(3) Construction of Interbasin Transfer Facilities

<u>Positive Impact</u>

Operation of interbasin transfer will contribute stability of public water supply and effective use of water resources.

<u>Negative Impact</u>

In general, no serious impact can be found.

(4) Improvement of Urban Drainage System

<u>Positive Impact</u>

Completion of urban drainage system improvement will bring effective drainage of stormwater and protection to people's life and assets. Moreover, epidemics that usually come out after inundation will remarkably decrease.

<u>Negative Impact</u>

No serious negative impact is found.

3.4 Preliminary Environmental Evaluation

The Preliminary Environmental Impact Matrix prepared by Diponegoro University is shown in Table IV.3.2. The project needs land for project site when the project is carried out. Significant and large scale negative impacts of land acquisition for the project, particularly, the proposed Kedung Suren Dam and improvement of urban drainage sub-projects, are expected.

Many residents in the project sites are expected to be resettled to other places. Implementing agencies should provide substitute land to resettled residents, and provide adequate information to residents who need to be resettled. Negotiations should be carried out with residents and related agencies for the smooth execution of resettlement.

Considering the magnitude and characteristics of impacts mentioned in Section 3.3, the following sub-projects will need ANDAL study when their feasibility study are carried out in the future.

River Improvement

- Bringin River
- Babon River

Dam Construction

- Kedung Suren Dam
- Mundingan Dam
- Babon Dam

Improvement of Urban Drainage

- Siringin River in Eastern Semarang Area
- Tenggang River in Eastern Semarang Area

CHAPTER 4 ENVIRONMENTAL IMPACT ANALYSIS (ANDAL) FOR FEASIBILITY STUDY

The ANDAL study has been entrusted to Diponegoro University in Semarang City under the supervision of the JICA Study Team. The ANDAL report was approved by the Central AMDAL Commission.

4.1 Targets of the ANDAL Study

According to Indonesian regulations on environmental impact assessment, ANDAL study is needed for the feasibility study on priority projects selected in the master plan study and, as mentioned in CHAPTER 3, PIL study was not then carried out.

The priority projects in each plan have the following project components:

Flood Control Plan

- River improvement
- Dam construction

Urban Drainage Plan

- Improvement of urban drainage system

Water Resources Development Plan

- Dam construction

The priority projects are summarized by type of structures as below:

- River improvement
- Construction of dam
- Improvement of urban drainage system

(1) River Improvement

River improvement will be implemented for West Floodway/Garang River for a stretch of about 9.6 km from the river mouth as the priority project.

(2) Dam Construction

Jatibarang Dam on Kreo River has been selected as the priority project of the flood control and water resources development plans. The ANDAL study is done for Jatibarang Dam and reservoir.

(3) Improvement of Urban Drainage System

Central Semarang Area has been selected as the priority project area for the urban drainage plan and priority projects are put on the following three rivers:

- Semarang River
- Baru River
- Asin River

4.2 Project Activities

The project activities of the priority projects are described below.

(1) River Improvement (West Floodway/Garang River)

Project activities of the river improvement are as follows:

- West Floodway

The width of the low water channel is to be expanded by excavating the high water channel including improvement of the existing embankment and retaining wall. The railway bridge will be raised to an appropriate elevation and Simongan Bridge will be reconstructed.

- Garang River

The existing fixed type Simongan Weir will be reconstructed to a movable weir with gates, and the riverbed will be excavated. Groundsills with and without head will be constructed.

(2) Dam Construction

Technical data of the proposed Jatibarang Dam are as follows:

Purpose : water supply, flood control, and hydropower generation

<u>Dam</u>

Type	:	Concrete Gravity
Catchment Area	:	53.0 km^2
Dam Height	:	81.0 m
Crest Length	:	180.0 m
Crest Elevation	:	EL. +164.0 m
Riverbed Elevation	:	EL. + 83.0 m
Dam Body Volume	:	219,000 m^3

Reservoir

Reservoir Area	:	1.3 km^2
Design Flood Water Level	:	EL. +162.0 m
Surcharge Water Level	:	EL. +158.8 m
Normal Water Level	:	EL. +155.3 m
Low Water Level	:	EL. +136.6 m
Gross Storage Capacity	:	27,800,000 m^3
Flood Control Capacity	:	4,300,000 m^3
Water Supply Capacity	:	16,700,000 m^3
Sediment Capacity	:	6,800,000 m^3

Major activities of dam construction are:

- Construction of temporary facilities
- Diversion works
- Temporary cofferdam
- Excavation
- Concrete placing
- Demobilization and demolition of temporary facilities

(3) Improvement of Urban Drainage System

Project activities for the improvement of urban drainage system are as follows:

Semarang River (total length: 6,900 m)

- Raising of existing earth dike	:	Length: 2,350 m
- Revetment	:	Length: 2,350 m
- Raising of existing retaining wall	:	Length: 540 m
- Dredging	:	Volume: 87,000 m^3
- Construction of pumping stations with gate and retarding ponds	:	2 stations; 2 ponds (area of pond: 2.67 ha and 0.84 ha)

- Construction of secondary drainage channel	:	Length: 800 m

Baru River (total length: 800 m)

- Construction of retaining wall	:	Length: 800 m
- Dredging	:	Volume: 22,000 m^3
- Construction of pumping station with gate		1 station
- Construction of retarding basin	:	Area: 0.93 ha
- Construction of secondary drainage channel	:	Length: 700 m
- Reconstruction of existing gate structure	:	1 unit

Asin River (total length: 1,300 m)

- Construction of retaining wall	:	Length: 1,300 m
- Dredging	:	Volume: 39,000 m^3
- Reconstruction of road bridge	:	1 bridge

4.3 Identification of Environmental Impact

The feasibility study includes river improvement, construction of a dam, and improvement of urban drainage systems. These sub-projects have both positive and negative environmental impacts.

Identification of significant impact is based on number of people and environmental components affected by the project, size, duration and intensity of impact and others. The impact of sub-projects can be identified in three phases: pre-construction phase, construction phase and post construction phase. Project impact flow that cover the possible positive and negative impacts on environment in each phase are shown in Fig. IV.4.1.

Significant and large scale impacts predicted in the ANDAL study are discussed below.

4.3.1 Pre-Construction Phase

Project components in the pre-construction phase are as follows:

(1) Land Acquisition for River Improvement

Land acquisition is not necessary because the construction works will be executed within the existing right-of-way.

(2) Land Acquisition for Dam Construction

Land acquisition of 5.50 ha for the reservoir and dam sites is necessary. No house is to be evacuated from the reservoir area, but the three steel towers of a high-voltage electric transmission line shall have to be relocated.

(3) Improvement of Urban Drainage System

The required area of land for the urban drainage priority project is 5.61 ha which include residential, industrial warehouses and so on. In the project area, 165 houses are to be evacuated. The interview survey by Diponegoro University shows that people do not want to be relocated, because they may lose their jobs and need to find new jobs. Their perception of relocation is mostly negative.

4.3.2 Construction Phase

Project components in the construction phase are as follows:

- Employment of laborers
- Mobilization of laborers
- Mobilization of construction materials
- Mobilization and operation of heavy equipment
- Land clearing
- Construction and operation of access road
- Construction and operation of base camp and warehouse
- Construction of temporary facilities and structures
- Construction of dam and appurtenant structures
- Reconstruction of existing weir
- River dredging
- Construction and improvement of dike
- Construction of pump stations and gate structures
- Transportation and disposal of excavated material
- Reconstruction of road and railway bridges
- Demobilization of heavy equipment and laborers
- Demobilization and demolition of temporary facilities and structures

(1) Impacts Common to all Project Works

Implementation of the project will create employment opportunities and promote economic activities around the project site during the construction period.

Mobilization of construction materials and heavy equipment, and operation of heavy equipment will generate air pollutants such as dust, CO, NO_2 and SO_2. Level of gas emission will depend on type, age and number of vehicles and equipment.

The amenities around project sites will be adversely affected by traffic related to the construction works which cause noise, traffic jams and traffic accidents.

(2) River Improvement

The construction of movable weir, improvement of dike, and dredging of high water channel will generate turbid water and increase construction waste. These situations are expected to cause negative impacts on aquatic biota such as benthos and other aquatic life. Dredging of high water channel will also contribute to the change of benthos habitat.

Construction activities will obstruct public transportation. Furthermore, traffic volume will increase on account of transportation of construction materials and disposal of excavated material.

The construction of revetment or improvement of the existing retaining wall upstream of the intake of PDAM on Garang River will cause river water turbidity and may adversely affect water intake.

(3) Dam Construction

Land clearing and stripping works may cause soil erosion. However, the construction site is protected by a temporary cofferdam so that the downstream will not be affected.

It has been estimated by Diponegoro University that the average plant density is 400 trees/ha in the forest around the project site. Flora in the forest area of 2.4 ha will be affected by the land clearing and stripping works in the project site.

The proposed Jatibarang Dam is a concrete gravity type requiring some 149,000 m^3 of andesitic rock aggregate from Mt. Mergi. The excavation of the borrow area at Mt. Mergi will affect flora and fauna, and transportation of the borrow material will affect public roads.

(4) Improvement of Urban Drainage System

During the dredging work on riverbeds, mud which include much organic matter will be suspended in the water and, accordingly, the mud will consume dissolved oxygen in the river water for a time. As a result, quality of river water may get worse during the dredging works.

The reconstruction of seven road bridges and one railway bridge on Semarang River are required. Since traffic density is already high around the construction sites at present, traffic jams will take place during the reconstruction work.

4.3.3 Post Construction Phase

Project components in the post construction phase are as follows:

- Reservoir impounding
- Reservoir operation
- Watershed management
- Operation and maintenance of flood control facilities
- Utilization of excavated materials for land reclamation

(1) River Improvement

In principle, the functions of the existing fixed weir and the proposed new weir with gates are the same. Therefore, flow regime will be improved by Jatibarang Dam. The improvement of West Floodway will consist of dredging the existing high water channels and does not include riverbed dredging. Therefore, the condition of saline water intrusion will not be changed.

(2) Dam Construction

From the viewpoint of geology, the groundwater level will rise after reservoir impounding so that water level of wells may also rise, and the moisture contents of soil may increase.

Forests under the reservoir level will disappear after impounding, and fauna such as monkeys will be affected. On the other hand, positive impacts after construction are as follows:

- Floods can be controlled.
- Public water supply and river maintenance flow are assured.
- Electric power supply will increase.
- Recreation areas will be developed.
- Life and assets of residents and infrastructures will be protected.
- Epidemics will decrease and public health will be enhanced.

(3) Improvement of Urban Drainage System

The following impacts are expected:

- Reduction of inundation depth, duration and frequency.
- Protection of resident's life and assets and infrastructures.
- Decrease of epidemics and promotion of public health.

4.4 Environmental Impact Evaluation

The Environmental Impact Matrix prepared by Diponegoro University is shown in Tables IV.4.1 and IV.4.2. Environmental impact evaluation on priority projects is as discussed below.

4.4.1 Pre-Construction Phase

(1) River Improvement

Positive Impact

Positive impact is not found in the pre-construction phase.

Negative Impact

The negative impacts during the pre-construction phase of river improvement works consist of negative perception on land acquisition and house evacuation related to the resettlement of 80 families.

(2) Dam Construction

Positive Impact

Positive impact is not found in the pre-construction phase.

Negative Impact

The negative impact during the pre-construction phase of Jatibarang Dam consists of the negative perception related to land acquisition.

(3) Improvement of Urban Drainage System

Positive Impact

Positive impact is not found in the pre-construction phase.

Negative Impact

The negative impacts during the pre-construction phase of urban drainage consists of negative perception related to land acquisition, and resettlement of 165 families.

4.4.2 Construction Phase

(1) River Improvement

<u>Positive Impact</u>

Implementation of the project will increase employment opportunities and promote economic activities.

<u>Negative Impact</u>

The negative impacts during the construction phase of river improvement consists of air pollution by the mobilization of construction materials and equipment, social interaction, change of benthos habitat by dredging, and water pollution by sea water intrusion.

(2) Dam Construction

<u>Positive Impact</u>

Implementation of the project will increase employment opportunities and promote economic activities.

<u>Negative Impact</u>

The negative impact during the construction phase of Jatibarang Dam consists of air pollution by the mobilization of heavy equipment, damage to infrastructures, social interaction, change of flora and fauna, change of water quality, and disturbance of water supply of PDAM.

(3) Improvement of Urban Drainage System

Positive Impact

Implementation of project will increase employment opportunities and promote economic activities.

Negative Impact

The negative impact during the construction phase of urban drainage consists of air pollution by the mobilization of heavy equipment, obstruction of transportation by construction activities and mobilization, social interaction, and water pollution by sea water intrusion.

4.4.3 Post Construction Phase

(1) River Improvement

Positive Impact

Operation and maintenance of Simongan Weir would control flood.

Negative Impact

There is no negative impact.

(2) Dam Construction

Positive Impact

Operation of Jatibarang dam will reduce the negative impacts and increase the positive impacts. The positive impacts cover the improvement of water resources, land, settlement, and public health.

Negative Impact

The negative impacts cover slope stability of Kreo Cave, water quality (eutrophication), aquatic biota, and sedimentation in the reservoir.

(3) Improvement of Urban Drainage System

Positive Impact

In general, the activities in the post construction phase will control inundation.

Negative Impact

The only possible negative impact is saltwater intrusion by riverbed dredging.

4.5 Recommendations

The following are recommended to minimize negative environmental impact and maximize positive impact.

(1) Pre-Construction Phase

Social restlessness created by the plan of project activities can be handled by disseminating adequate information to related communities about the purposes and advantages of the project.

Negative impacts of land acquisition, house evacuation and resettlement can be reduced by giving appropriate and prompt compensation. Evacuation should be performed carefully and appropriately by preparing all alternative resettlement areas properly.

Coordination with related central and regional government agencies are indispensable for the smooth implementation of the project.

(2) Construction Phase

The negative impact of air pollution, noise and vibration cannot be avoided. Mobilization of construction materials and equipment, and operation of heavy equipment will increase such impacts. Number of vehicles operated will also damaged road systems. This impact may be reduced by covering dump-trucks during hauling of excavated material, arranging the number of vehicles and equipment, and proper maintenance.

The negative impact of recruiting laborers from other regions will increase social interaction. This can be prevented through proper association with contractors and the labour recruitment bureau.

(3) Post Construction Phase

Goa Kreo (Kreo Cave) will not be affected by the reservoir because the design flood level of Jatibarang Dam is proposed at EL. 162.0 m which is slightly lower than the elevation of Goa Kreo based on the probable maximum flood (PMF) with recurrence probability of once in ten years or more. However, the access road to Goa Kreo should be elevated higher than EL. 162.0 m (DFWL) for the free access of visitors.

