	
	L- 7	4	0.26	0.13	2	0.500	0.400	8.4	
	L- 8	4	0.26	0.13	2	0.500	0.400	8.4	
	M- 6	4	0.26	0.13	1	0.001	0.500	0.0	
	M- 7	4	0.26	1.63	2	0.500	0.400	102.7	
	M- 8	4	0.26	1.63	4	0.001	0.500	0.3	
	N- 5	4	0.26	0.13	1	0.001	0.500	0.0	
	N- 6	4	0.26	0.13	1	0.001	0.500	0.0	
	N- 7	4	0.26	4.43	2	0.500	0.400	279.3	
	N- 8	4	0.26	0.13	4	0.001	0.500	0.0	
	O- 5	4	0.26	0.13	1	0.001	0.500	0.0	
	O- 7	4	0.26	4.43	2	0.500	0.400	279.3	67.9
BL-18	O- 6	4	0.26	4.43	2	0.500	0.400	279.3	
	P- 4	4	0.26	1.63	2	0.500	0.400	102.7	
	P- 5	4	0.26	1.63	2	0.500	0.400	102.7	
	P- 6	4	0.26	1.63	1	0.001	0.500	0.3	
	P- 7	4	0.26	4.43	1	0.001	0.500	0.7	
	Q- 4	4	0.26	1.63	1	0.001	0.500	0.3	
	Q- 5	4	0.26	1.63	1	0.001	0.500	0.3	
	Q- 6	4	0.26	1.63	1	0.001	0.500	0.3	
	Q- 7	4	0.26	1.63	2	0.500	0.400	102.7	
	R- 3	4	0.26	0.13	1	0.001	0.500	0.0	
	R- 4	4	0.26	0.13	1	0.001	0.500	0.0	
	R- 5	4	0.26	1.63	1	0.001	0.500	0.3	
	R- 6	4	0.26	4.43	1	0.001	0.500	0.7	
	S- 5	4	0.26	0.13	3	0.010	0.040	0.0	
	T- 5	4	0.26	0.13	1	0.001	0.500	0.0	59.0
BL-19	S- 3	4	0.26	0.13	2	0.500	0.400	8.4	
	S- 4	4	0.26	0.13	1	0.001	0.500	0.0	
	T- 1	4	0.26	0.13	1	0.001	0.500	0.0	
	T- 2	4	0.26	1.63	1	0.001	0.500	0.3	
	T- 3	4	0.26	1.63	1	0.001	0.500	0.3	
	T- 4	4	0.26	0.13	1	0.001	0.500	0.0	
	U- 2	4	0.26	1.63	1	0.001	0.500	0.3	
	U- 3	4	0.26	0.78	1	0.001	0.500	0.1	
	U- 4	4	0.26	1.63	1	0.001	0.500	0.3	
	U- 5	2	0.26	1.63	1	0.001	0.500	0.3	
	U- 6	2	0.26	0.13	1	0.001	0.500	0.0	
	V- 6	2	0.26	1.63	1	0.001	0.500	0.3	1.0
	Basin Average Annual Soil Loss :							32.8	545.1

Table VIII.3.2 RAINFALL FACTOR R BY OBSERVED RECORD IN 1989

No.	Month/Day	Rainfall Depth r (mm)	Rainfall Duration (hr)	Rainfall Average Intensity I (mm/hr)	Rainfall I30 (mm/hr)	Kinetic Energy Ek (mt/ha)	Ek*I30 (1000mm *mt/ha *hr)
1	1 / 4	18.13	6	3.02	17.06	327	6
2	1 / 8	24.20	3	8.07	44.00	538	24
3	1 / 8	35.30	10	3.53	44.00	661	29
4	1 /12	34.80	1	34.80	71.00	990	70
5	1 /18	33.80	51	0.66	33.60	392	13
6	1 /25	45.56	7	6.51	64.00	971	62
7	2 / 2	29.00	6	4.83	42.60	582	25
8	2 / 4	28.20	14	2.01	20.80	460	10
9	2 / 5	38.20	5	7.64	32.80	840	28
10	2 / 5	225.50	41	5.50	74.60	4,646	347
11	2 / 7	13.50	7	1.93	34.00	218	7
12	2 / 9	110.50	5	22.10	80.00	2,931	234
13	2 /13	36.80	6	6.13	20.00	775	16
14	2 /18	89.00	8	11.13	67.80	2,100	142
15	2 /19	49.83	6	8.31	72.10	1,114	80
16	2 /22	17.53	3	5.84	16.24	366	6
17	3 / 2	27.72	5	5.54	39.00	572	22
18	3 / 4	27.74	5	5.55	38.42	573	22
19	3 / 8	18.50	2	9.25	34.00	422	14
20	3 /23	13.30	4	3.33	12.80	246	3
21	3 /26	13.46	5	2.69	3.96	236	1
22	3 /31	19.30	7	2.76	16.00	341	5
23	4 / 1	21.50	5	4.30	12.00	420	5
24	4 / 3	52.93	3	17.64	45.56	1,353	62
25	4 /29	63.70	5	12.74	68.00	1,540	105
26	5 /12	29.00	1	29.00	58.00	803	47
27	5 /15	35.00	1	35.00	70.00	997	70
28	5 /16	28.50	2	14.25	52.60	703	37
29	5 /17	141.28	9	15.70	100.40	3,541	356
30	5 /27	14.90	2	7.45	28.20	326	9
31	6 / 2	76.30	13	5.87	61.80	1,593	98
32	6 /11	64.90	4	16.23	51.40	1,636	84
33	6 /20	55.50	4	13.88	88.00	1,362	120
34	6 /21	29.50	3	9.83	52.00	681	35
35	7 / 8	50.80	8	6.35	60.00	1,078	65
36	7 /12	28.90	2	14.45	51.80	714	37
37	8 /20	18.70	3	6.23	16.40	395	6
38	8 /30	34.80	6	5.80	34.80	725	25
39	9 /16	20.60	1	20.60	41.20	540	22
40	10 / 2	22.60	2	11.30	44.30	535	24
41	10 /16	22.97	2	11.49	37.08	545	20
42	10 /29	82.10	10	8.21	62.00	1,831	114
43	11 / 8	19.97	2	9.98	38.68	462	18
44	11 / 9	13.90	6	2.32	14.40	235	3
45	11 /12	52.43	2	26.22	54.60	1,429	78
46	11 /15	15.10	9	1.68	16.20	235	4
47	11 /24	84.00	5	16.80	60.00	2,130	128
48	11 /26	68.60	3	22.87	74.80	1,829	137
49	11 /29	22.97	3	7.66	20.60	506	10
50	12 / 1	78.70	7	11.24	61.20	1,861	114
51	12 / 2	44.30	9	4.92	67.00	892	60
52	12 / 9	34.50	10	3.45	55.00	642	35
53	12 /10	15.90	5	3.18	21.60	291	6
54	12 /13	18.50	6	3.08	22.80	336	8
55	12 /14	53.70	11	4.88	64.20	1,079	69
56	12 /24	14.20	1	14.20	28.20	350	10
57	12 /25	16.00	1	16.00	31.80	402	13
58	12 /27	25.60	3	8.53	23.80	575	14
Total						54,874	R= 3,214

Table VIII.3.3(1/2) ANNUAL SEDIMENT YIELD BY BANK EROSION

River	Sub-Basin	Length of Valley (km) Valley Order 1st	2nd	3rd	4th	5th	Annual Bank Erosion (m3/yr)
BABON RIVER	BA-1	17.0	6.0	4.5			540
	BA-2	29.0	11.5	4.5	2.0		1,098
	BA-3	16.0	3.5	2.0	3.0		748
	BA-4	17.5	9.0	5.0			638
	BA-5	1.0	1.0	0.0	1.0	3.5	633
	BA-6	20.0	6.5	2.5			538
	BA-7	7.5	1.5	0.5		4.0	705
	BA-8	9.0	5.5				273
	BA-9	13.5	4.0	3.0	2.0		633
	BA-10					3.0	405
	Total	130.5	48.5	22.0	8.0	10.5	6,208
EAST FLOODWAY	EA-1	1.5	0.0			3.0	428
	EA-2	12.0	5.5	5.5			483
	EA-3	8.0	4.0	1.5	1.0		385
	EA-4	8.5	4.5	2.5			315
	EA-5	0.5				4.0	548
	EA-6	2.0	2.0				80
	Total	32.5	16.0	9.5	1.0	7.0	2,238
GARANG RIVER	GA-1	34.5	23.0	10.5	0.5		1,468
	GA-2	31.5	21.5	3.0	4.5		1,640
	GA-3	26.0	5.0	7.5			740
	GA-4	23.5	7.0	5.0			678
	GA-5	7.0	1.5				143
	GA-6	5.0			5.0		675
	GA-7	8.5	1.0		5.5		813
	GA-8	11.5	5.0		4.0		778
	GA-9	11.0	6.5	2.5			403
	GA-10	16.0	3.0	4.0			435
	GA-11	8.0	2.0	0.0	3.0		530
	GA-12	11.0	6.5	0.5			343
	GA-13	12.5	2.5		4.0		730
	GA-14	28.5	9.5	7.5	2.5		1,190
	GA-15	8.5	6.5	1.0			320
	GA-16	6.0	3.5		2.0		418
	GA-17	22.5	10.0	3.5	7.5		1,593
	GA-18	3.5	2.0				103
	GA-19	7.0	2.0				155
	GA-20	9.5	3.0			6.5	1,095
	GA-21	19.0	5.0	0.5		5.5	1,168
	GA-22	1.0				1.5	218
	GA-23	10.0	6.0			4.0	840
	Total	321.5	132.0	45.5	38.5	17.5	16,470

Table VIII.3.3(2/2) ANNUAL SEDIMENT YIELD BY BANK EROSION

River	Sub-Basin	Length of Valley (km) Valley Order 1st	2nd	3rd	4th	5th	Annual Bank Erosion (m3/yr)
SILANDAK RIVER	SI-1	11.0	4.0	1.5	1.0		430
	SI-2	5.0	1.5		3.0		473
	Total	16.0	5.5	1.5	4.0	0.0	903
BRINGIN RIVER	BR-1	8.5	9.0	0.5	0.5		428
	BR-2	8.0	1.5	4.5			293
	BR-3	9.5	3.5		5.0		830
	Total	26.0	14.0	5.0	5.5	0.0	1,550
BLORONG RIVER	BL-1	11.0	5.5	2.0			363
	BL-2	3.5	2.0	3.5			208
	BL-3	11.5	7.0				348
	BL-4	9.0	10.0	1.5			430
	BL-5	5.0	7.0	2.0			310
	BL-6	6.0			5.5		750
	BL-7	10.5	2.0	2.5			283
	BL-8	9.5	0.5		5.5		815
	BL-9	11.0	6.0	1.5			360
	BL-10	11.0	0.5		4.5		718
	BL-11	12.0	3.5	4.5			403
	BL-12	2.5	4.0	1.0	3.0		528
	BL-13	6.0	8.5				303
	BL-14	22.5	11.0	4.5			748
	BL-15	0.5		3.0			98
	BL-16	5.0	3.0	3.0			240
	BL-17	12.0	3.0	1.0	8.0		1,245
	BL-18	23.0	3.5	1.5	10.0		1,678
	BL-19	23.0	5.0			5.0	1,145
	Total	194.5	82.0	31.5	36.5	5.0	10,968

Table VIII.3.4 CALCULATION OF BED LOAD TRANSPORT

Outlet of Sub-Basin	Catchment Area (km2)	Channel Gradient	Grain Size Dm (mm)	Bed Load Transport (1000m3/yr.)
Babon River Basin				
BA-1,2	23.06	0.0167	9.570	16.9
BA-5,6	51.85	0.00741	9.570	8.4
BA-7,9	75.04	0.00772	9.570	10.1
BA-10	77.00	0.00841	9.570	16.3
East Floodway Basin				
EA-1,3	17.04	0.00025	0.160	0.1
EA-5,6	29.70	0.000525	0.160	0.4
Garang River Basin				
GA-2,3	56.19	0.0111	12.354	25.3
GA-6	70.90	0.0116	12.354	39.3
GA-7	82.19	0.0119	12.354	46.5
GA-8	90.83	0.00839	12.354	22.4
GA-9,10	13.86	0.0333	14.507	28.1
GA-13	37.69	0.0105	14.507	8.7
GA-17,19	45.70	0.0186	15.154	34.2
GA-20	53.00	0.0152	15.154	22.8
GA-21	62.39	0.0176	15.154	53.1
GA-13,21	100.08	0.0128	15.154	45.6
GA-22	102.60	0.0145	15.154	69.4
GA-8,22	193.43	0.00839	15.154	22.7
GA-23	204.00	0.00046	0.058	3.0

Outlet of Sub-Basin	Catchment Area (km2)	Channel Gradient	Grain Size Dm (mm)	Bed Load Transport (1000m3/yr.)
Silandak River Basin				
SI-1	5.43	0.00555	12.863	0.0
SI-2	8.50	0.0046	0.244	1.7
Bringin River Basin				
BR-1,2	21.91	0.0138	6.551	11.8
BR-3	32.10	0.00113	0.065	1.1
Blorong River Basin				
BL-2,3,4	34.97	0.00952	0.324	24.3
BL-6	50.50	0.0167	0.324	41.1
BL-8,9	73.96	0.0087	0.324	25.5
BL-12	93.74	0.00645	0.324	22.1
BL-17	40.28	0.0154	0.324	37.7
BL-18	52.71	0.0111	0.324	32.1
BL-12,18	146.45	0.00645	0.324	36.3
BL-19	157.00	0.00667	0.324	41.1