TABLES

Table IV.1.1 (1/3) RESULTS OF WATER QUALITY SURVEY IN FLOOD CONTROL AND WATER RESOURCES DEVELOPMENT PROJECT AREAS

Sampling Data : Blorong River May 19 , 1993 ,Bringin River and Silandak River May 17 , 1993

		BLORONG RIVER							BRINGIN RIVER		SILANDAK RIVER		
PARAMETER	unit	BL-0A	BL-0B	BL-1	BL-2	BL-3	BL-4	BL-5	BR-1	BR-2	SL-1	SL-2	SL-3
Temperature	C	29.4	25.7	29.2	30.0	30.5	29.5	31.0	24.6	24.5	24.4	24.8	24.8
pH	-	8.6	7.7	8.9	9.0	9.1	8.7	9.1	7.7	7.8	8.1	8.4	7.8
ORP	mv	238	152	342	259	255	241	260	163	200	177	215	195
DO	ppm	6	8	11	9	11	7	11	7	7	7	13	0
BOD	ppm	6	4	5	4	6	24	8	2	2	5	0	2
COD	ppm	5	6	6	16	6	89	14	81	79	27	20	72
PO4-P	ppm	2.45	2.57	1.75	1.63	1.75	1.81	1.75	2.10	2.22	1.95	3.27	6.07
Total-Phosphate	ppm	4.08	7.18	1.87	4.08	1.86	2.86	2.34	5.02	4.97	6.13	5.43	8.76
NO2-N	ppm	0.04	0.05	0.01	0.01	0.00	0.00	0.90	0.00	0.08	0.07	0.02	0.01
NO3-N	ppm	0.17	0.09	0.07	0.06	0.05	0.21	0.13	0.08	0.07	0.06	0.00	0.01
NH4-N	ppm	0.00	0.06	0.02	0.06	0.00	0.18	0.34	0.23	0.08	0.09	0.18	0.27
Total-Nitrogen	ppm	1.05	0.97	1.05	1.05	1.06	1.01	1.12	0.87	0.85	0.86	0.83	0.86
Ca	ppm	22.8	19.3	24.4	26.8	30.7	41.7	41.7	29.9	32.3	63.0	82.7	64.6
Mg	ppm	4.0	4.9	6.6	5.6	5.6	7.5	19.1	9.2	6.3	10.4	45.4	3.7
Total-Hardness	ppm	4.1	3.8	4.9	5.1	5.6	7.6	10.3	6.3	6.0	11.3	22.2	9.9
ALK-pp	ppm	4.9	5.0	4.9	7.4	5.0	9.9	4.9	4.9	9.9	4.9	4.9	9.9
Alk-MO	ppm	124	129	132	139	159	199	211	146	139	293	283	248
Cl	ppm	23.80	88.93	47.59	138.90	22.54	26.30	140.20	66.38	40.76	36.32	608.69	61.37
Mn	ppm	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fe	ppm	0.52	0.44	0.82	0.47	0.08	0.08	0.05	0.62	0.62	0.14	0.63	0.62
Suspended Solid	ppm	44	95	42	40	120	17	9	121	105	46	16	21
TDS	ppm	147	330	128	167	140	238	421	222	118	317	1538	363
Na	ppm	26.3	29.8	38.6	38.4	34.4	39.5	148.2	34.9	57.1	95.6	48.5	88.1
SO4	ppm	11.3	14.7	19.2	20.4	13.6	20.4	20.4	23.8	23.8	24.9	28.3	12.4
EC	mho	214	211	285	273	281	398	786	444	350	593	2750	613

BL-2 :proposed Kedung Suren Dam

BL-OB:Sampling Data May 22 ,1993

Table IV.1.1 (2/3) RESULTS OF WATER QUALITY SURVEY IN FLOOD CONTROL AND WATER RESOURCES DEVELOPMENT PROJECT AREAS

Sampling Data : May 22 , 1993

PARAMETER	unit	KREO RIVER and INTAKE POINT in BLORONG RIVER								
		KR-1	KR-2	KR-3	KR-4	KR-5	KR-6	KR-7	KR-8	KR-9
Temperature	C	28.9	28.6	28.0	29.5	30.5	31.8	32.0	30.8	30.1
pH	-	7.8	7.8	8.2	7.8	9.1	9.2	9.1	7.6	7.9
ORP	mv	169	159	172	159	216	238	244	171	173
DO	ppm	8	8	8	8	10	9	8	6	6
BOD	ppm	3	3	4	4	4	2	3	5	4
COD	ppm	3	3	6	6	8	45	30	2	30
PO4-P	ppm	1.75	1.44	2.10	1.63	1.28	10.16	3.74	2.10	2.34
Total-Phosphate	ppm	3.15	2.22	4.91	8.70	6.77	11.21	4.32	2.45	8.52
NO2-N	ppm	0.00	0.00	0.11	0.00	0.00	0.04	0.04	0.04	0.05
NO3-N	ppm	0.03	0.05	0.05	0.06	0.04	0.62	0.05	0.04	0.03
NH4-N	ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.25
Total-Nitrogen	ppm	0.96	0.94	0.97	0.98	0.93	1.00	0.98	0.95	0.59
Ca	ppm	21.6	11.8	14.8	17.3	21.2	18.1	21.6	26.8	70.1
Mg	ppm	7.6	5.6	4.9	5.2	3.5	8.0	6.6	11.3	161.7
Total-Hardness	ppm	4.7	2.9	3.3	3.6	3.8	4.4	4.5	6.4	47.5
ALK-pp	ppm	9.9	14.9	9.9	9.9	24.8	27.3	17.4	9.9	19.9
Alk-MO	ppm	134	109	117	112	109	114	122	154	164
Cl	ppm	22.54	22.54	22.54	23.80	27.55	27.55	26.30	105.20	2279.00
Mn	ppm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fe	ppm	0.62	0.51	0.54	0.32	0.17	0.61	0.27	0.16	0.17
Suspended Solid	ppm	12	22	9	29	31	52	17	26	5
TDS	ppm	174	221	191	141	220	199	182	365	5291
Na	ppm	30.7	35.7	33.1	35.8	43.8	51.4	44.5	197.6	3405.0
SO4	ppm	3.9	1.7	2.2	4.5	5.5	11.3	9.6	19.2	39.6
EC	mho	227	192	201	262	243	259	255	596	8540

KR-1,KR-2,KR-3 : Proposed Mundingan Dam Site

KR-4 : Proposed Jutibarang Dam Site

Table IV.1.1 (3/3) RESULTS OF WATER QUALITY SURVEY IN FLOOD CONTROL AND WATER RESOURCES DEVELOPMENT PROJECT AREAS

Sampling Data : East Floodway May 17 , 1993 ,Babon River May 20 , 1993

		EAST FLOODWAY					BABON RIVER			
PARAMETER	unit	EF-1	EF-2	EF-3	EF-4	EF-5	BA-1	BA-2	BA-3	BA-4
Temperature	C	24.9	24.9	24.8	24.8	24.8	31.6	30.0	35.1	32.2
pH	-	8.5	8.5	7.9	8.1	8.1	9.0	8.8	8.6	9.6
ORP	mv	231	214	-131	175	180	268	262	193	-211
DO	ppm	8	14	0	3	3	9	7	10	0
BOD	ppm	2	1	153	2	2	5	5	4	66
COD	ppm	11	23	253	190	109	42	33	21	250
PO4-P	ppm	7.85	1.40	8.97	3.03	6.42	5.96	6.19	7.47	11.33
Total-Phosphate	ppm	10.28	5.14	10.07	3.32	7.72	9.34	7.01	9.34	15.77
NO2-N	ppm	0.13	0.04	0.01	0.06	0.05	0.09	0.04	0.04	0.17
NO3-N	ppm	0.08	0.00	0.00	0.00	0.00	0.05	0.08	0.03	0.00
NH4-N	ppm	0.16	0.13	0.08	0.60	1.12	0.01	0.69	0.15	0.64
Total-Nitrogen	ppm	1.95	0.86	0.88	0.74	0.86	1.01	1.12	1.18	0.98
Ca	ppm	46.1	46.1	61.4	201.7	189.5	39.4	35.4	35.4	226.9
Mg	ppm	12.5	14.4	22.7	568.4	500.1	12.7	24.1	35.4	540.5
Total-Hardness	ppm	9.1	9.8	13.8	160.8	143.2	8.5	9.6	13.2	157.9
ALK-pp	ppm	2.4	4.9	9.9	7.4	9.9	2.4	7.4	9.9	9.9
Alk-MO	ppm	203	238	355	233	248	213	216	251	330
Cl	ppm	32.56	30.06	70.14	8091.00	7364.00	33.82	38.83	38.83	9456.00
Mn	ppm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fe	ppm	0.16	0.39	0.21	0.26	0.13	0.51	0.02	0.01	0.02
Suspended Solid	ppm	10	48	21	28	28	73	84	75	76
TDS	ppm	416	306	515	16409	15835	455	291	290	20238
Na	ppm	121.0	110.0	58.5	9689.0	9661.0	131.6	115.6	117.0	13556.0
SO4	ppm	18.1	20.4	24.9	215.3	215.3	35.1	47.6	53.2	224.4
EC	mho	565	557	731	27200	25300	593	606	703	32400

Table IV.1.2 RESULTS OF WATER QUALITY SURVEY IN URBAN DRAINAGE PROJECT AREAS

Sampling Data : May 24 , 1993

		EASTERN SEMARANG			CENTRAL SEMARANG							WESTERN SEMARANG	
PARAMETER	Unit	ES-1	ES-2	ES-3	CS-1	CS-2	CS-3	CS-4	CS-5	CS-6	CS-7	WS-1	WS-2
Temperature	C	30.5	32.5	30.5	31.0	32.0	31.8	30.0	31.5	32.6	30.4	30.0	30.5
pH	-	7.9	8.5	8.6	7.6	7.7	7.8	8.0	7.8	7.7	7.8	7.9	7.7
ORP	mv	87	176	165	-229	-309	134	-112	63	-294	-210	184	132
DO	ppm	3	1	13	0	0	3	1	1	0	0	2	1
BOD	ppm	10	57	12	33	35	0	11	13	99	66	49	2
COD	ppm	20	113	30	112	80	21	64	93	184	128	127	58
PO4-P	ppm	3.04	9.11	2.45	9.81	10.86	3.62	9.81	5.49	9.46	40.88	3.85	8.18
Total-Phosphate	ppm	3.73	10.86	3.04	12.85	14.60	12.26	12.56	11.68	33.29	61.90	33.87	8.87
NO2-N	ppm	0.05	0.00	0.07	0.01	0.04	1.30	0.01	0.00	0.04	0.06	0.04	1.01
NO3-N	ppm	0.33	0.03	0.01	0.01	0.02	0.27	0.03	0.01	0.00	0.01	0.02	0.10
NH4-N	ppm	0.23	0.91	0.13	2.71	3.69	0.04	0.58	1.70	10.22	12.19	2.11	0.00
Total-Nitrogen	ppm	1.02	0.86	0.98	0.91	0.98	0.98	1.00	0.92	0.98	1.01	1.00	1.01
Ca	ppm	48.8	208.8	61.4	174.1	73.0	28.3	37.0	160.7	54.3	64.6	66.2	24.4
Mg	ppm	12.7	578.8	21.7	473.3	212.5	5.6	14.9	453.0	36.1	29.0	15.3	9.9
Total-Hardness	ppm	9.8	164.3	13.6	134.8	62.6	5.3	8.6	128.2	16.0	15.8	12.8	5.8
ALK-pp	ppm	14.9	19.9	4.9	5.0	5.0	7.4	14.9	9.9	9.9	9.9	14.9	5.0
Alk-MO	ppm	258	318	333	253	258	174	241	199	583	635	422	139
Cl	ppm	41.33	8579.00	399.50	7101.50	3005.00	33.82	147.70	6863.00	155.30	234.20	102.70	26.30
Mn	ppm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.4	1.8	0.0
Fe	ppm	0.45	0.04	0.25	0.54	0.25	0.68	0.55	0.04	0.07	0.08	0.05	0.05
Suspended Solid	ppm	74	36	40	90	94	49	31	94	20	77	17	169
TDS	ppm	355	19352	9157	15532	6402	268	495	16471	1220	883	787	599
Na	ppm	371.0	9780.0	742.4	6659.0	3823.0	58.1	204.1	8892.0	351.8	471.2	173.2	30.6
SO4	ppm	13.6	65.7	30.6	31.7	53.2	12.4	23.8	55.5	36.2	39.6	19.2	15.8
EC	mho	677	28800	1986	24100	10980	416	869	24300	1662	1884	1113	338

Table IV.1.3 NUMBER OF VISITORS OF RECREATIONAL AREAS AND FACILITIES IN SEMARANG, 1988 - 1992

NO.	NAME	TYPE	MANAGED BY	1988	1989	1990	1991	1992
1.	Kreo Park	Recreational area	Tourism Agency	14,573	19,955	16,633	28,470	26,148
2.	Taman Majapahit	Recreational area	Private Company	17,268	206,370	212,209	210,440	176,209
3.	Kebon Binatang Tinjomoyo	Zoo	Tourism agency	-	95,190	89,863	84,272	114,125
4.	Taman Tanjung Mas	Reservation area	Private Company	433,290	421,193	316,292	165,767	171,163
5.	Taman Tirto Unggul	Recreational area	Private Company	18,652	70,542	44,232	37,849	19,400
6.	Hutan Wisata Penggaron	Recreational area	Department of Forestry	38,466	43,218	47,773	47,708	49,556
7.	Taman Lele	Recreational area	Tourism Agency	71,371	72,363	58,060	42,866	35,638
8.	Kolam Renang Tugu	Swimming Pool	Private Company	36,196	41,574	43,129	41699	46,609

Source :No.1 Tourism Agency, Semarang City
No.2-8 Data & Statistik Pariwisata, Pos dan Telekomuinikasi Jawa Tengah 1988-1992

Table IV.1.4 NUMBER OF VISITORS IN GOA KREO PARK, 1988-1992

unit: number of persons

	1988	1989	1990	1991	1992
January	1,579	2,333	1,313	1,543	2,780
February	817	749	1,490	1,106	2,265
March	1,065	1,081	1,465	830	1,266
April	1,302	1,030	704	5,306	6,017
May	921	3,205	1,623	1,725	1,499
June	1,695	1,888	1,407	5,859	1,630
July	2,237	1,499	1,939	3,510	1,827
August	1,017	1,330	1,251	1,666	1,249
September	843	1,346	1,280	2,431	1,593
October	1,242	1,839	1,348	934	1,306
November	943	1,514	1,238	1,273	2,597
December	912	2,141	1,575	2,287	2,119
Total	14,573	19,955	16,633	28,470	26,148

source: Tourisum Agency, Semarang City

Table IV.2.1 LEVELS OF ENVIRONMENTAL IMPACT STUDY AND PROJECT COMPONENTS

Study Level / Project Component	PIL	ANDAL
River Improvement	Blorong River Bringin River Silandak River East Floodway Babon River	West Floodway/Garang River
Construction of Dams and Interbasin Transfer	Kedung Suren Dam Mundingan Dam Babon Dam Interbasin Transfer from Blorong to Mundingan Dam	Jatibarang Dam
Improvement of Urban Drainage System	Eastern Semarang Area -Siringin River -Tenggang River (New Diversion Channel) -Tenggang River Central Semarang Area -Banger River -Bulu River Western Semarang Area -Ronggolawe River -Karangayu River -Silandak Channel	Central Semarang Area -Semarang River -Baru River -Asin River

Proposed Kedung Suren Dam and Jatibarang Dam are for flood control and water resources development
Proposed Mundingan Dam and Babon Dam are for water resources development

Table IV.3.1 TECHNICAL DATA OF PROPOSED DAMS FOR THE PIL STUDY

DESCRIPTION	NAME OF DAM		
	BABON	MUNDINGAN	KEDUNG SUREN
Purpose	Water Supply	Water Supply	Water Supply and Flood Control
DAM			
Type	Rockfill	Concrete Gravity	Rockfill
Catchment Area	51.9 km2	45.7 km2	146.5 km2
Dam Height	35.0 m	45.0 m	41.0 m
Crest Length	1,280.0 m	400.0 m	800.0 m
Crest Elevation	E.L .+ 75.0 m	E.L. + 230.0 m	E.L. + 76.0 m
Riverbed Elevation	E.L. + 40.0 m	E.L. + 185.0 m	E.L. + 35.0 m
Volume of Dam Body	5,890,000 m3	188,000 m3	4,120,000 m3
RESERVOIR			
Reservoir Area	3.8 km2	2.5 km2	8.6 km2
Design Flood Level	E.L. + 72.0 m	E.L. + 228.0 m	E.L. + 73.0 m
Surcharge Water Level	-	-	E.L. + 71.0 m
Normal Water Level	E.L. + 69.0 m	E.L. + 224.6 m	E.L. + 69.9 m
Low Water Level	E.L. + 55.7 m	E.L. + 207.9 m	E.L. + 60.3 m
Gross Storage Capacity	45,900,000 m3	35,900,000 m3	72,100,000 m3
Flood Control Capacity	0 m3	0 m3	10,700,000 m3
Effective Storage Capacity	35,700,000 m3	28,500,000 m3	52,400,000 m3
Sediment Capacity	10,200,000 m3	7,400,000 m3	19,700,000 m3

source: Doponegoro University ,Preliminary Environmental Information Study for the Master Plan on Water Resources Development and Feasibility Study for Urgent Flood Control and Urban Drainage in Semarang City and Suburs, 1993