Table VIII.3.5 (1/3) ANNUAL SEDIMENT BALANCE

Outlet of Sub-Basin	Sub-Basin	Wash Load (1000m3/yr) Inflow	Sediment Yield: Sheet Erosion	Sediment Yield: Bank Erosion	Deposit within Basin	Discharge	Bed Load (1000m3/yr) Inflow	Deposit	Discharge	Total Sediment Discharge (1000m3/yr)	Specific Sediment Discharge (m3/km2/yr)
< Babon River Basin >											
	BA-1		68.7	0.5	54.9	14.2					
	BA-2		31.9	1.1	25.5	7.5					
BA-1,2	(23.06km2)		100.6	1.6	80.5	21.7			16.9	38.6	1675
	BA-3		70.7	0.7	53.0	18.4					
	BA-4		84.5	0.6	67.6	17.5					
	BA-5		10.3	0.6	7.2	3.7					
	BA-6		55.1	0.5	41.3	14.3					
BA-5,6	(51.85km2)	21.7	220.6	2.4	169.2	75.5	16.9	8.5	8.4	83.9	1619
	BA-7		12.8	0.7	9.6	3.9					
	BA-8		4.4	0.3	3.3	1.4					
	BA-9		43.0	0.6	32.3	11.4					
BA-7,9	(75.04km2)	75.5	60.2	1.6	45.2	92.2	8.4	-1.7	10.1	102.3	1363
	BA-10		2.7	0.4	1.9	1.2					
BA-10	(77.0km2)	92.2	2.7	0.4	1.9	93.4	10.1	-6.2	16.3	109.7	1425
< East Floodway Basin >											
	EA-1		2.6	0.4	1.8	1.2					
	EA-2		47.9	0.5	36.0	12.5					
	EA-3		11.0	0.4	8.3	3.2					
EA-1,3	(17.04km2)		61.5	1.3	46.0	16.8			0.1	16.9	992
	EA-4		21.9	0.3	0.1	22.1					
	EA-5		0.1	0.5	0.0	0.6					
	EA-6		0.6	0.1	0.4	0.3					
EA-5,6	(29.70km2)	16.8	22.5	0.9	0.5	39.7	0.1	-0.3	0.4	40.1	1351
< Silandak River Basin >											
	SI-1		71.9	0.4	53.9	18.4					
SI-1	(5.43km2)		71.9	0.4	53.9	18.4			0.0	18.4	3382
	SI-2		5.7	0.5	4.0	2.2					
SI-2	(8.50km2)	18.4	5.7	0.5	4.0	20.6	0.0	-1.7	1.7	22.3	2624
< Bringin River Basin >											
	BR-1		35.8	0.4	26.9	9.4					
	BR-2		10.3	0.3	8.2	2.4					
BR-1,2	(21.91km2)		46.1	0.7	35.1	11.7			11.8	23.5	1073
	BR-3		63.6	0.8	47.7	16.7					
BR-3	(32.10km2)	11.7	63.6	0.8	47.7	28.4	11.8	10.7	1.1	29.5	919

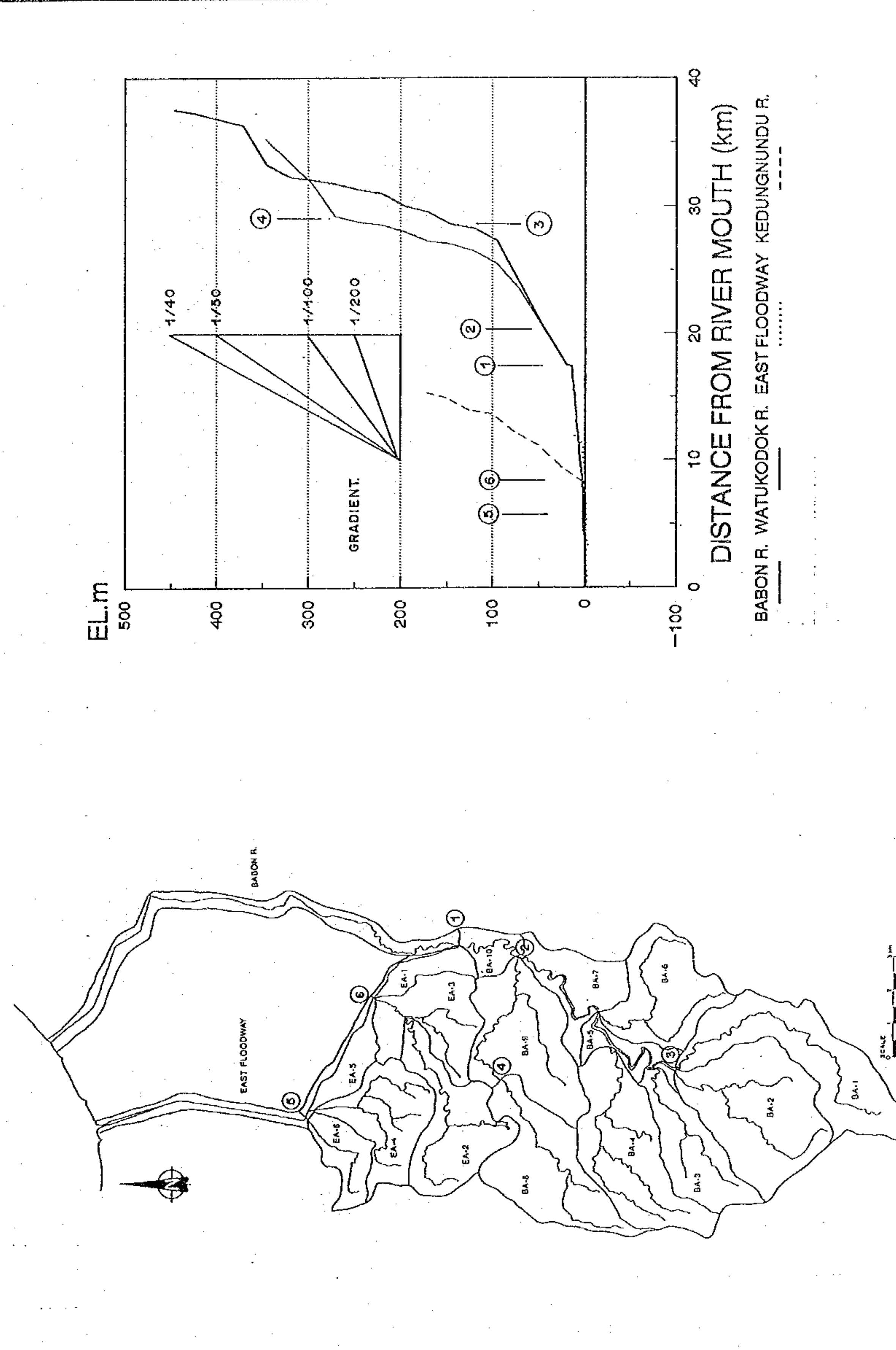
Table VIII.3.5 (2/3) ANNUAL SEDIMENT BALANCE

Outlet of Sub-Basin	Sub-Basin	Wash Load (1000m3/yr)					Bed Load (1000m3/yr)			Total Sediment Discharge (1000m3/yr)	Specific Sediment Discharge (m3/km2/yr)
		Inflow	Sediment Yield		Deposit within Basin	Discharge	Inflow	Deposit	Discharge		
			Sheet Erosion	Bank Erosion							
< Garang River Basin >											
	GA-1		6.0	1.5	4.8	2.7					
	GA-2		96.8	1.6	77.5	21.0					
	GA-3		1.8	0.7	1.4	1.1					
GA-2,3	(56.19km2)		104.6	3.8	83.7	24.7			25.3	50.0	890
	GA-4		57.7	0.7	46.2	12.2					
	GA-5		35.4	0.1	24.8	10.7					
	GA-6		83.5	0.7	58.4	25.7					
GA-6	(70.90km2)	24.7	176.6	1.5	129.4	73.4	25.3	-14.0	39.3	112.7	1590
	GA-7		142.5	0.8	106.9	36.4					
GA-7	(82.19km2)	73.4	142.5	0.8	106.9	109.8	39.3	-7.2	46.5	156.3	1902
	GA-8		133.1	0.8	99.8	34.1					
GA-8	(90.83km2)	109.8	133.1	0.8	99.8	143.9	46.5	24.1	22.4	166.3	1831
	GA-9		25.1	0.4	18.8	6.7					
	GA-10		20.2	0.4	15.1	5.4					
GA-9,10	(13.86km2)		45.3	0.8	34.0	12.1			28.1	40.2	2902
	GA-11		23.9	0.5	17.9	6.5					
	GA-12		45.3	0.3	33.9	11.6					
	GA-13		22.2	0.7	16.7	6.3					
GA-13	(37.69km2)	12.1	91.4	1.5	68.5	36.4	28.1	19.4	8.7	45.1	1198
	GA-14		64.0	1.2	51.2	14.0					
	GA-15		0.0	0.3	0.0	0.3					
	GA-16		5.0	0.4	3.5	1.9					
	GA-17		31.6	1.6	25.3	7.9					
	GA-18		0.0	0.1	0.0	0.1					
	GA-19		5.8	0.2	4.1	1.9					
GA-17,19	(45.70km2)		106.4	3.8	84.0	26.2			34.2	60.4	1321
	GA-20		24.7	1.1	18.5	7.3					
GA-20	(53.00km2)	26.2	24.7	1.1	18.5	33.5	34.2	11.4	22.8	56.3	1062
	GA-21		55.5	1.2	44.4	12.3					
GA-21	(62.39km2)	33.5	55.5	1.2	44.4	45.8	22.8	-30.3	53.1	98.9	1585
GA-13,21	(100.08km2)	82.2				82.2	61.8	16.2	45.6	127.8	1277
	GA-22		11.9	0.2	9.6	2.6					
GA-22	(102.60km2)	82.2	11.9	0.2	9.6	84.8	45.6	-23.8	69.4	154.2	1503
GA-8,22	(193.43km2)	228.7				228.7	91.8	69.1	22.7	251.4	1300
	GA-23		38.3	0.8	30.6	8.5					
GA-23	(204.00km2)	228.7	38.3	0.8	30.6	237.2	22.7	19.7	3.0	240.2	1177

Table VIII.3.5 (3/3) ANNUAL SEDIMENT BALANCE

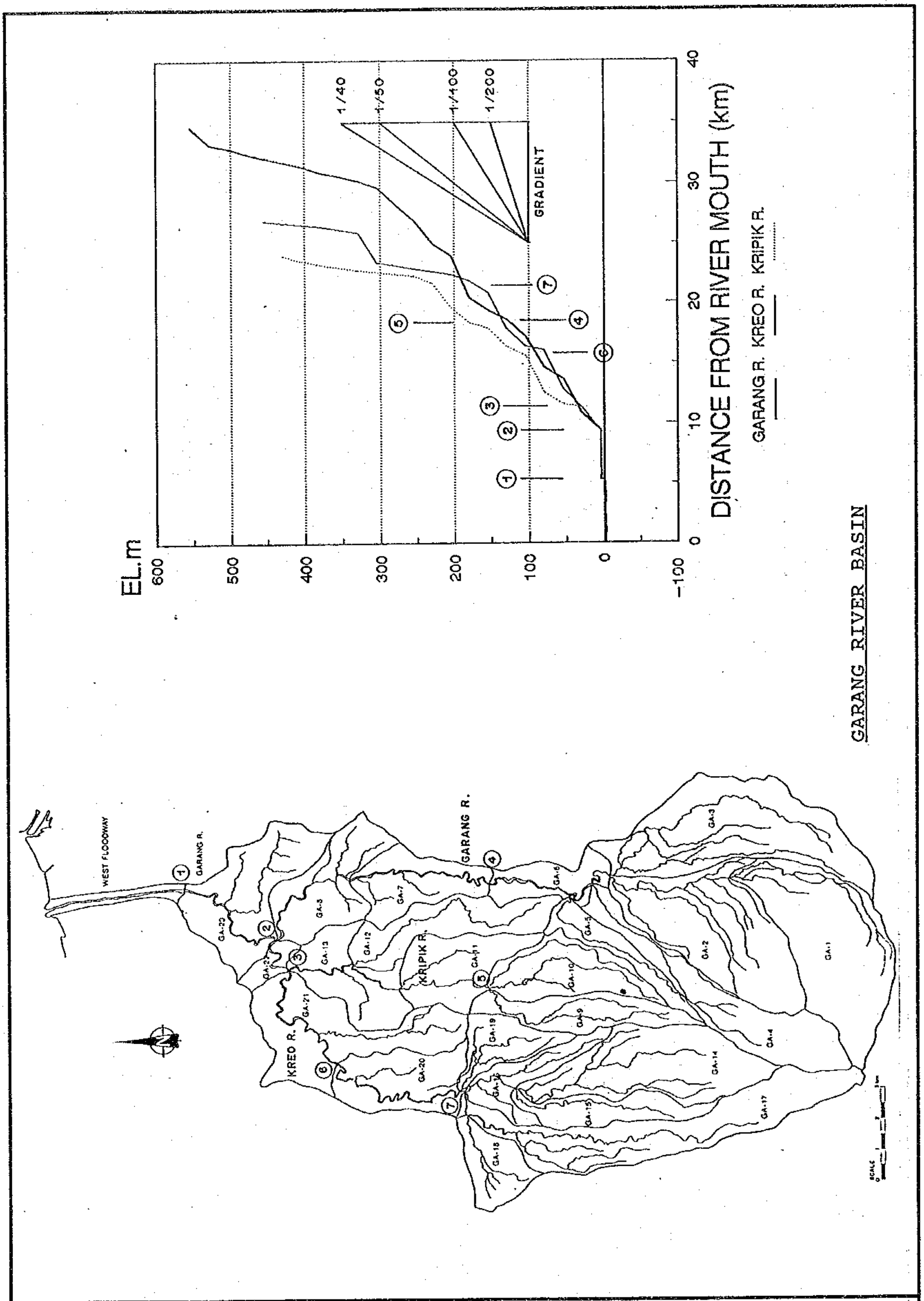
Outlet of Sub-Basin	Sub-Basin	Wash Load (1000m3/yr) Inflow	Wash Load Sediment Yield: Sheet Erosion	Wash Load Sediment Yield: Bank Erosion	Wash Load Deposit within Basin	Wash Load Discharge	Bed Load (1000m3/yr) Inflow	Bed Load Deposit	Bed Load Discharge	Total Sediment Discharge (1000m3/yr)	Specific Sediment Discharge (m3/km2/yr)
< Blorong River Basin >											
	BL-1		0.3	0.4	0.2	0.5					
	BL-2		0.8	0.2	0.6	0.4					
	BL-3		41.3	0.3	31.0	10.6					
	BL-4		38.2	0.4	28.7	10.0					
BL-2,4	(34.97km2)		80.7	1.3	60.5	21.4			24.3	45.7	1308
	BL-5		5.1	0.3	3.8	1.6					
	BL-6		11.2	0.8	8.4	3.6					
BL-6	(50.50km2)	21.4	16.2	1.1	12.2	26.6	24.3	-16.8	41.1	67.7	1340
	BL-7		6.7	0.3	5.0	2.0					
	BL-8		0.1	0.8	0.0	0.8					
	BL-9		11.2	0.4	8.4	3.2					
BL-8,9	(73.96km2)	26.6	17.9	1.5	13.4	32.6	41.1	15.6	25.5	58.1	785
	BL-10		0.9	0.7	0.7	0.9					
	BL-11		56.8	0.4	45.5	11.8					
	BL-12		0.1	0.5	0.1	0.5					
BL-12	(93.74km2)	32.6	57.8	1.6	46.2	45.8	25.5	3.4	22.1	67.9	724
	BL-13		28.4	0.3	22.7	6.0					
	BL-14		167.8	0.7	134.2	34.3					
	BL-15		0.0	0.1	0.0	0.1					
	BL-16		48.5	0.2	33.9	14.7					
	BL-17		67.9	1.2	54.3	14.8					
BL-17	(40.28km2)		312.5	2.5	245.2	69.9			37.7	107.6	2670
	BL-18		59.0	1.7	47.2	13.5					
BL-18	(52.71km2)	69.9	59.0	1.7	47.2	83.4	37.7	5.6	32.1	115.5	2191
BL-12,18	(146.45km2)	129.2				129.2	54.2	17.9	36.3	165.5	1130
	BL-19		1.0	1.1	0.8	1.3					
BL-19	(157.00km2)	129.2	1.0	1.1	0.8	130.5	36.3	-4.8	41.1	171.6	1093