Table IV.3.2 PRELIMINARY ENVIRONMENTAL IMPACT MATRIX FOR THE MASTER PLAN PROJECT

		Micro Climate	Phisiography	Geology	Watershed character	Rainfall	River Discharge	Flood	Erosion Sedimentation	Water Quality	Water Resources	Land Use	Terrestrial Flora	Terrestrial Fauna	Plankton	Bentos	Bacteri Coli	Population	Educaation	Labour	Income	Social Relationship	Amenity	Tradition	Society Perception
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
PRE- CONSTRUCTION																									
1	Land Clearing		-	-	-		-	-	-	--	--	--	-	-				-		+			-		+
2	Land Acquisition			-	--		--	-	-	-	-	-	-	-									--		--
3	Resettlement		-					-			-	-						+	+	+		++	--	-	--
CONSTRUCTION																									
4	Mobilisation & Demo. Heavy Equip.										-	-							++	+	+	+			
5	Mobilisation of Labour																	+	+	++	++	+			
6	Land Clearing		+	-	-		-	-	--	-	-	-	-	-											-
7	Construction/Operat.of Base Camp								-			-	-	-						+	+				+
8	Construction/Operat.of Access Road	-	+						-			-	-	-						+	+	+			
9	Constr./Operat.of Diversion Tunnel		-	+	+		+	+	-	-					-	-				+	+				
10	Construction of Dam		++	++	++		-		--	-		+								++	++				
11	Dredging/Excavation of River		+		+			+++	--	--	-				--	--	+			++	++		-		+
12	Raising Dike Level		+		+		+	+++	+											+	+			-	+
13	Hauling of Soil																			+	+		-		
14	Disposal of Soil		-		-			-	--											+	+		-		-
15	Reconstruction/Relocation of Bridge									-										+	+	+	--	-	-
16	Relocation of Transmission Line																			+	+		-		-
POST CONSTRUCTION																									
17	Impounding of Reservoir	+			+++	+	--	+++	--	+	-		+		+	+		--		+	+				-
18	Operation of Dam	+			+++		++++	++++	+	+	+++		+		+	+				++	++		++		+
19	Operation of Flood Control - Facilities				++		+	++	+	+	-		+		+	+		+		++	+		+++	+	+
20	Watershed Management	++	+		++	+	+++	++++	+++	+++	+++	+						+		++	+	+	+		+
21	Usage of Dike						-	-	--	--		+									+	+		-	
22	Usage of Soil Disposal		+						+			+									+		+		+

Note +: Positive Environmental Impact
–: Negative Environmental Impact

Prepared by Deponegoro University

Table IV.4.1 (1/2) ENVIRONMENTAL IMPACT MATRIX FOR FEASIBILITY STUDY PROJECTS

ENVIRONMENTAL COMPONENT	Number of people affected by Impacts	Impact spreading area	Duration of Impacts	Impact Intencity	Component affected by Impacts	Commulative of Impacts	Impact go back or no	Conclusion
I. PRE CONSTRUCTION STAGE								
1. Site Selection								
- Perception	4	4	2	3	2	2	2	3
2. Land Acquisation								
- Land Use	3	2	5	3	3	3	4	3
- Compensation	5	4	5	4	3	3	3	4
- Land Ownership								
wet field	3	2	5	2	3	3	3	3
dry fiel	3	2	5	2	3	3	3	3
3. Resettlement								
- Family (KK)	5	4	5	5	5	4	3	4
4. Relocation of Electric Tower								
- Electric coverage	2	2	1	2	1	1	2	1
II. CONSTRUCTION STAGE								
1. Mobilisation of Equip. & Material								
- Air Quality and noisy	3	3	2	2	3	4	3	3
- Condition of road and traffic	3	3	4	2	3	4	2	3
2. Mobilisation of Labour								
- Social Interaction	3	3	2	3	3	3	3	3
- Society Income	2	3	2	3	4	3	3	3
- Informal sector	2	3	2	3	4	3	3	3
- Local Labour	2	3	3	2	2	3	1	2
3. Land clearing								
- Air Quality and noisy	3	3	2	2	3	4	3	3
- Erosi lahan : Kreo	1	2	2	2	1	3	2	2
- Flora & Fauna	1	2	2	3	2	3	3	3
4. Construction and Operation of base camp								
- Air Quality and noisy	3	3	2	2	3	4	3	3
- Water Quality	2	2	2	3	2	3	2	2
5. Construction of Access road								
- Air Quality and noisy	3	3	2	2	3	4	3	3
6. Construction and Operation of Divertion tunnel								
- Air Quality and noisy	3	3	2	2	3	4	3	3
- Local Labour	2	3	3	2	2	3	1	2
- Informal sector	2	3	3	2	2	3	1	2
7. Construction of Dam								
- Air Quality and noisy	3	3	2	2	3	4	3	3
- Water Quality	2	2	2	3	2	3	2	2
- Local Labour	2	3	3	2	2	3	1	2
- Informal sector	2	3	3	2	2	3	1	2
8. Dregging and Refiling of river								
- Air Quality and noisy	2	3	2	2	3	4	3	3
- Environmental aesthetics	2	2	3	3	3	3	2	3
- Public health	2	2	3	3	3	3	2	3
- Water Quality	2	2	2	3	2	3	2	2
9. Increasing dike level								
- Air Quality and noisy	1	2	3	2	2	4	3	2
- Penggunaan badan air	1	2	4	3	3	4	2	3
- Borrow area	1	2	3	2	2	4	3	2
- Local Labour	2	3	3	2	2	3	1	2
- Informal sector	2	3	3	2	2	3	1	2
10. Construction of Pump Station and gate								
- Air Quality and noisy	2	3	2	3	2	3	2	2
- Water Quality	2	2	2	3	2	3	2	2
- Local Labour	2	3	3	2	2	3	1	2
- Informal sector	2	3	3	2	2	3	1	2
11. Soil hauling								
- Air Quality and noisy	3	3	2	2	3	4	3	3
- Condition of road and traffic	3	3	4	2	3	4	2	3
12. Quarry management								
- Air Quality and noisy	3	3	2	2	3	4	3	3
- Erosion and land slide	2	2	4	3	2	3	3	3
- Flora and Fauna	1	2	2	3	2	3	3	3
13. Soil disposal								
- Water resources	2	3	3	2	2	3	1	2
- Air Quality and noisy	2	2	2	2	1	2	1	2
14. Reconstruction of railway and road								
- Air Quality and noisy	3	3	2	2	3	4	3	3
- Informal sector	2	3	3	2	2	3	1	2
- Condition of road and traffic	3	3	4	2	3	4	2	3

Table IV.4.1 (2/2) ENVIRONMENTAL IMPACT MATRIX FOR FEASIBILITY STUDY PROJECTS

ENVIRONMENTAL COMPONENT	Number of people affected by impacts	Impact spreading area	Duration of impacts	Impact Intencity	Component affected by impacts	Commulative of impacts	Impact go back or no	Conclusion
III. AFTER CONSTRUCTION								
1. Reservoir development								
– Water quality	2	2	2	3	2	3	2	2
– Sheet erosion : Kreo	2	2	4	3	2	3	3	3
– Conservation of Kreo Cave	2	2	4	3	2	3	3	3
– Flora and Fauna	2	2	3	3	1	2	2	2
– Plankton & Benthos	2	2	3	3	1	2	2	2
– Water resources (status)	2	2	2	3	2	3	2	2
– water table	3	3	4	2	3	4	2	3
2. Dam Operation								
– Watre Quality at d/s of Kali garang	2	2	2	3	2	3	2	2
– Water resources (status)	2	2	2	3	2	3	2	2
– Sedimentation	2	2	3	2	2	4	2	3
– Alteration of flow pattern	2	2	3	2	2	4	2	3
– Water Supply	2	3	3	2	3	3	2	3
– Electrical	2	3	3	2	3	3	2	3
– Tourism	1	2	3	2	3	3	3	2
– Society Income	2	3	2	3	4	3	3	3
3. Operation ofFlood Control Structures								
– Water resources	3	4	1	3	4	3	3	3
– Land resources	3	4	1	3	4	3	3	3
– Human resources	3	3	2	3	3	3	3	3
– Settlement	3	2	2	2	4	2	3	3
– Property (1990)	3	2	2	2	4	2	3	3
– Public health	3	3	2	3	3	3	3	3
4. The use of dike for public road								
– Price of settlement area	1	2	4	2	1	3	2	2
– Water resources	1	1	3	2	2	2	2	2
– Land slide	1	1	3	2	2	2	2	2
5. Watershed management								
– Erosion	2	4	4	3	2	3	3	3
– Flora and Fauna	1	3	3	1	3	3	2	2

Prepared by Deponegoro University

Note
1 Less important
2 Important enough
3 Important
4 More important
5 Very important

Table IV.4.2 ENVIRONMENTAL IMPACT MATRIX FOR THE URGENT PROJECT

ENVIRONMENTAL ASPECTS SUBJECT TO IMPACT	IMPACT PREDICTION	INITIAL CONDITION					PRE	CONSTRUCTION PHASE							OPERATION		AFTER PROJECT IMPLEMENTATION			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PHYSICAL-CHEMICAL																				
A. Land	1. Land Use Change	3/2	6.0	25.0	24.0	2	3/3									3/3	18.0	50.0	30.0	2
	2. Erosion																			
B. Water/ River	1. Water Quality	3/4	12.0	25.0	48.0	3				2/3	3/4	2/3				2/4	32.0	100.0	32.0	2
	2. Water Quantity	3/4	12.0	25.0	49.0	3					2/4	3/4		2/3	4/4		42.0	100.0	32.0	2
	3. Sedimentation	3/3	9.0	25.0	36.0	2					2/4	3/4					20.0	50.0	40.0	2
	4. Saline Water Intrussio	2/3	6.0	25.0	24.0	2					3/4	3/4					24.0	50.0	48.0	3
	5. Degradation/ Aggradati	3/4	12.0	25.0	48.0	3					3/4	3/4			2/4		32.0	75.0	43.0	3
C. Air	1. Solid Particle	4/2	8.0	25.0	32.0	2			2/3				2/3	2/3			18.0	75.0	32.0	2
	2. Noise	4/3	12.0	25.0	48.0	3			2/4	2/3			2/4	2/4			30.0	100.0	43.0	3
BIOLOGY	1. Aquatic Flora and Faun																			
	- Plankton	3/3	9.0	25.0	36.0	2					2/3	2/3			3/2	3/3	27.0	100.0	27.0	2
	- Benthos	1/3	3.0	25.0	12.0	1					1/2	2/3			2/2	3/3	21.0	100.0	21.0	2
	- Fish and Others	2/3	6.0	25.0	24.0	2					2/3	2/3			2/3	4/4	44.0	100.0	44.0	3
SOCIAL, ECONOMIC AND CULTURE	1. Amenity	3/3	9.0	25.0	36.0	2	2/3		3/3	4/4				3/3		2/3	55.0	150.0	36.7	2
	2. Informal Sector	2/4	8.0	25.0	32.0	2		4/4		3/3	2/3	3/3				3/3	49.0	125.0	39.2	2
	3. Income	2/3	6.0	25.0	24.0	2		4/4	3/3	2/3	2/3	3/3		3/3		3/3	67.0	175.0	38.3	2
	4. Aesthetics	3/3	9.0	25.0	36.0	2											16.0	25.0	64.0	4
	5. Employment opportunit	2/3	6.0	25.0	24.0	2		4/4	3/3	3/3	2/3	3/3				3/3	69.0	175.0	39.4	2
	6. Land Value	3/3	9.0	25.0	36.0	2										3/3	9.0	25.0	36.0	2
	7. Public Health	3/3	9.0	25.0	36.0	2			2/3								6.0	25.0	24.0	2

NOTE :

1 Initial Condition
2 Value
3 Maximum Possible Valu
4 Percentage (%)
5 Scale
6 Land Acquisition
7 Labor Force Mobilizat and Recruitment
8 Mobilization/ Demobil of Material and Equip
9 Operation of Base Cam
10 River Channel Improve
11 Barrage Construction
12 Hauling of Soil
13 Disposal Area
14 O & M of Barrage
15 O & M of Rowing, Spor Centre and Tourism
16 Value
17 Maximum Possible Valu
18 Percentage (%)
19 Scale
20 Percentage Different
21 Scale Different

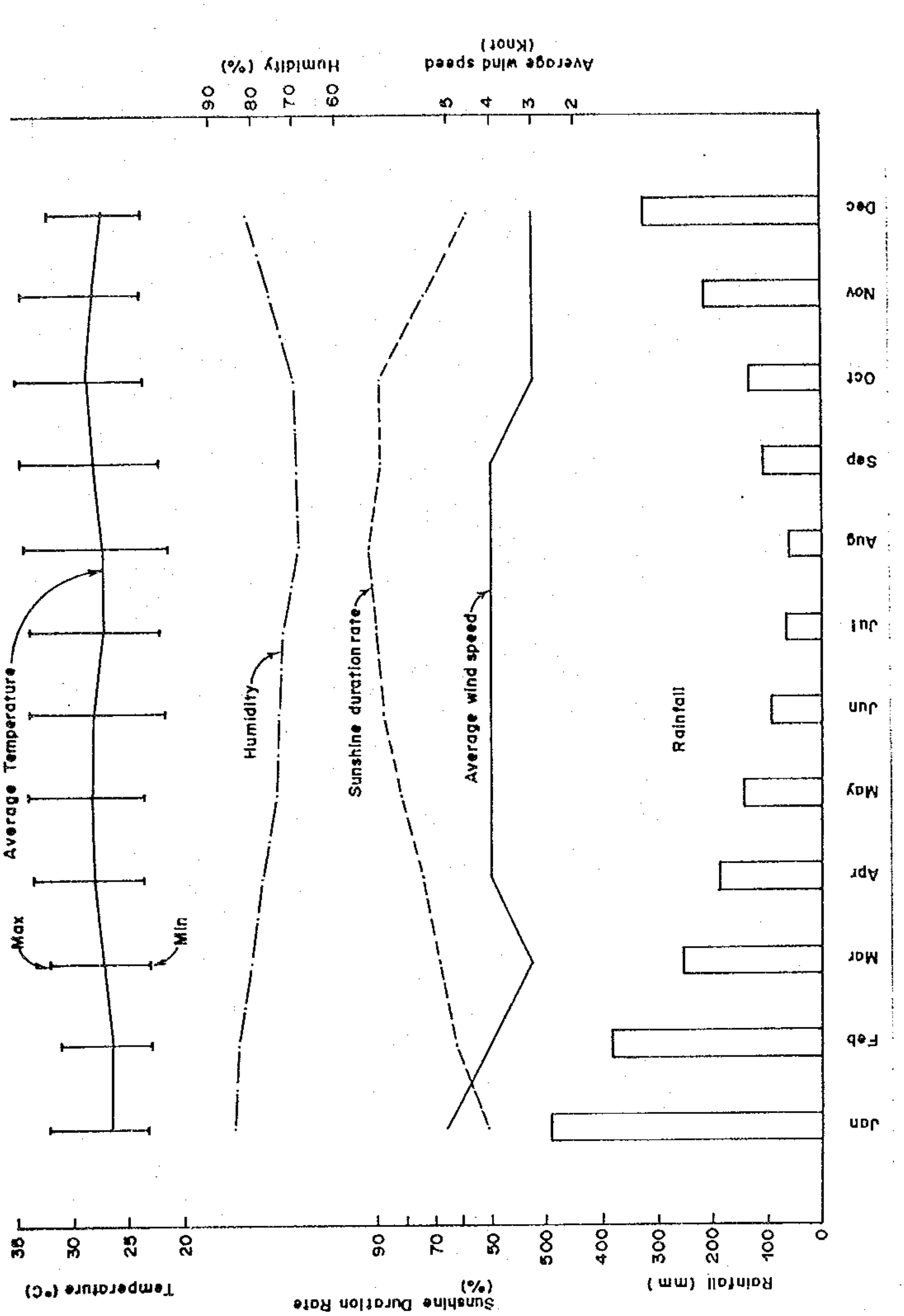
Prepared by Deponegoro University

Condition of Environmental Aspect
1 : Worst
2 : Worse
3 : Good
4 : Better
5 : Best