FIGURES



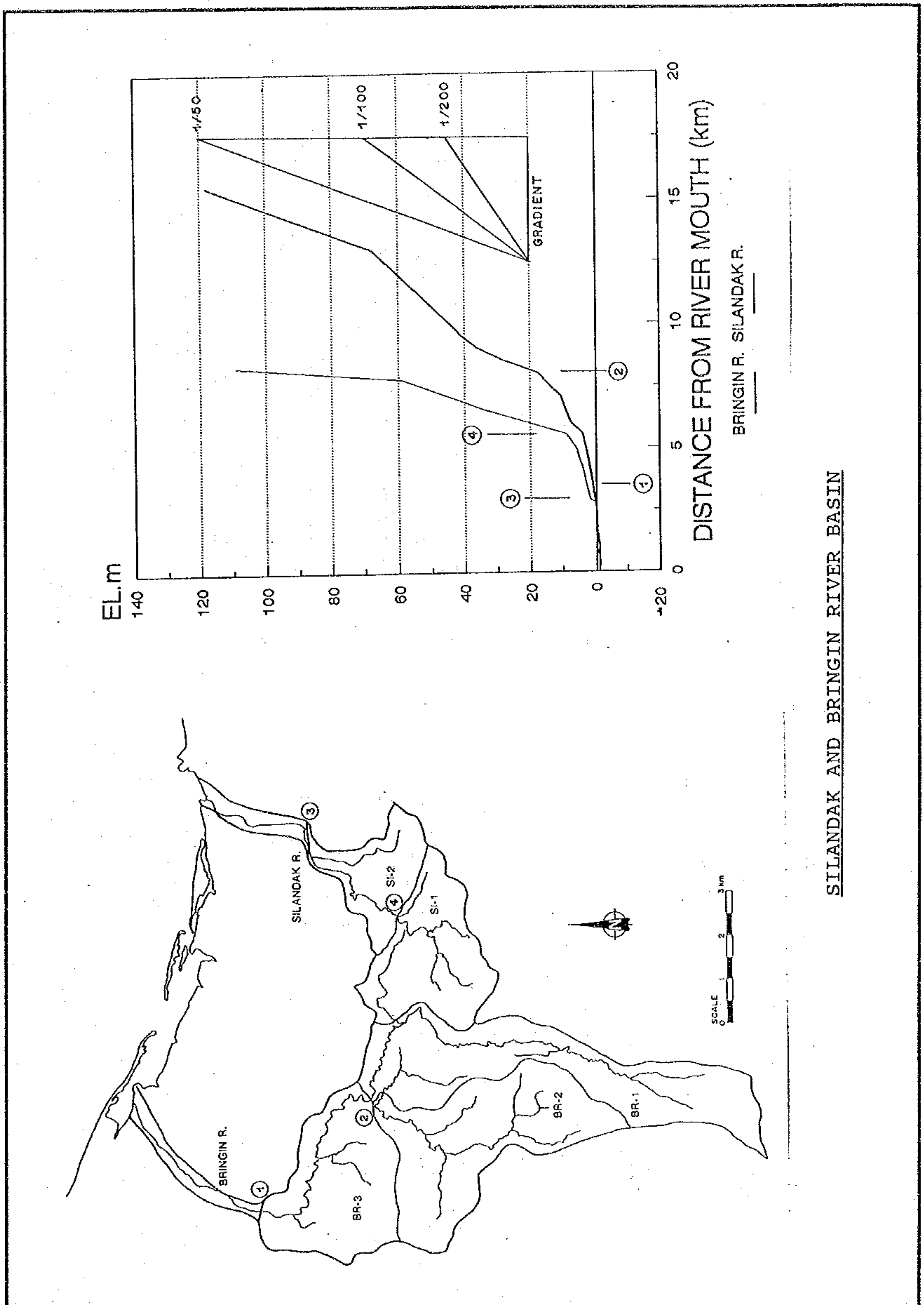
BABON RIVER AND EAST FLOODWAY BASIN

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VIII.2.1 (1/4) BASIN MAP AND LONGITUDINAL PROFILE OF MAJOR RIVERS



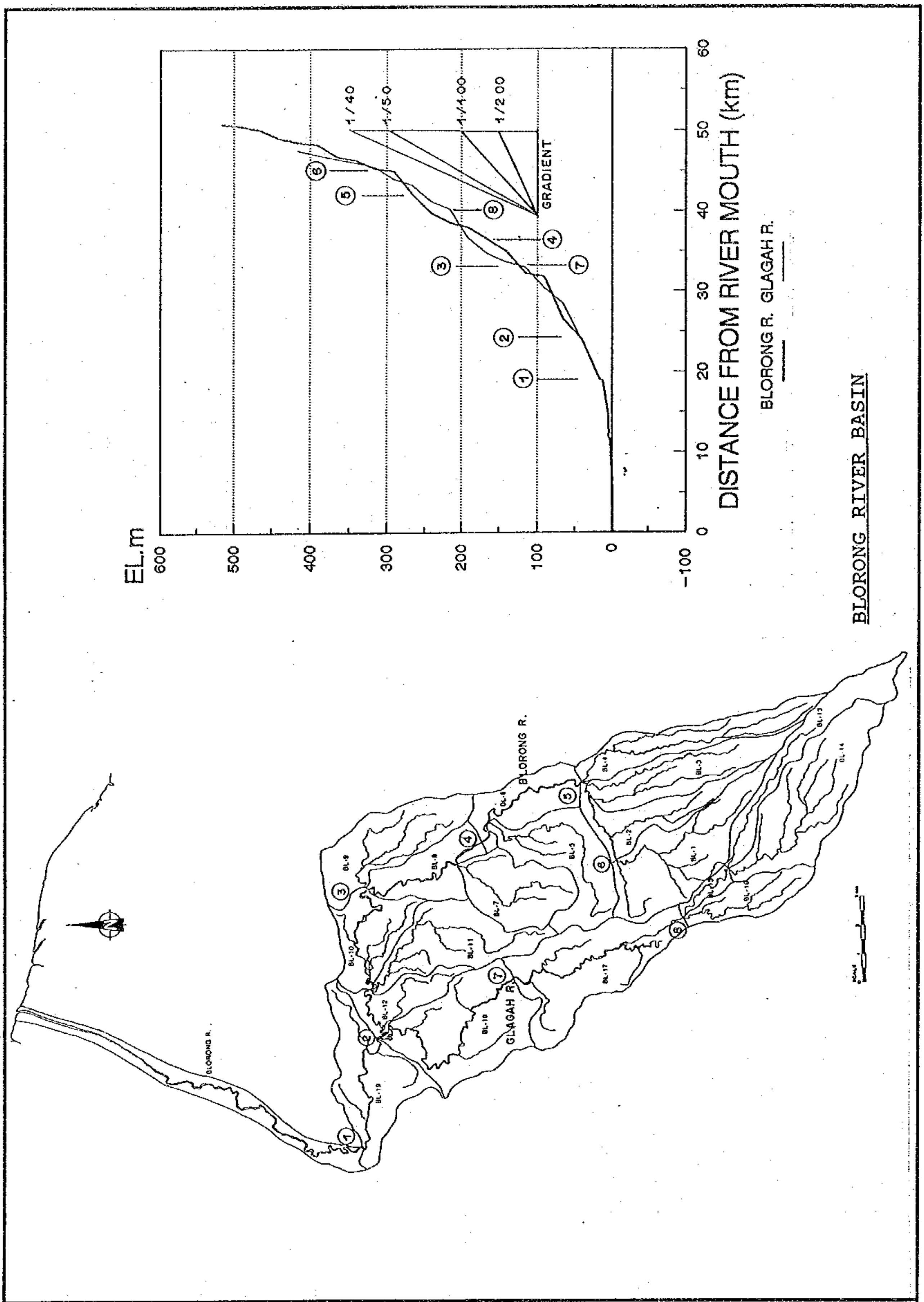
GARANG RIVER BASIN

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VIII.2.1 (2/4) BASIN MAP AND LONGITUDINAL PROFILE OF MAJOR RIVERS
JAPAN INTERNATIONAL COOPERATION AGENCY	



SILANDAK AND BRINGIN RIVER BASIN

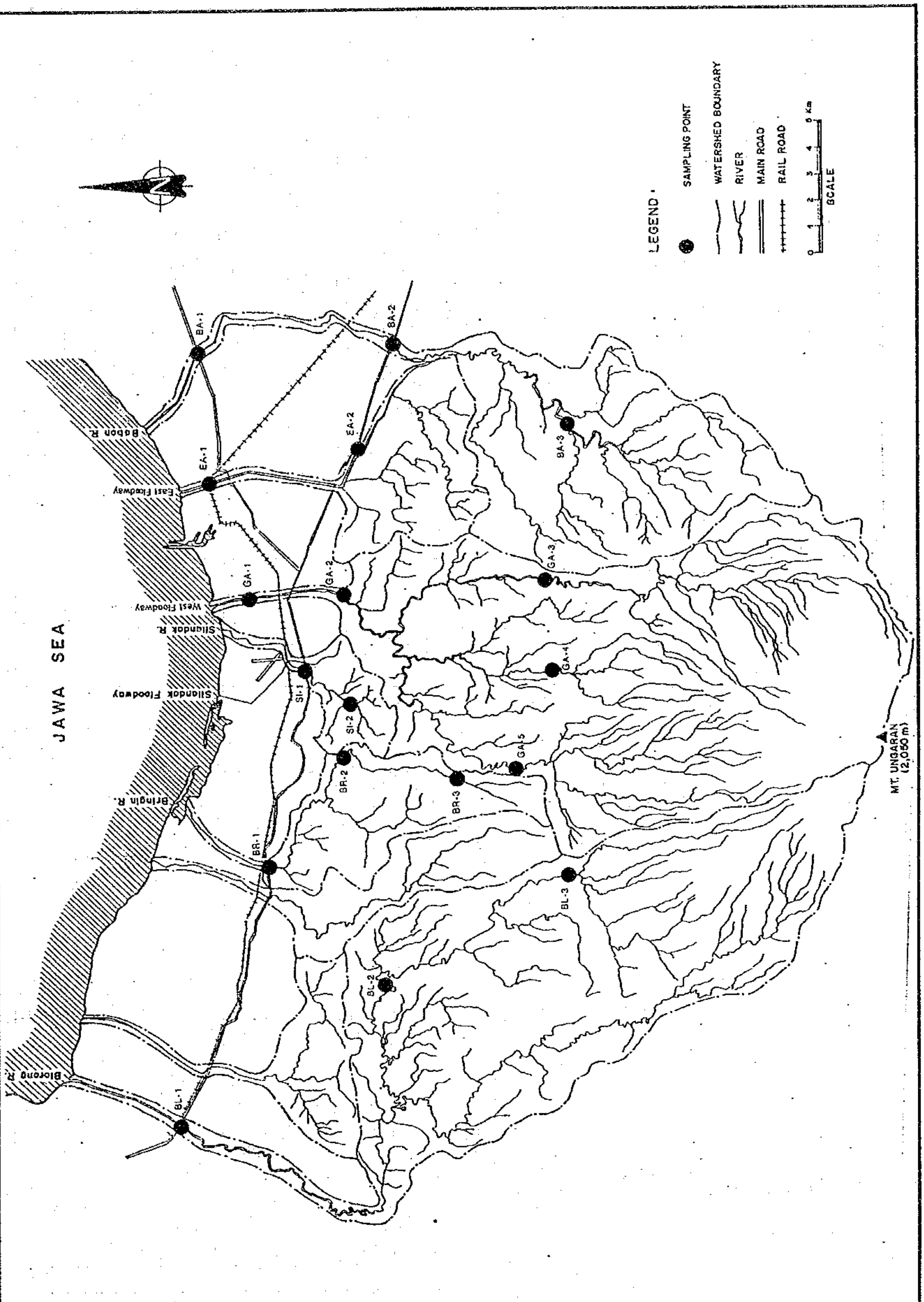
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VIII.2.1 (3/4) BASIN MAP AND LONGITUDINAL PROFILE OF MAJOR RIVERS