Importancy of Environmental Aspect
1 : Not Important
2 : Less Important
3 : Important
4 : More Important
5 : Most Important

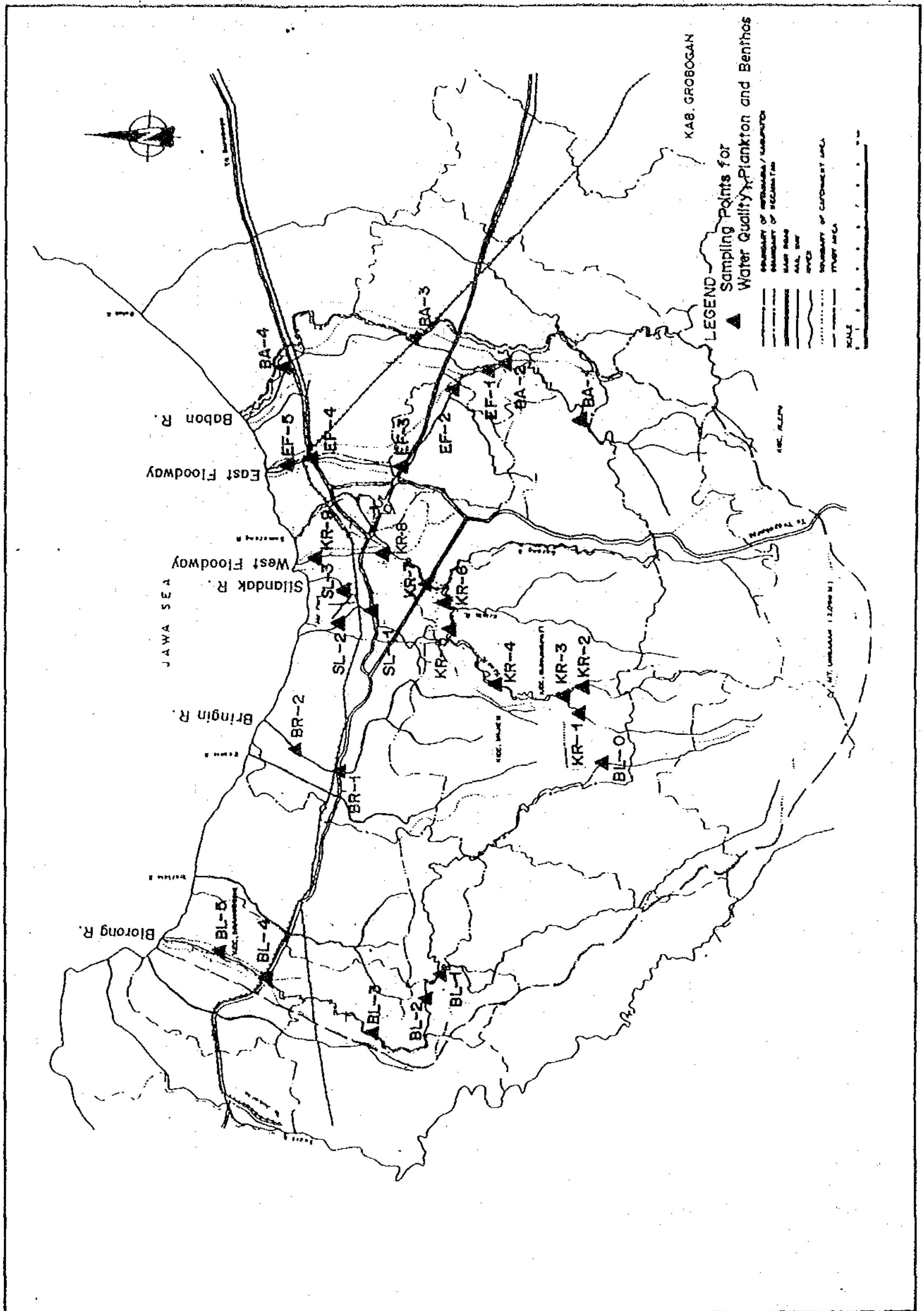
Impact to Environment
1 : Not Important
2 : Less Important
3 : Important
4 : More Important
5 : Most Important

FIGURES

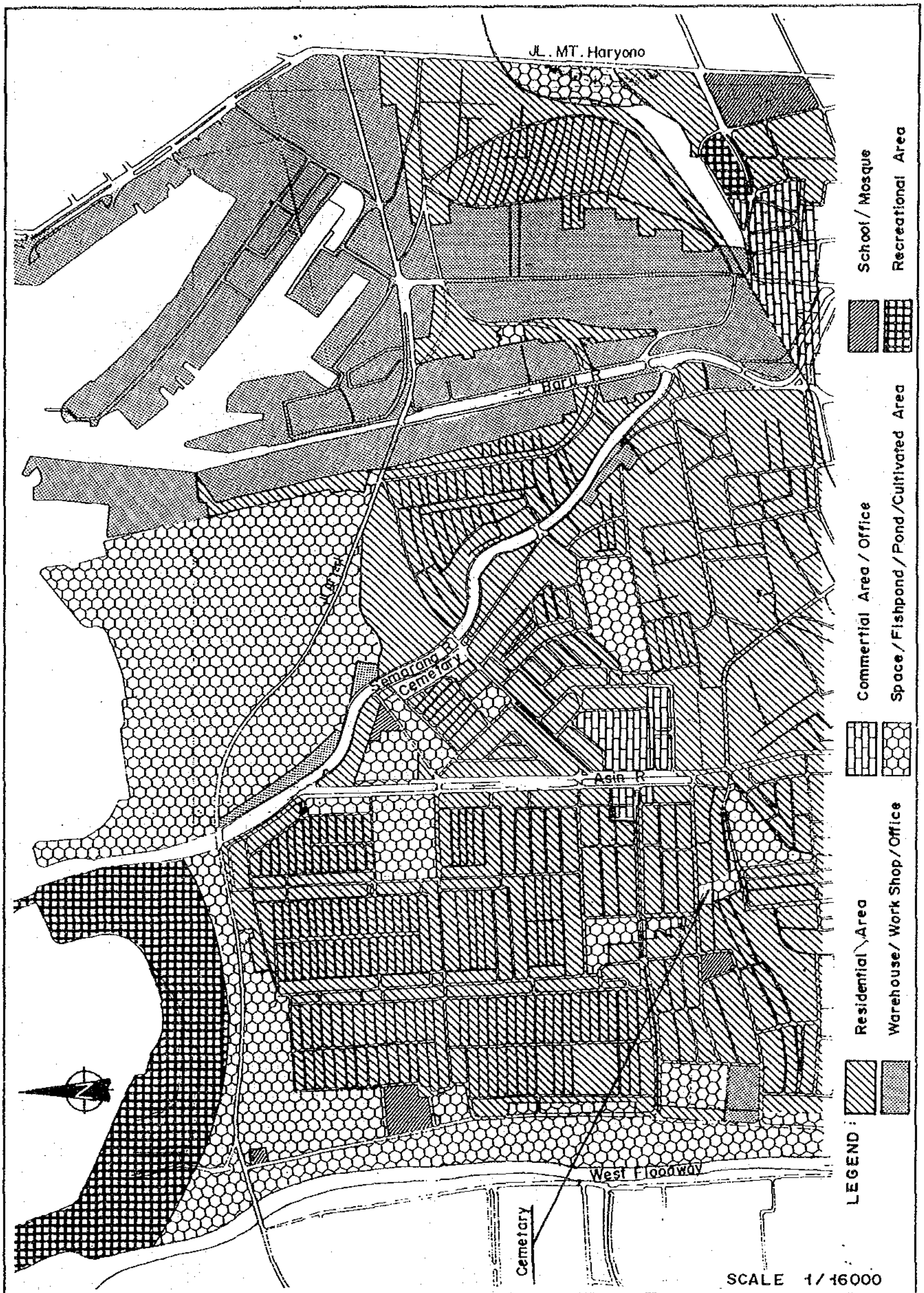


Station: A.Yani (Airport)
Sunshine duration ratio : 8 hr (8:00~16:00) = 100%
Wind speed: 1 knot = 0.5 m/s

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. IV. 1. 1 MONTHLY CLIMATE DATA IN SEMARANG, 1980-1989
JAPAN INTERNATIONAL COOPERATION AGENCY	



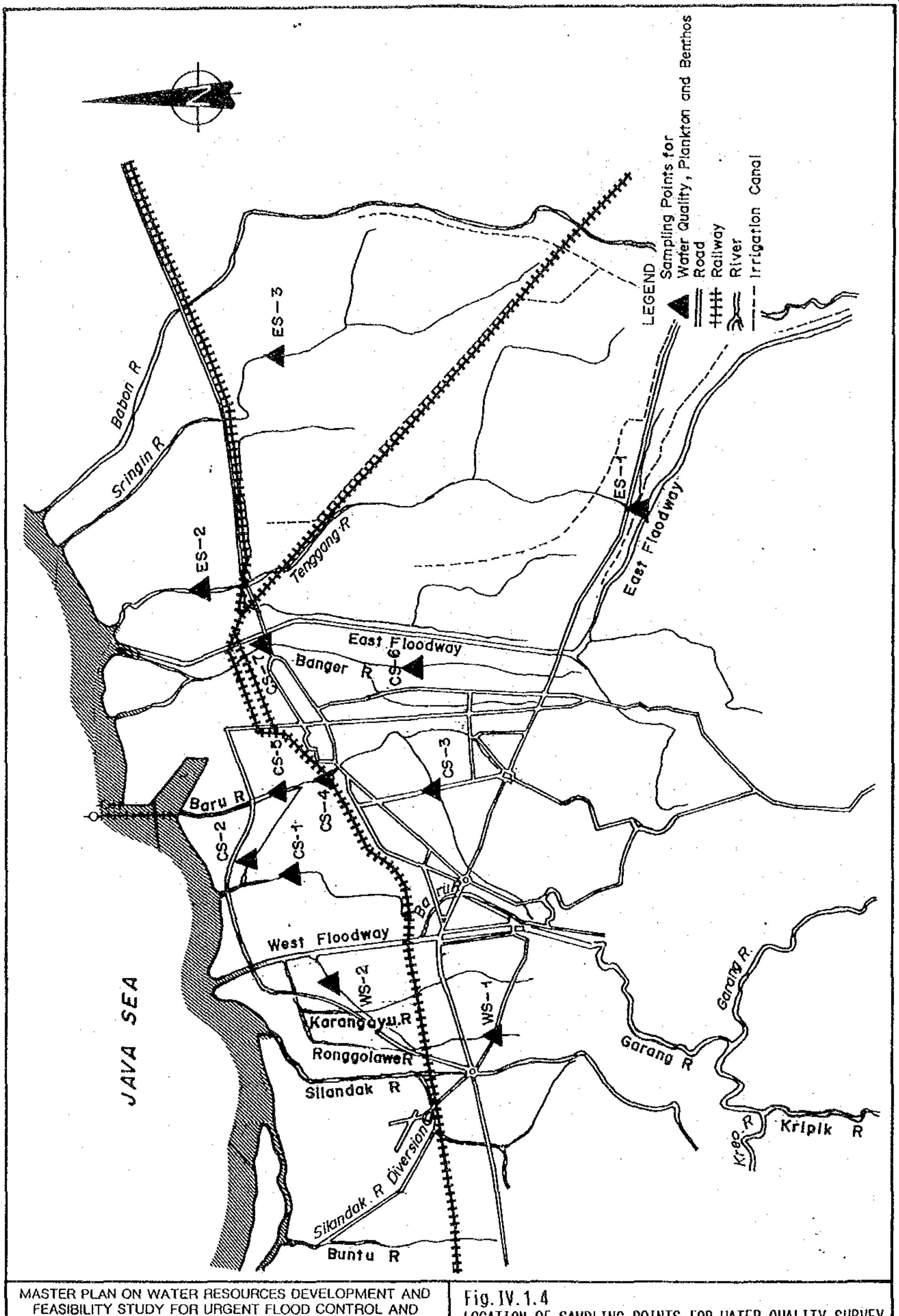
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. IV.1.2
JAPAN INTERNATIONAL COOPERATION AGENCY	LOCATION OF SAMPLING POINTS FOR WATER QUALITY SURVEY IN FLOOD CONTROL AND WATER RESOURCES DEVELOPMENT AREA



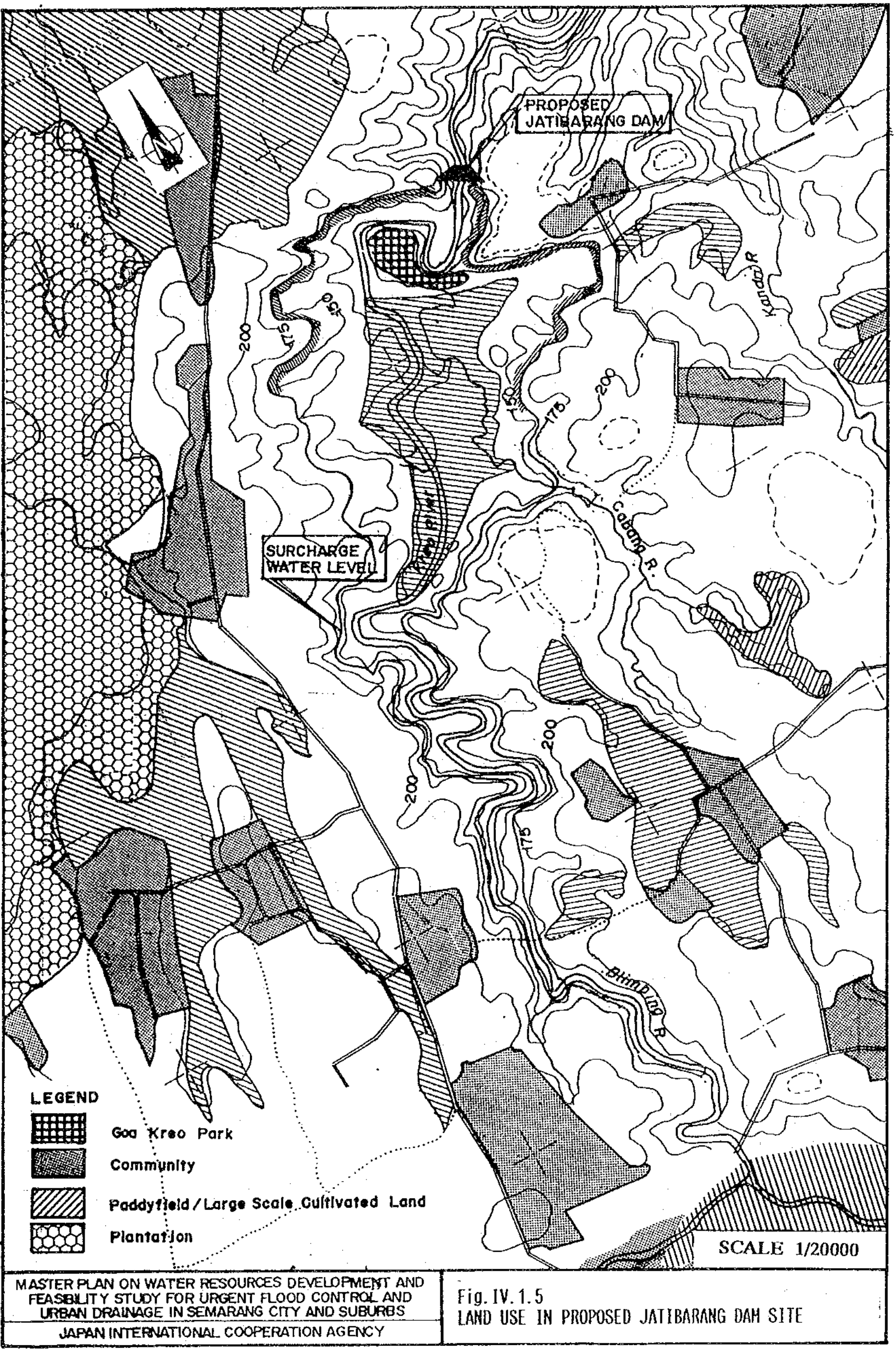
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. IV.1.3
LAND USE OF SURROUNDING URBAN DRAINAGE FEASIBILITY STUDY AREA IN CENTRAL SEMARANG