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

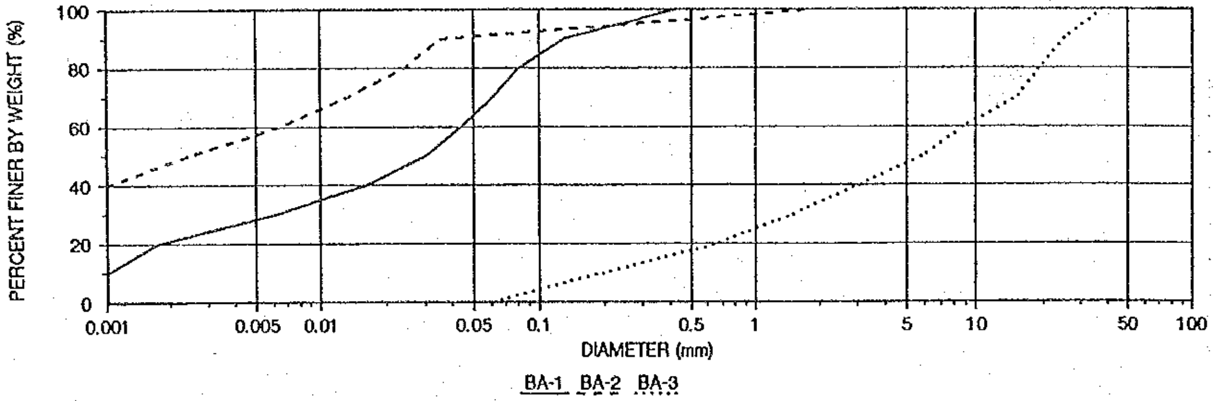
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. VIII.2.1 (4/4)
BASIN MAP AND LONGITUDINAL PROFILE OF MAJOR RIVERS

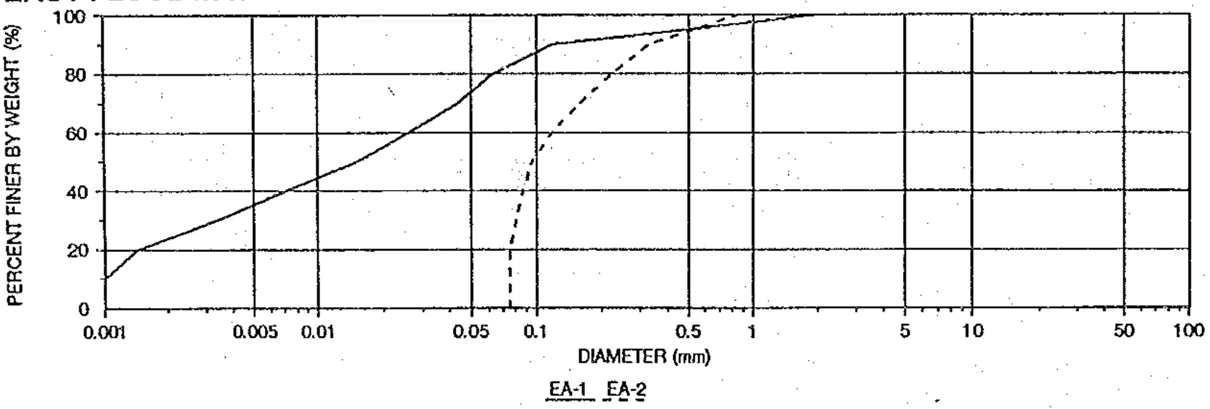


MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VIII.2.2 RIVER BED MATERIAL SURVEY POINTS
JAPAN INTERNATIONAL COOPERATION AGENCY	

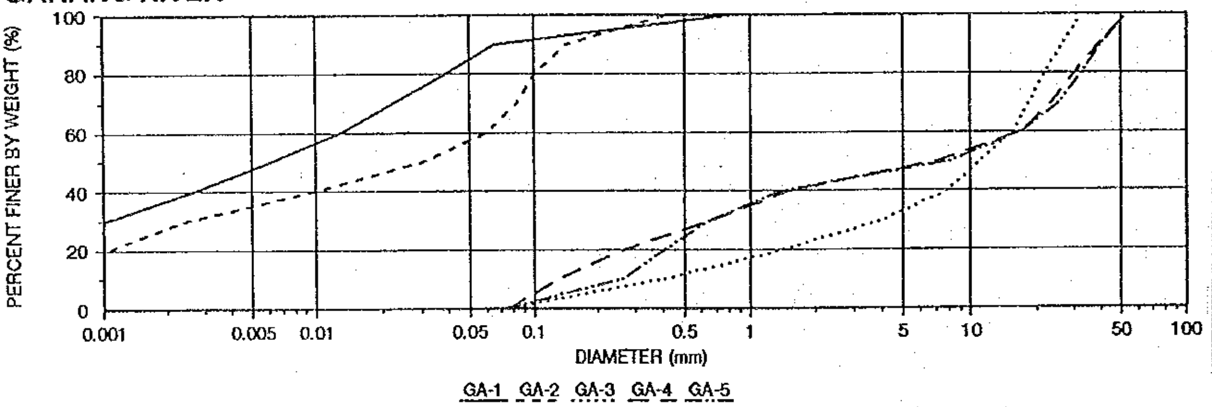
BABON RIVER



EAST FLOODWAY

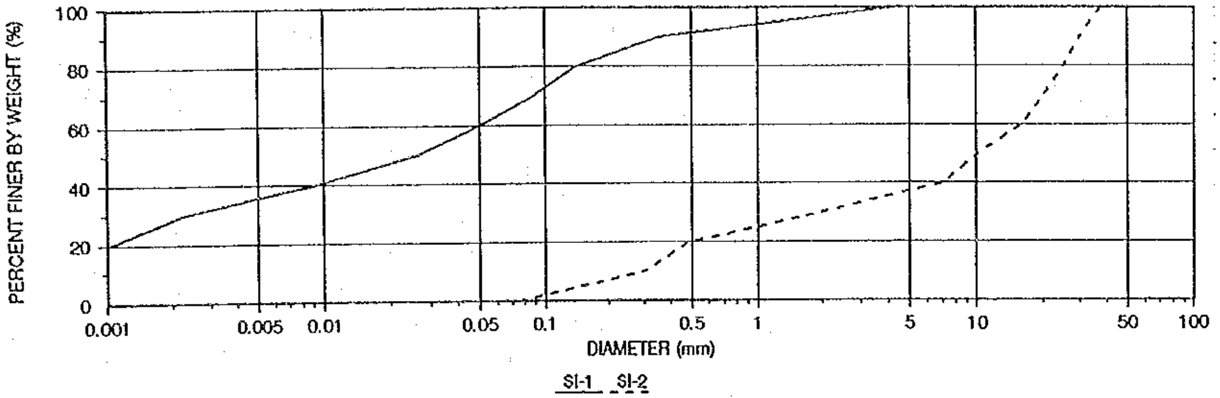


GARANG RIVER

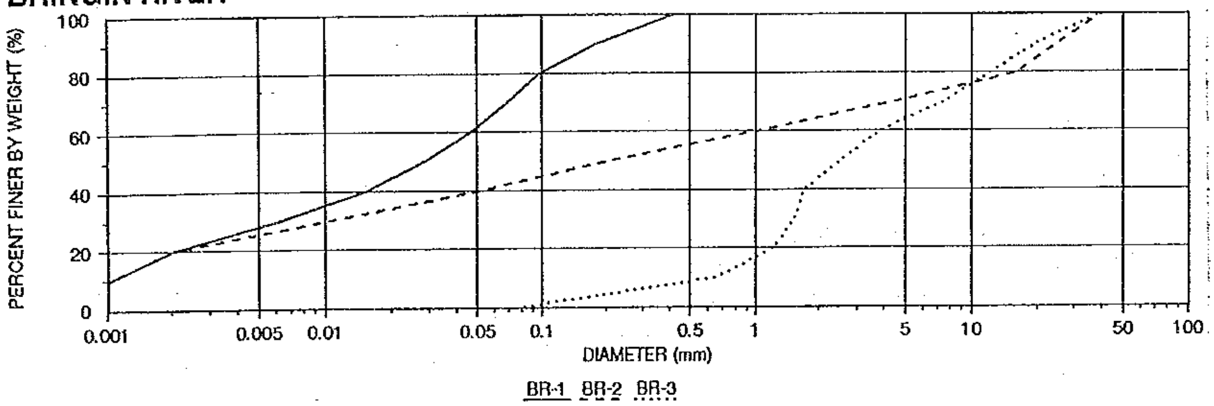


MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VIII.2.3(1/2) GRAIN SIZE ACCUMULATION CURVE OF RIVER BED MATERIALS
JAPAN INTERNATIONAL COOPERATION AGENCY	

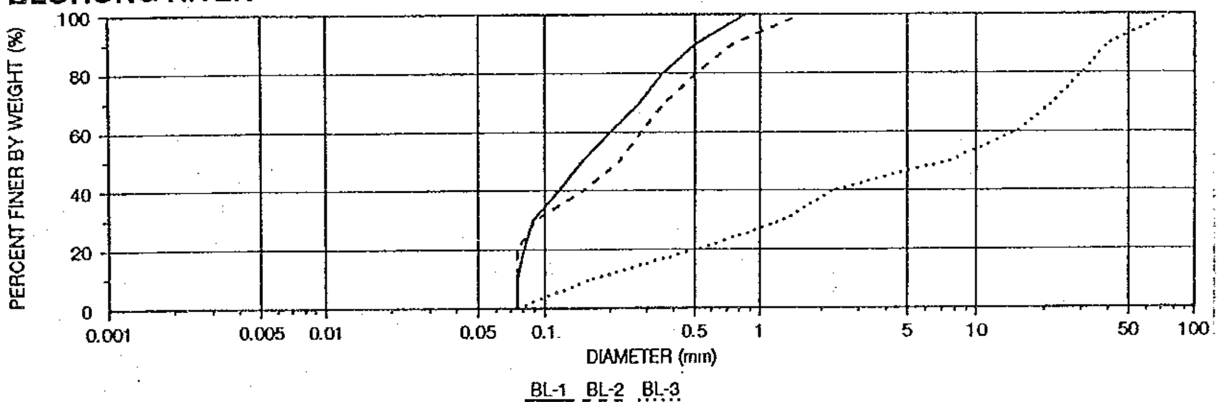
SILANDAK RIVER



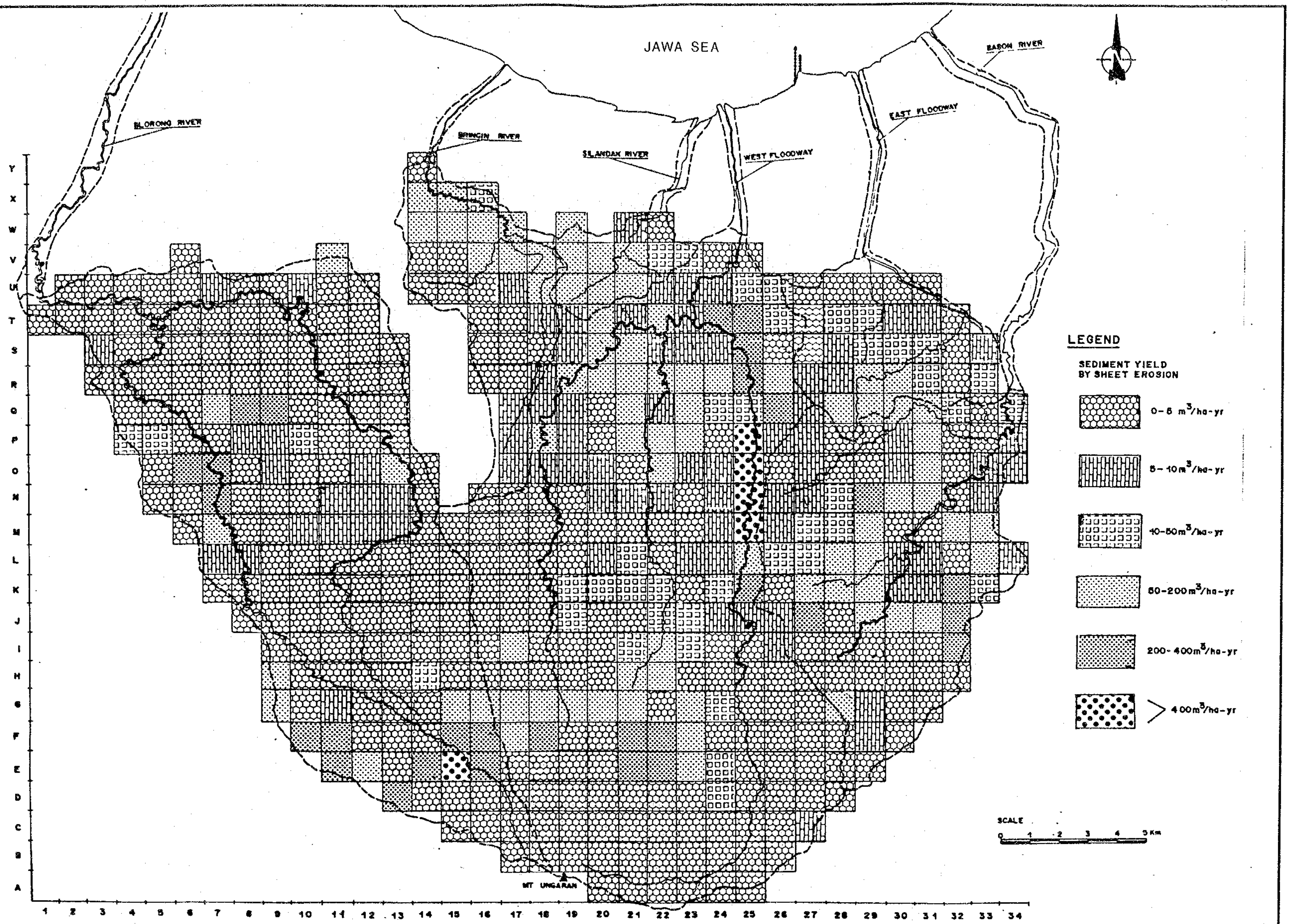
BRINGIN RIVER



BLORONG RIVER



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VIII.2.3(2/2) GRAIN SIZE ACCUMULATION CURVE OF RIVER BED MATERIALS
JAPAN INTERNATIONAL COOPERATION AGENCY	



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VIII.3.1 SEDIMENT YIELD BY SHEET EROSION