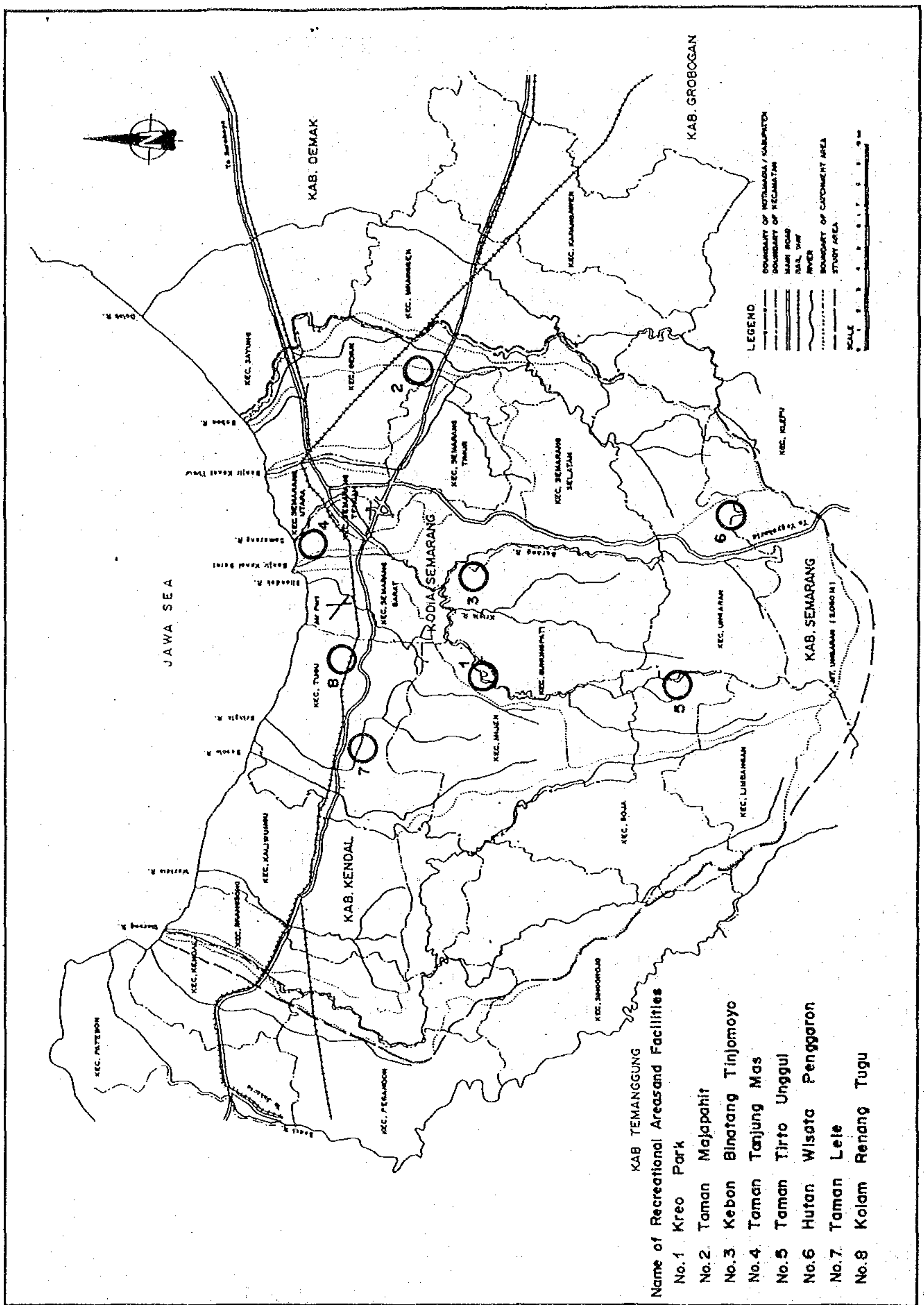
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. IV.1.4
JAPAN INTERNATIONAL COOPERATION AGENCY	LOCATION OF SAMPLING POINTS FOR WATER QUALITY SURVEY IN URBAN DRAINAGE PROJECT AREA



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. IV. 1. 5
LAND USE IN PROPOSED JATIBARANG DAM SITE



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JAPAN INTERNATIONAL COOPERATION AGENCY	LOCATION OF RECREATIONAL AREA AND FACILITIES IN SEMARANG

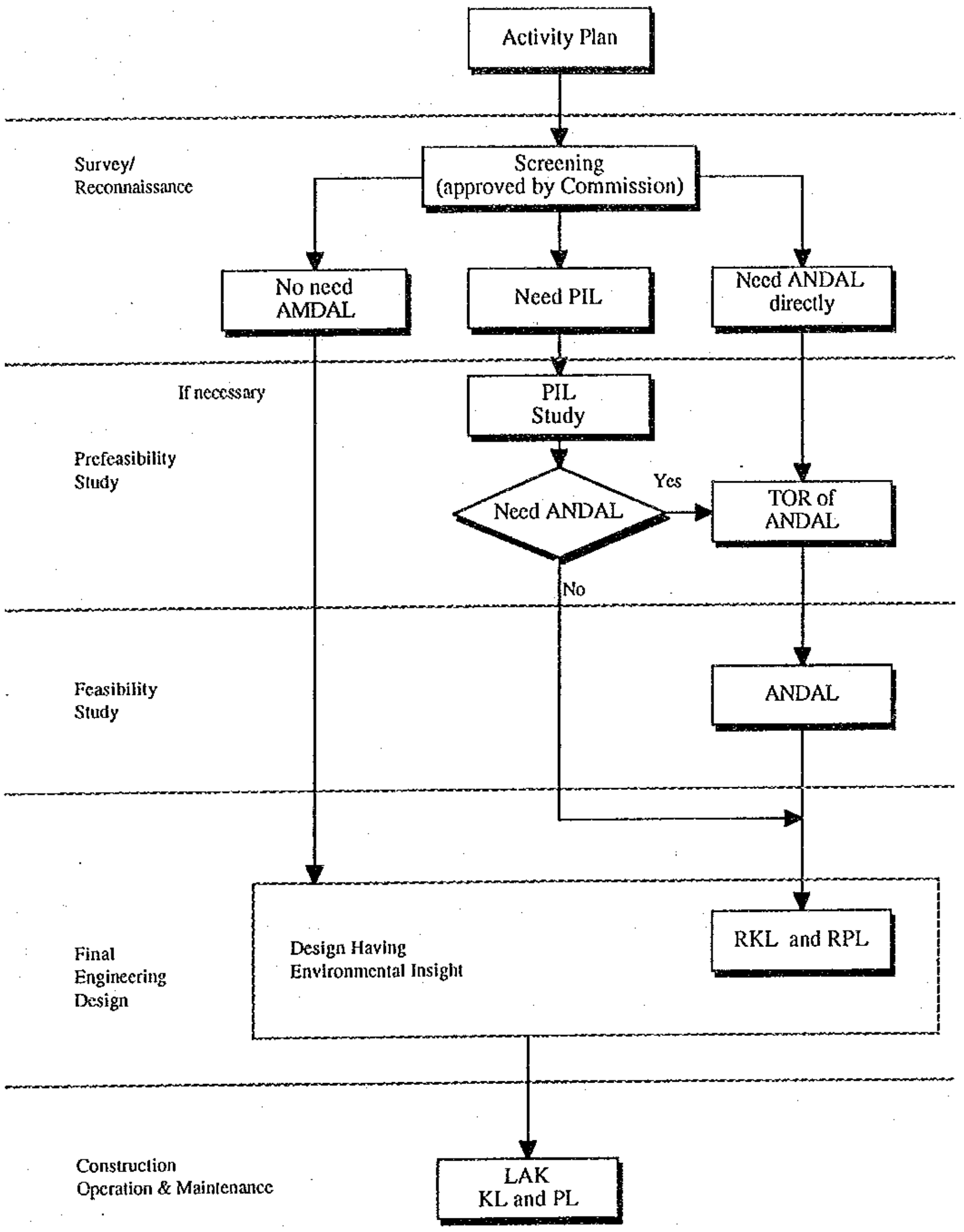

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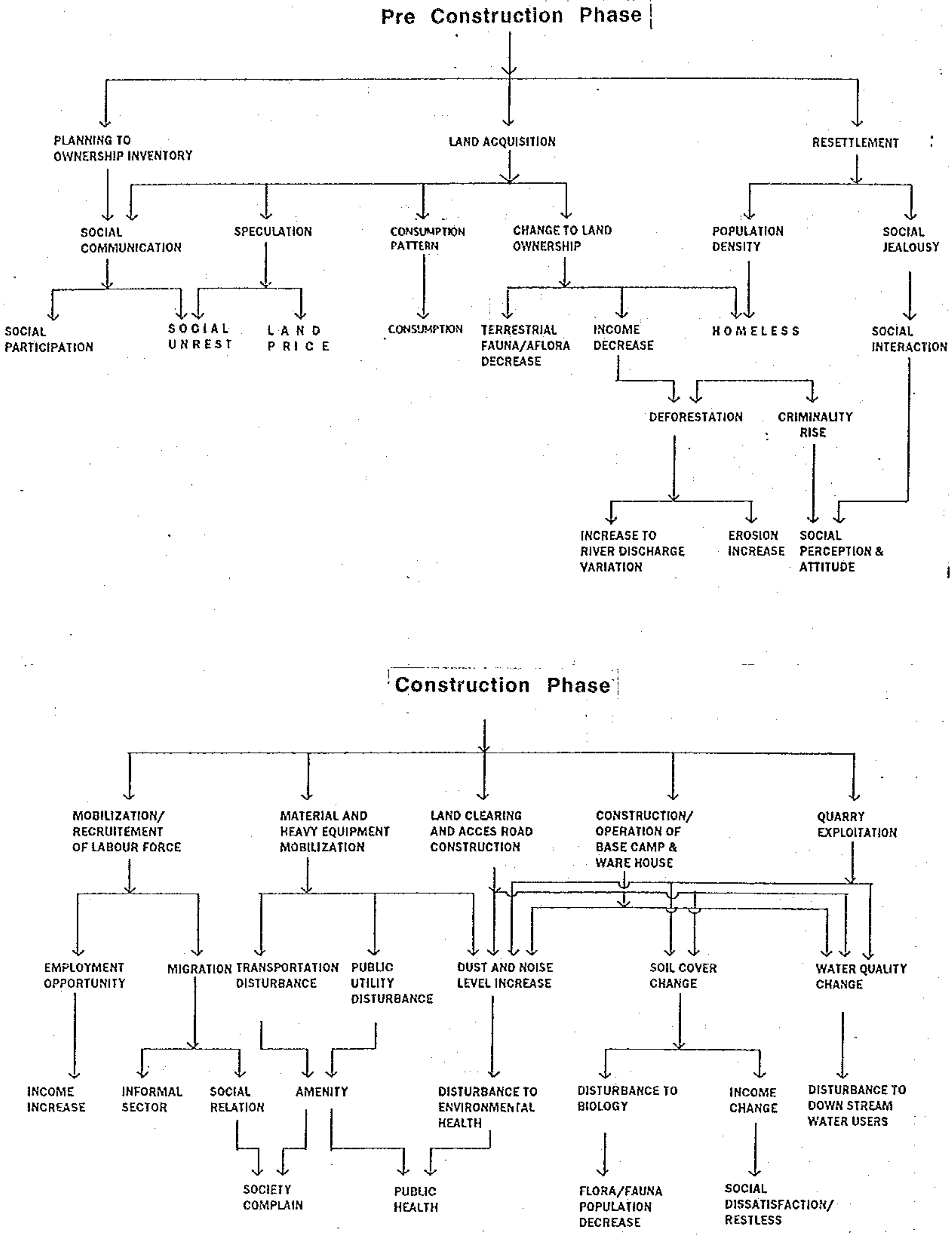
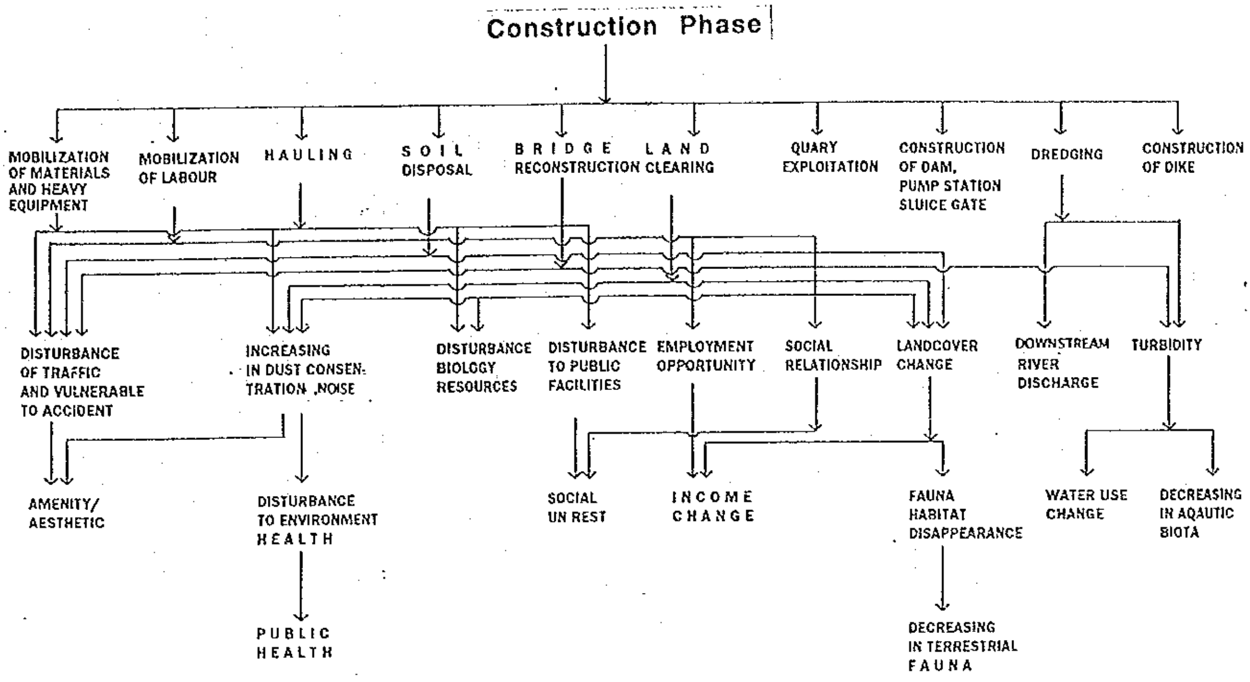
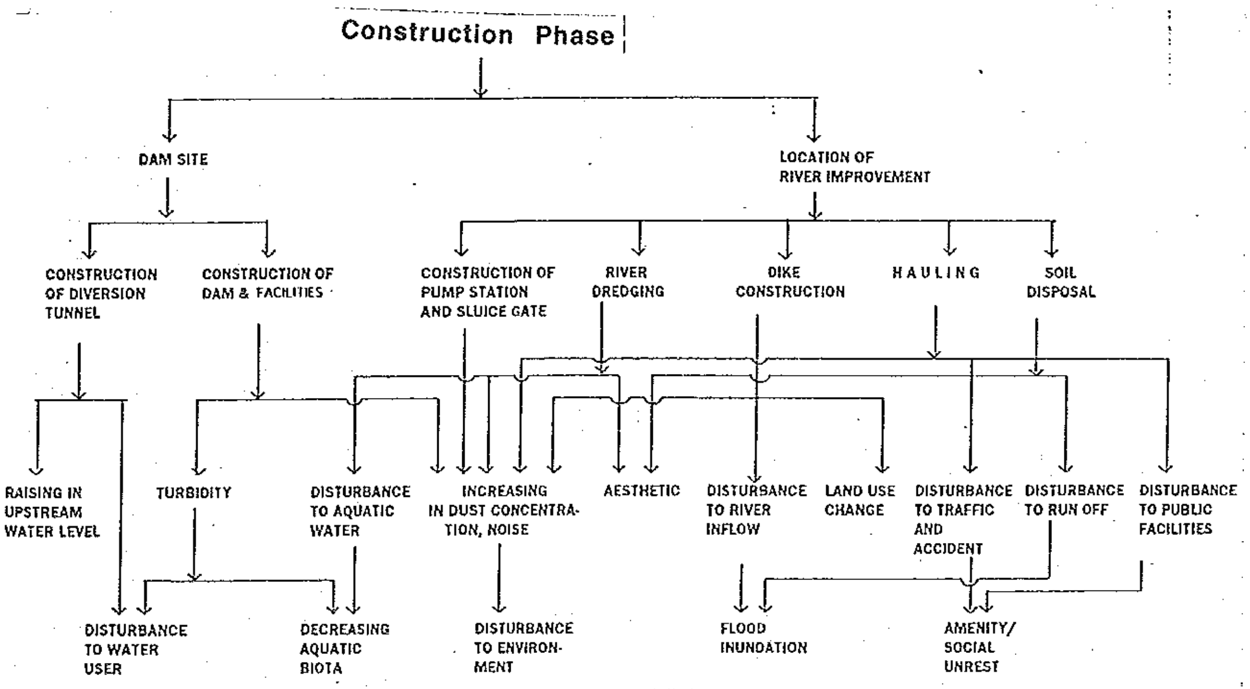
Fig. IV. 2. 1
PROCEDURE OF ENVIRONMENTAL ASSESSMENT SYSTEM IN INDONESIA



source: Diponegoro University ,Preliminary Environmental Information Study for the Master Plan on Water Resources Development and Feasibility Study for Urgent Flood Control and Urban Drainage in Semarang City and Suburs, 1993

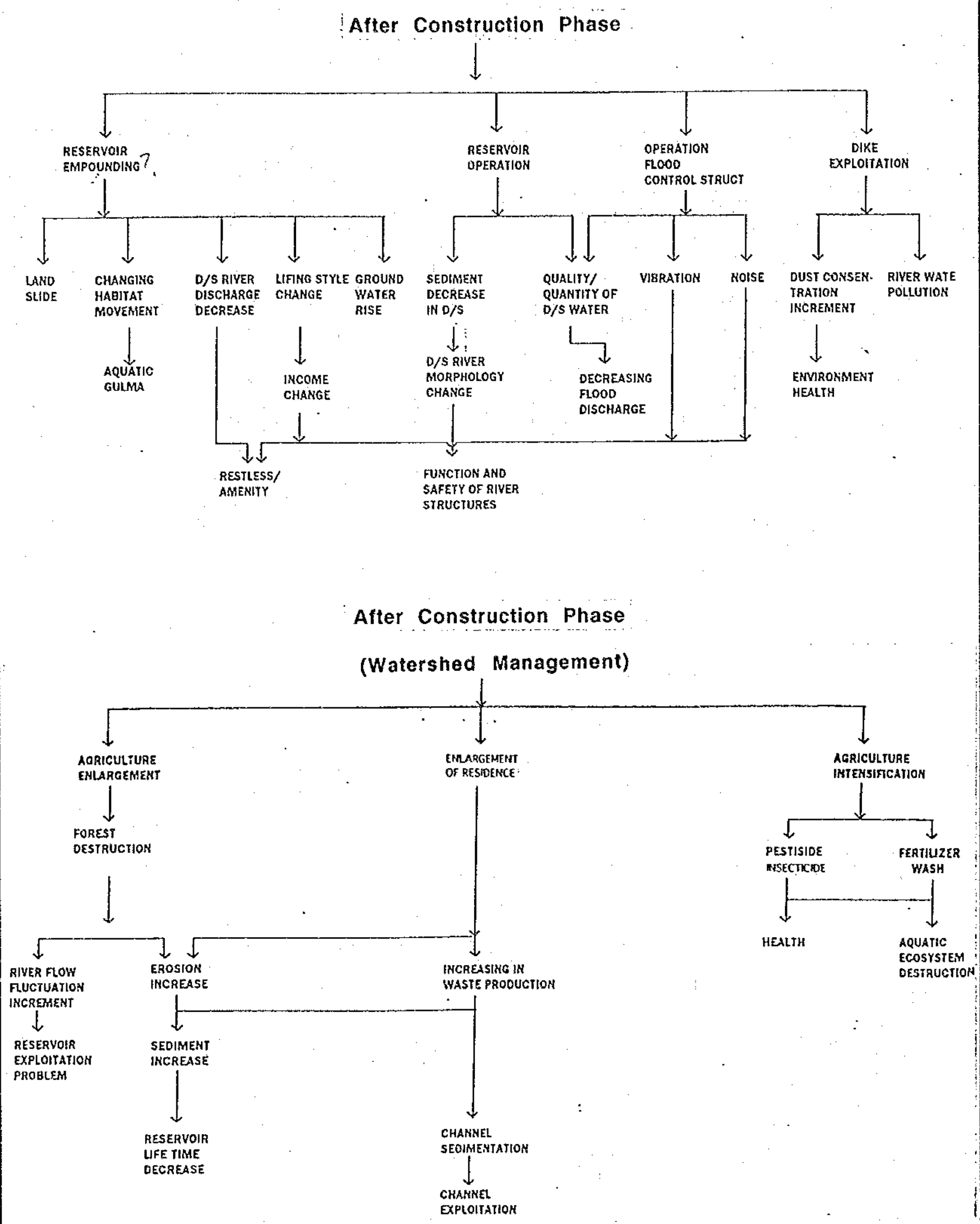
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. IV. 3. 1(1/3) ENVIRONMENTAL IMPACT FLOW FOR MASTER PLAN STUDY PROJECTS
JAPAN INTERNATIONAL COOPERATION AGENCY	





source: Diponegoro University ,Preliminary Environmental Information Study for the Master Plan on Water Resources Development and Feasibility Study for Urgent Flood Control and Urban Drainage in Semarang City and Suburs, 1993

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. IV. 3. 1(2/3) ENVIRONMENTAL IMPACT FLOW FOR MASTER PLAN STUDY PROJECTS
JAPAN INTERNATIONAL COOPERATION AGENCY	



source: Diponegoro University ,Preliminary Environmental Information Study for the Master Plan on Water Resources Development and Feasibility Study for Urgent Flood Control and Urban Drainage in Semarang City and Suburs, 1993

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. IV. 3. 1(3/3) ENVIRONMENTAL IMPACT FLOW FOR MASTER PLAN STUDY PROJECTS
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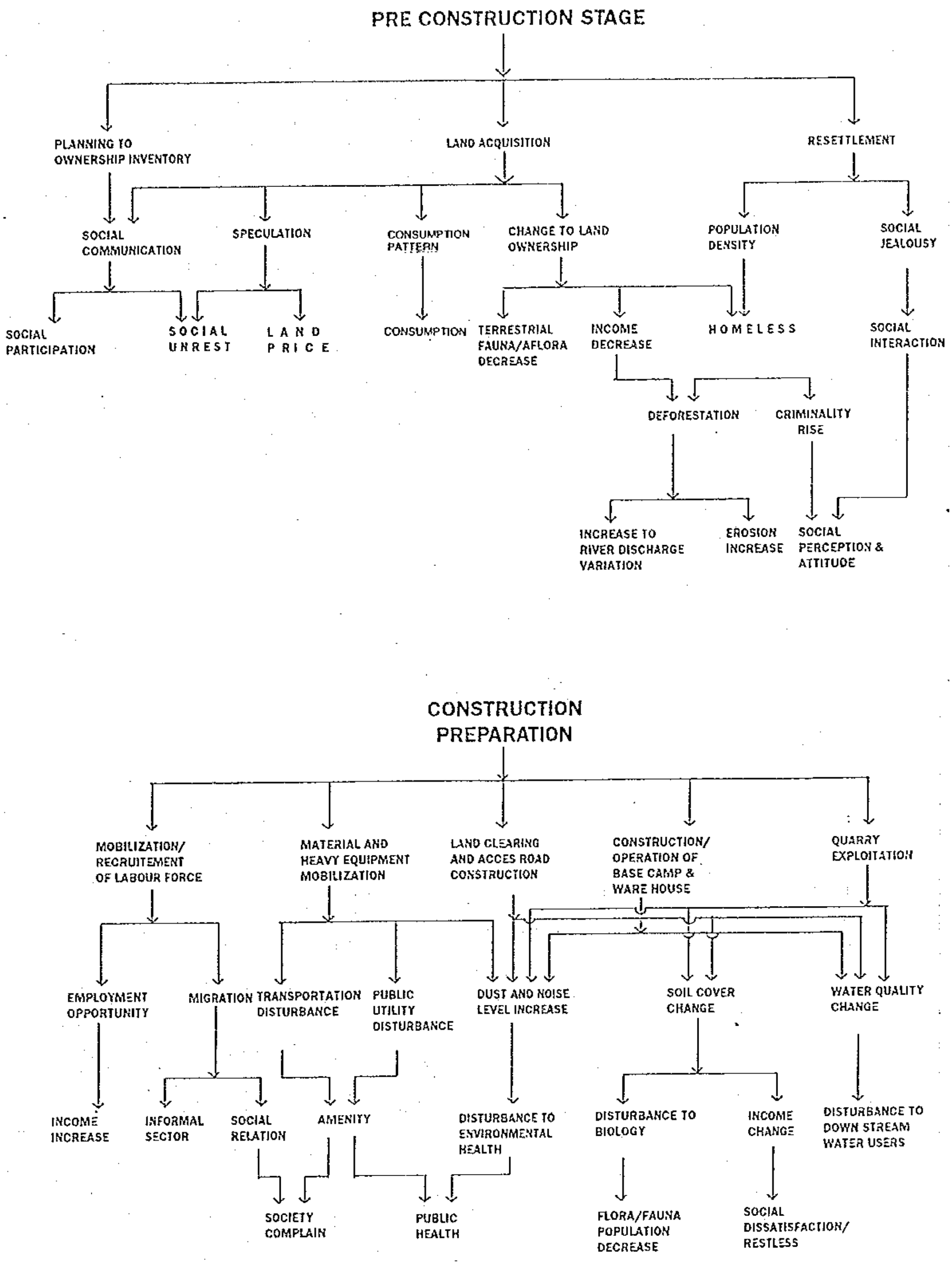
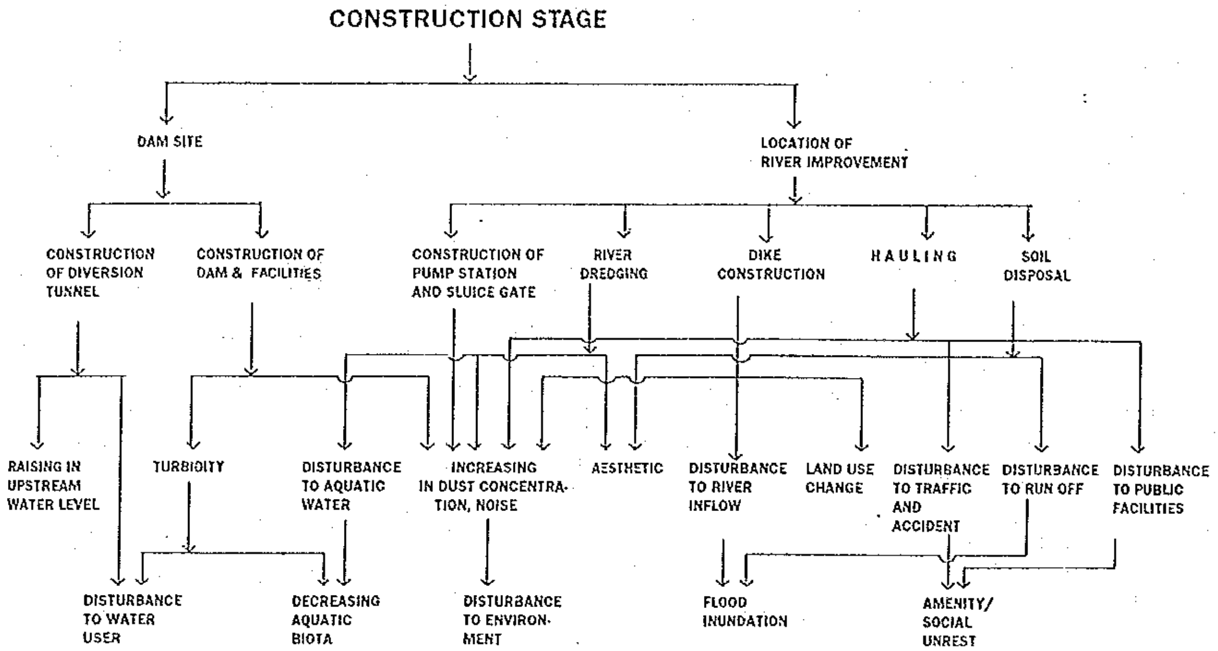
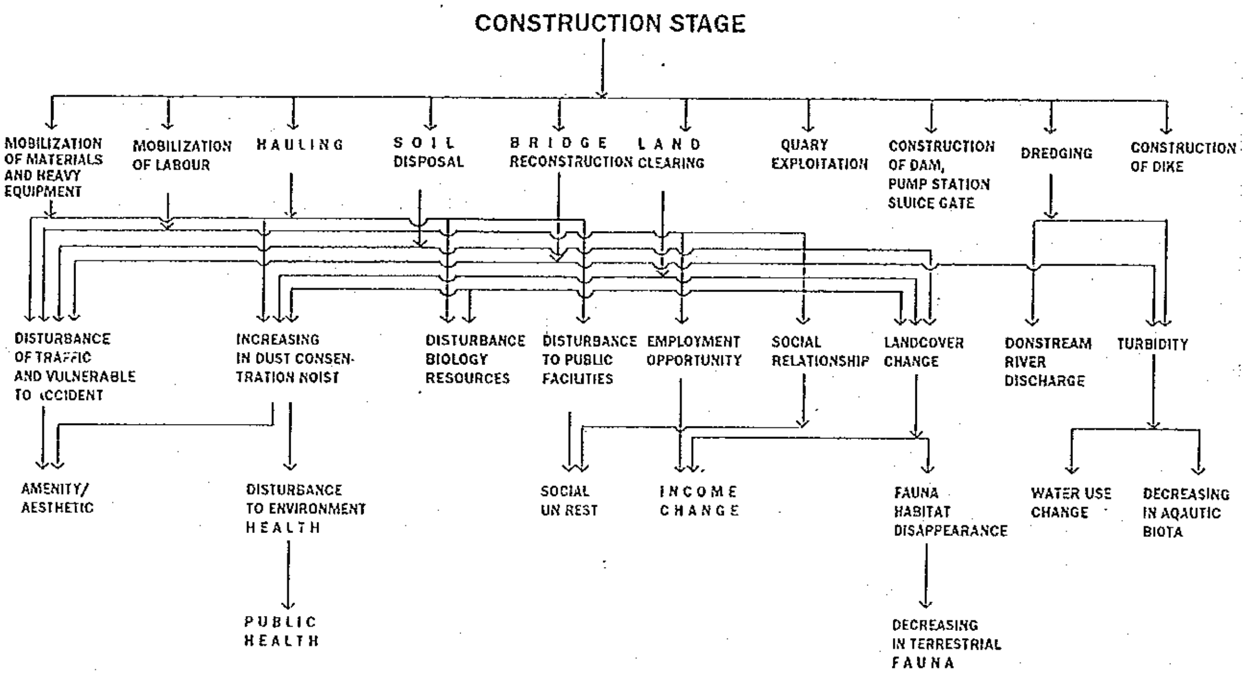


MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. IV. 4. 1(1/3) ENVIRONMENTAL IMPACT FLOW FOR THE FEASIBILITY STUDY PROJECTS
JAPAN INTERNATIONAL COOPERATION AGENCY	





MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. IV. 4. 1(2/3) ENVIRONMENTAL IMPACT FLOW FOR THE FEASIBILITY STUDY PROJECTS
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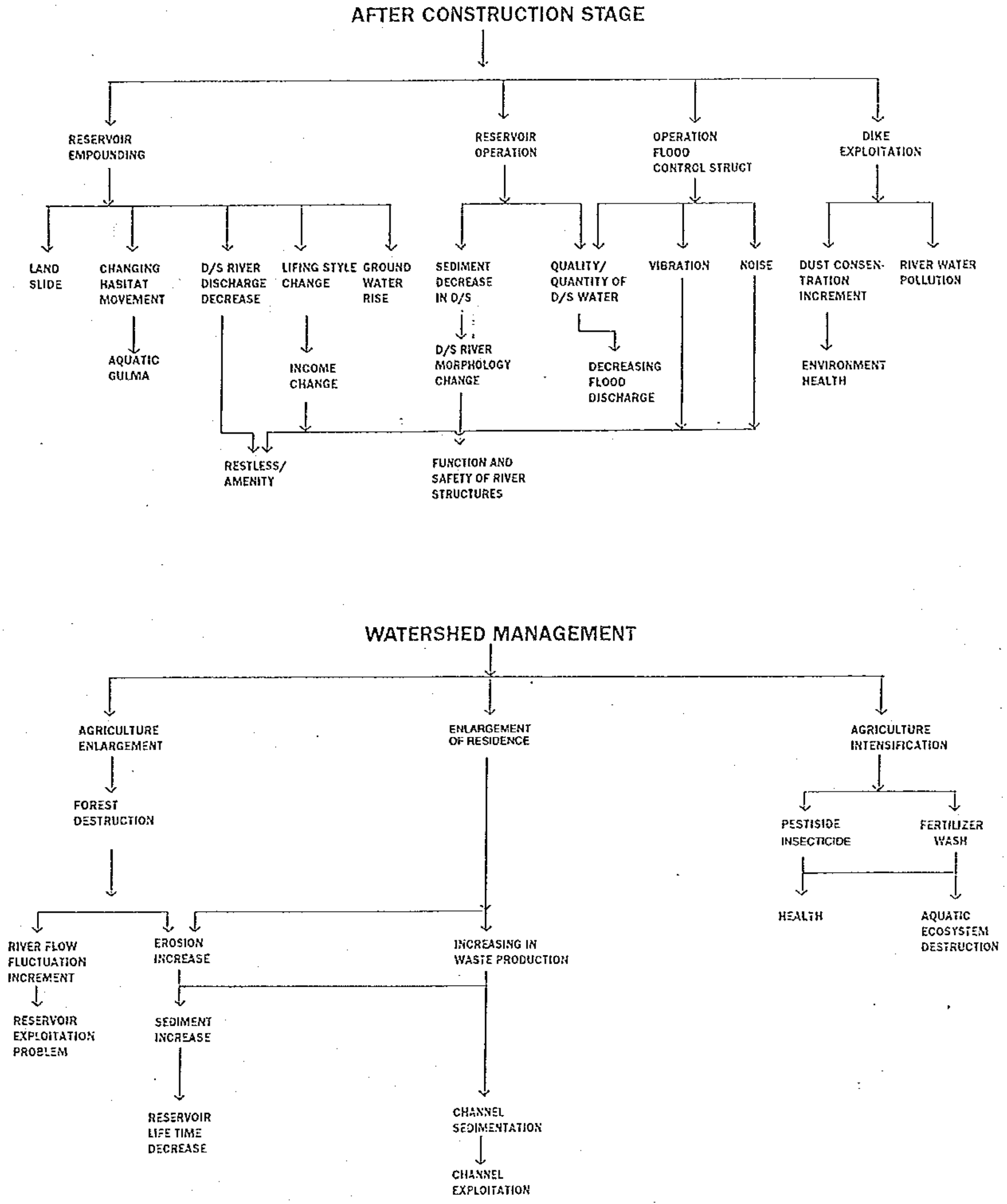

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

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Fig. IV. 4. 1(3/3)
ENVIRONMENTAL IMPACT FLOW FOR THE FEASIBILITY STUDY PROJECTS

V FLOOD CONTROL PLAN

V FLOOD CONTROL PLAN

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CHAPTER 1 OBJECTIVE RIVERS

As agreed between the Government of Indonesia and the JICA Study Team, the following six (6) rivers were selected as the objectives of the flood control master plan:

Name of River		Catchment Area (km^2)	Approx. Length (km)	District Within the Watershed
(1)	Blorong River	157.0	60.0	Kab. Kendal
(2)	Bringin River	32.1	15.5	Kota. Semarang
(3)	Silandak River	8.5	11.0	Kota. Semarang
(4)	West Floodway/ Garang River	204.0	32.0	Kota. Semarang Kab. Semarang
(5)	East Floodway	29.7	12.0	Kota. Semarang
(6)	Babon River	77.0	30.0	Kota. Semarang Kab. Semarang
	Total	508.3		

The above six (6) objective rivers are located on the plains situated between the hilly land to the south and the Jawa Sea to the north. Due to the topographic condition and the insufficient flood control capacities, these rivers suffer from habitual flood inundation during the rainy season. The upper reaches of the rivers have rather steep slope and soil is rather fragile. Accordingly, a large quantity of sediment load tends to accumulate on the riverbeds reducing the channel flow capacity.

CHAPTER 2 PRESENT CONDITION OF OBJECTIVE RIVERS

2.1 River Features

The present condition of the objective six (6) rivers for the flood control master plan were clarified, as described below, on the basis of the field reconnaissance, topographic maps, land use maps and other related data collected.

(1) Blorong River

Blorong River is located on the western part of the study area, covering a catchment area of 157.0 km^2 and running about 60 km from the river mouth up to Mt. Ungaran. Glaggah River is the major tributary of Blorong River in the western area of the basin, meeting the main stream above the existing irrigation intake structure of Pengilon Weir (refer to Fig. V.2.1).

Extensive paddy fields spread out in the lower reaches from Pengilon Weir, while the middle reaches is reserved as the forest/plantation area occupying about 40% of the whole watershed (refer to Fig. V.2.2). The upper reaches from the forest/plantation area is rather hilly but developed as terraced paddy field continuing until the foot of Mt. Ungaran. Settlement areas are scattered in the lower reaches from Pengilon Weir and in the hilly terraced paddy field of the upper reaches.

(2) Bringin River

Bringin River has a catchment area of about 32.1 km^2 and river length of about 15.5 km flowing northward into Jawa Sea (refer to Fig. V.2.1).

From the viewpoint of topography, the basin is divided into the upper, the middle, and the lower reaches. The upper reaches is hilly with a very steep gradient of less than 1/100, taking about 55% of the entire river basin. The middle reaches is agricultural land with a rather steep gradient of 1/100 to 1/750, taking about 40% of the entire basin. In the middle reaches, an urban area is being developed along the national road, and the Semarang City Office has planned to develop an industrial area in a large part of the area along the national road by the year of 2000 (refer to Fig. V.2.3).

The lower reaches from the national road is an extremely flat low-lying area, the habitual flood inundation area. The lower reaches is now used as paddy field and fishpond, but almost all the presently existing paddy field is planned to be developed as an industrial area by the year of 2000.

(3) Silandak River

Silandak River has a catchment area of 8.5 km^2 with a total river length of about 11 km which originates in Mt. Pancang-pancing. The river runs north toward the airport, and separates before reaching the airport into the following two (2) channels (refer to Fig. V.2.1):

(a) Floodway of 2.92 km in length which runs along the west side of the airport and flows into Jawa Sea;

(b) Diversion channel of 1.0 km in length connected to Siangker River (catchment area of about 2.0 km^2) which runs on the east side of Silandak River and flows into Jawa Sea passing along the east side of the airport.

The upper reaches from the airport is a hilly land being used as settlement and farm/plantation area (refer to Fig. V.2.2), and no serious flood damage therein has been experienced. However, flood run-off has repeatedly caused overflow in the lower reaches, particularly, around the airport, causing adverse effects on airport operation. Moreover, the area surrounding the airport is forecast to be developed as an industrial area due to the convenient transportation, and flood damage potential in the area could remarkably increase.

Serious sediment deposition on river channels in the lower reaches is also pointed out as a particular problem of Silandak River. To cope with the problem, the Ministry of Public Works constructed two (2) sediment check dams in the upper reaches of Silandak River in 1990. However, it is confirmed through the field reconnaissance and interview survey that the effectiveness of the check dams is rather limited, and sediment deposition on the river channel still continues to reduce the design channel flow capacity.

(4) West Floodway/Garang River

Garang River flows from Mt. Ungaran to the north meeting its two (2) major tributaries, Kripik and Kreo, about 12 km and 10 km upstream from the river mouth, respectively (refer to Fig. V.2.1). The whole catchment area is about 204 km^2 which includes the catchment area of 70 km^2 for Kreo River (river length of about 12 km) and 34 km^2 for Kripik River (river length of about 8 km).

Simongan Weir located about 5.3 km upstream from the river mouth is the major river structure of West Floodway/Garang River. The downstream from the weir is called West Floodway (Banjir Kanal Barat), and the discharge from Garang River flows into Jawa Sea through the floodway.

Simongan Weir was constructed at the end of the 19th century and now used as the intake facility for municipal water supply (PDAM) and for maintenance discharge of Semarang River and some other small irrigation channels.

A densely populated area spreads out in the lower reaches from the confluence of Kreo River, particularly, the downstream from Simongan Weir. On the other hand, the upper reaches is used as either cropland or forest area and scarcely populated (refer to Fig.V.2.2).

(5) East Floodway (Banjir Kanal Timur)

East Floodway of about 12 km in length was constructed from 1896 to 1903 to lead the flood run-off from the hilly/mountainous areas located southeast of Semarang City directly into Jawa Sea. The catchment area of East Floodway covers 29.7 km^2 which is composed of the following three (3) watersheds: 5.8 km^2 of the Candi river basin, 6.8 km^2 of the Bajok river basin and 17.1 km^2 of the Kedungmundu river basin (refer to Fig. V.2.1).

In 1920, a flood diversion channel of about 1.7 km in length was constructed to connect with East Floodway and to divert flood run-off discharge of less than 200 m^3/s flowing from the upper reaches of Babon River (called Penggaron River) into East Floodway.

The channel flow capacity of East Floodway was studied in the Master Plan for Jratunseluna River Basin Development Project in 1981 and estimated as 333 m^3/s at the downstream section of the floodway. However, the existing channel flow capacity could be remarkably reduced due to a large quantity of sediment being transported from Penggaron River and deposited on the channel bed, particularly in the downstream section. Consequently, the present condition of East Floodway could be exposed to the menace of rather frequent channel overflow. The details of the existing channel flow capacity is described in Section 2.4.

(6) Babon River

Babon River with a catchment area of about 77.0 km^2 and river length of about 30 km (including Penggaron River) originates in Mt. Ungaran and flows northward to Jawa Sea. A major river control structure called Pucang

Gading Weir is located on Babon River about 17.4 km upstream from the river mouth, and the upstream from the weir is particularly called Penggaron River which has a river length of about 13 km (refer to Fig. V.2.1). Pucang Gadding Weir is now being used as an intake facility for irrigation water and also as flood diversion facility from Penggaron River to East Floodway.

As mentioned above, the diversion channel was constructed in 1920 to divert flood discharge of less than 200 m^3/s from Penggaron River to East Floodway. The diversion point was placed just upstream of Pucang Gading Weir. Kebonbatur Floodway (Banjir Kanal Kebonbatur) was also recently constructed to divert a part of flood run-off from Dolok River to Penggaron River (Dolok River flows on the east side of Penggaron River). The outlet of Kebonbatur Floodway was placed about 1 km upstream of Pucang Gading Weir.

Consequently, these present diversion channels/ floodway systems have a function to collect flood run-off from Dolok River/Penggaron River into East Floodway. In other words, the flood run-off from Dolok/Penggaron River is guided to the central part of Semarang City through the diversion channel/floodway, thus increasing the flood damage potential.

The lower reaches of Babon River from Pucang Gading Weir is a low-lying area covered with rather densely populated areas and/or irrigation area (refer to Fig. V.2.2). Serious flood damage often occur in this low-lying area due to the insufficient channel flow capacity of Babon River. On the other hand, the upper reaches from Pucang Gading Weir is hilly/mountainous area and no serious flood damage has been recorded.

2.2 Flood Damage Condition

Flood damage conditions were studied from field reconnaissance and the results of the flood damage survey undertaken by the Ministry of Public Works and the Semarang City Office. As a result of the flood damage study, the approximate extent of annual maximum flood inundation for the recent 12-year period from 1980 up to 1991 was estimated as shown in Fig. V.2.4.

Among the floods in the recent 12 years, major river channel overflow occurred in 1988 and 1990 causing an extensive inundation area. In the 1990 flood of 26th January, almost all low-lying areas in the study area were inundated. The flood area-depth-duration in the 1990 flood was estimated from the results of flood damage survey as shown in Table V.2.1.

The flood damage conditions of major rivers are summarized below.

(1) Blorong River

Inundation by flood spread in the lower reaches from Pengilon Weir. The total inundation area was about 590 ha with the maximum inundation depth of about 0.5 m and the maximum inundation duration of 24 to 30 hours. Major flood damage came about in the paddy field, and several settlement areas were also flooded.

(2) Bringin River

There was no record on flood damage for the January 1990 flood in Bringing River, so that the details of flood area-depth-duration is not included in Table V.2.1. The approximate extent of the flood was only estimated from the interview survey carried out by the Study Team. According to the interview survey, the flood inundation area spread out in the lower reaches from the national road, and almost all the present paddy fields and fishponds were submerged. The approximate extent of the flood inundation area is estimated at 860 ha, and the maximum inundation depth and duration are about 0.6 m and 48 hours, respectively.

(3) Silandak River

As in Bringin River, there was no record on flood damage for the January 1990 flood in Silandak River. Therefore, details on flood area-depth-duration could not be included in Table V.2.1. According to the interview survey, however, it is clear that the inundation spread out in the lower reaches from the railway bridge and a part of the airport was also inundated. The maximum inundation depth and duration is estimated at about 1.2 m and 14 hours, respectively.

(4) West Floodway/Garang River

In January 1990, flood discharge overflow occurred along West Floodway/Garang River leading to flood damage associated with the destruction of a considerable part of the river dike. The serious flood overflow occurred particularly along the downstream of Garang River between the confluence of Kreo River and Simongan Weir, and the following flood calamities were at least confirmed by the Ministry of Public Works:

(a)	Death	:	47
(b)	House Collapsed	:	25
(c)	House Damaged	:	126
(d)	School Building Collapsed	:	1
(e)	Dormitory Collapsed	:	1

The total inundation area for West Floodway and Garang River was about 1,670 ha with the maximum inundation depth of 2 to 3 m and the maximum inundation duration of 2 to 4.5 hours.

(5) East Floodway (Banjir Kanal Timur)

Channel overflow occurred along the right bank of East Floodway, particularly, at the bridge of the national road (bending portion of the floodway) and around the confluence of Kedungmundu River (the major tributary of the floodway). Due to the channel overflow, the inundation spread over the densely populated area of Semarang City located north of East Floodway. Major flood damage were the houses flooded with the maximum depth of 0.6 m for a duration of 5 to 20 hours. Total area of flood inundation was about 51.5 ha.

(6) Babon River

Channel overflow occurred along the river section of about 5 km starting from the river mouth. Due to the channel overflow, the paddy irrigation area and a large number of houses were flooded with the maximum depth of 0.3 to 1.0 m and for a duration of 7 to 21 hours. Total flood area was estimated at about 190 ha.

2.3 Major Flood Control Works Recently Carried Out

To cope with the habitual flood damage, various flood control plans have been formulated for the objective six (6) rivers, and some of them were already implemented (refer to Fig. V.2.5 and Table V.2.2). The design scale adopted to the latest flood control plans range from 5-year return period up to 100-year return period, and such flood control plans are being undertaken by the Department of Public Works through the following three (3) projects:

(1) West Semarang Irrigation Project;

(2) Central Jawa River Improvement and Maintenance Project; and

(3) Jratunseluna Project.

The details of the latest flood control works for each objective river are described below.

(1) Blorong River

Serious flood damage habitually occur in the lower reaches of Pengilon Weir. To cope with the flooding problem, detailed design for river improvement works with a design scale of 20-year return period was made for the river stretch of 15.0 km starting from the river mouth up to the Pengilon Weir under the West Semarang Irrigation Project in 1985. However, construction works for the river improvement has not been implemented yet.

(2) Bringin River

The river improvement plan with a design scale of 5-year return period was preliminarily conceived by the Central Jawa River Improvement and Maintenance Project in 1991. The river improvement stretch was assumed to be about 5.5 km in length starting from the river mouth to mitigate the flood damage in the lower reaches from the bridge of the national road. However, the river improvement plan has not been implemented yet.

(3) Silandak River

A diversion channel was connected from Silandak River to Siangker River which runs on the east side of Silandak River and flows into Jawa Sea passing along the east side of the airport. At the same time, the downstream of Siangker River from the outlet of the diversion channel was enlarged, and Silandak Floodway of 2.92 km in length was constructed running along the west side of the airport in order to mitigate the flood inundation in the lower reaches of Silandak River, particularly, around the airport. All of these flood control works were completed under the Central Jawa River Improvement and Maintenance Project in 1991.

The design scale for the flood control works was set at 50-year return period corresponding to the probable flood run-off discharge of 110.5 m^3/s, divided into 91.5 m^3/s from Silandak River and 19.0 m^3/s from Siangker

River. The following design discharge was allocated to each channel section:

(a)	Floodway	:	82.0 m^3/s
(b)	Downstream of Siangker river: the outlet of diversion channel		28.5 m^3/s
	Total	:	110.5 m^3/s

(4) Garang River

Immediately after the flood damage in January 1990, the river improvement/rehabilitation works of Garang River started under the Central Jawa River Improvement and Maintenance Project. The length of the improvement works is about 4.3 km starting from Simongan Weir up to the confluence of Kreo River. The design scale and discharge of the improvement works were set at 100-year return period and 1,100 m^3/s, respectively. It is herein noted that the probable discharge of 100-year return period is estimated at 980 m^3/s in this Study instead of the 1,100 m^3/s used for the said design discharge as described in SECTOR I, METEOROLOGY AND HYDROLOGY.

The main improvement works is the reconstruction of river dike and, in addition, excavation of short cut channel was adopted as the supplementary improvement measure. The improvement works are still in progress and the major remaining work is the necessary treatment works for drainage channels/drains which flow into the main stream requiring prevention of reverse flow from the main stream.

(5) East Floodway

A densely populated area spreads out along East Floodway, therefore, a high flood damage potential is expected once channel overflow of the floodway occurs. To cope with such high potential of flood damage, the following flood control plan is proposed by the aforesaid Jratunseluna Project and projected to be completed in the year of 2000.

(a) To close the diversion channel and stop the flood discharge diverted from the Penggaron River into East Floodway; and

(b) To dredge sediments deposited on the channel bed of East Floodway so as to restore the channel flow capacity and accommodate the flood scale of 25-year return period.

(6) Babon River

To cope with the flood damage in the lower reaches of Babon River, river improvement works for the stretch of 17.4 km starting from the river mouth up to Pucang Gading Weir was undertaken under the Central Jawa River Improvement and Maintenance Project and completed in 1991. The design scale for the river improvement works was set at 5-year return period corresponding to the probable flood run-off discharge of 320 m^3/s.

Following the above river improvement works, further flood control plan for Babon River is now being proposed under the aforesaid

Jratunseluna Project and projected to be completed in the year 2000. The outline of the proposed plan is enumerated as follows:

(a) The present Kebonbatur Floodway from Dolok River to Penggaron River will be closed to reduce the flood flow discharge of Babon River and East Floodway.

(b) The present diversion channel from Penggaron River to East Floodway will also be closed to reduce the flood flow discharge of East Floodway.

(c) A new floodway will be constructed starting from Pucang Gading Weir on Penggaron River to Dombo/Sayung River which flows on the east side of Babon River. Thereby, the design flood discharge of 25-year return period could be discharged into Jawa Sea through the new floodway.

2.4 Present Channel Flow Capacity of the Rivers

In order to evaluate the present channel flow capacity of the objective six (6) rivers, the probable flood high water level for the existing river channel was estimated by non-uniform calculation method. In the calculation, the Manning's roughness coefficient of the channel was assumed at 0.03 for the low water channel and 0.04 for the high water channel, and the tidal level at the river mouth was assumed at EL. 0.6 m which was the mean high water level (MHWL) observed at Semarang Harbor in 1991.

The above non-uniform calculation require the results of the longitudinal and cross sectional river channel survey. The river channel survey results by the JICA Study Team were used for the objective four (4) rivers of Blorong, Silandak, East Floodway and Babon, while the survey data for the other two (2) rivers of Bringin River and West Floodway/Garang River were provided from the office of the Central Jawa River Improvement and Maintenance Project.

The results of the non-uniform calculation are as shown in Fig. V.2.6, and the following evaluation on the present channel capacity is given to the objective rivers.

(1) Flow Capacity of the Improved Rivers

River improvement works have been completed for Babon River with the design discharge of 320 m^3/s, and the present channel flow capacity of more than 10 km upstream from the river mouth is still maintained to be almost the same as the design discharge. However, the present channel flow capacity in the downstream portion is evaluated to be lower than the design flow capacity, particularly, in the downstream from Karangroto Weir located about 4.5 km upstream from the river mouth where the present channel flow capacity is reduced to 100 m^3/s.

Embankment works also are now being implemented for Garang River. In this connection, it is evaluated that the completed embankment portion of Garang River could accommodate even a 100-year return period flood discharge (980 m^3/s), while the tributaries connected to Garang River are not provided with sufficient embankment height and/or flap gate to prevent reverse flow. Accordingly, channel overflow of the tributaries could occur even in case of 5 to 10-year return period discharge. Furthermore, channel flow capacity tends to decrease in the downstream from 100-year return period flood discharge (980 m^3/s) on Garang River to 10 to 25-year return period discharge (630 to 770 m^3/s) on West Floodway. The detailed evaluation on the channel flow capacity of West Floodway/Garang River is as described in CHAPTER 5.

(2) Flow Capacity of the Non-improved Rivers

No major river improvement works have been implemented for Blorong and Bringin River, and the present channel flow capacity of these two rivers are fairly lower than even 2-year return period flood discharge, as given below:

River	Present Flow Capacity	2-year Return Period Discharge
Blorong River	50 to 150 m^3/s	450 m^3/s
Bringin River	20 to 100 m^3/s	190 m^3/s

It is further noted that the channel flow capacity tends to be remarkably reduced in the downstream portion due to the gentle river bed gradient and the narrower channel cross section.

(3) Flow Capacity of East Floodway

East Floodway has a rather large channel flow capacity of about 330 m^3/s at more than 4.5 km upstream from the river mouth. The channel flow capacity of 330 m^3/s could accommodate the probable flood discharge of 100-year return period, should any flood discharge not be diverted from Penggaron River as proposed in the Jratunseluna Project. However, the channel flow capacity tends to be reduced in the downstream. The flow capacity downstream within 4.0 km from the river mouth is only 100 m^3/s which could not accommodate even a 2-year return period flood of about 170 m^3/s.

(4) Flow Capacity of West Floodway

West Floodway has a channel flow capacity slightly lower than the 25-year return period flood of about 770 m^3/s.

(5) Flow Capacity of Silandak Floodway

The channel flow capacity of the floodway portion (0.0 to 2.92 km from the river mouth) is remarkably reduced from the design flow capacity of 82 m^3/s to less than 30 m^3/s. The reduction of the channel flow capacity is attributed to the sediment deposits forming the extremely gentle river bed gradient and the narrower channel cross section. The upstream channel flow capacity from the floodway is estimated to be about 50 m^3/s slightly higher than the channel flow capacity of the floodway.

CHAPTER 3 FLOOD CONTROL MASTER PLAN

3.1 Planning Criteria

<u>Target Completion Year</u>

The target completion year of the Flood Control Master Plan is set at the year 2015.

<u>Objective River Stretch</u>

Based on the study on present river channel conditions, past flood damage records and present/future land use, the following sections are proposed as the major targets to be protected against the design flood in the master plan (refer to Fig. V.3.1):

(1)	Blorong River	:	Downstream from Pengilon Weir (15.0 km in length)
(2)	Bringin River	:	Downstream from Dondong bridge (5.04 km in length)
(3)	Silandak River	:	Entire floodway portion (2.92 km in length) and the upstream river portion (2.39 km in length)
(4)	West Floodway/ Garang River	:	Downstream from the junction of Kreo River (9.54 km in length).

(5) East Floodway : Downstream from the junction of Kedungmundu River (12.0 km in length)

(6) Babon River : Downstream from Pucang Gading Weir (17.40 km in length)

Design Scale

The design scales so far adopted for flood control works in Indonesia are within 10 to 50-year return period flood (refer to Table V.3.1). In comparison, the design scale of present/ongoing river improvement works in the study area is not so different. However, this Flood Control Master Plan aims at implemention with the target year 2015, and the design scale for the target year must be elevated from the present value in due consideration of the increment of future flood damage potential associated with the increment of population and enlargement of urbanized area.

Among the objective rivers, the watersheds of Silandak River, West Floodway/Garang River and East Floodway is projected to be fully urbanized with a high flood damage potential in 2015; hence, the optimum design scale is required. A considerable part of the watersheds of Bringin and Babon rivers are also projected to be developed as industrial area by the year 2000 (refer to Fig. V.2.3) and, accordingly, a rather high design scale also is required for the two (2) rivers. As for Blorong River, the urbanized ratio in the watershed will be lower than the above urban river groups, and a lower design scale could be applied.

In due consideration of the future land use conditions, the design scales adopted to the latest flood control plans as well as the present channel flow capacities of the objective rivers, the following design scales are proposed for the Master Plan (refer to Table V.3.2).

Name of River	Design Scale (Return Period)
Blorong River	20-year
Bringin River	50-year
Silandak River	100-year
West Floodway/Garang River	100-year
East Floodway	100-year
Babon River	50-year

Standard Flood Discharge

In accordance with the aforesaid design scales adopted for the objective river stretches, the standard flood discharge is estimated as below (refer to SECTOR I, METEOROLOGY AND HYDROLOGY).

Name of River	Standard Flood Discharge
Blorong River	630 m^3/s
Bringin River	320 m^3/s
Silandak River	120 m^3/s
West Floodway/Garang River	980 m^3/s
East Floodway	350 m^3/s
Babon River	630 m^3/s

Planning Criteria for River Improvement and Floodway Construction

The following criteria are applied to the plans for river improvement and floodway construction and the estimate for the necessary work volume.

(1) High Water Level

The principal criterion is to set the design high water level below the hinterland ground level so as to minimize the flood damage potential. The design high water level is, however, unavoidably set higher than the hinterland ground level for the low-lying downstream stretch where the riverbed gradient is extremely flat, and it is technically difficult to set the design high water level lower than the hinterland ground level due to the backwater effect of the tidal level.

(2) Riverbed Profile

The design riverbed profile principally follows the existing riverbed profile to avoid channel erosion or sedimentation and to minimize relocation and modification of existing river structures.

(3) River Channel Cross Section

A compound cross section with high and low water channels is principally adopted to minimize embankment height and to assure channel stability. In the compound cross section, the low water channel is designed to have a channel flow capacity of 1.01-year return period to assure channel stability.

However, the low water channels of West Floodway/Garang River and East Floodway are designed to have a channel flow capacity higher than 1.01-year return period due to the difficulty of land acquisition. As an exceptional case to the compound cross section, a single cross section is adopted to the low-lying downstream stretch where the backwater effect of tidal level is dominant. The single cross section is also adopted to the entire river stretch of Silandak Floodway which is subject to rather small design discharges of 120 m^3/s. Side slope of cross sections is 1:2 in general.

(4) Dike

Earth dike with a side slope of 1:2 is adopted to the standard design of all objective rivers, except a part of West Floodway/Garang River and East Floodway where the concrete retaining wall is partly adopted due to the difficulty of land acquisition.

In addition, the following standards are adopted to the freeboard of the dike.

Design Discharge (m^3/s)	Freeboard Height (m)
Less than 200	0.6
200 to ≤ 500	0.8
500 to ≤ 1,000	1.0

The crown width of the dike is assumed at 4 m to serve as inspection road and to prevent seepage at the dike.

Planning Criteria for Flood Control Dam

The following items are adopted as the principal criteria for planning flood control dams:

(1) Flood Regulation Method

The flood discharge will be naturally regulated by a non-gated spillway in due consideration of easier operation and maintenance.

(2) Flood Control Capacity to be Allocated

As both the flood control capacity and cost of the dam reservoir are increased, the design discharge and cost for river improvement of the downstream stretch could be decreased. The flood control capacity will be determined in due consideration of the minimum cost among the totals of river improvement cost and dam construction cost.

3.2 Alternative Plan

Possible Flood Control Measures

Based on the detailed reconnaissance on topographic condition of the study area, possible flood control measures are proposed including channel improvement works for the six (6) river stretches of about 64.3 km in total, four (4) flood control dams and two (2) floodways, as shown in Fig. V.3.1. In addition to these flood control measures, retarding basin is generally adopted as an effective measure. It was, however, confirmed through the field reconnaissance and the aero-photographs that there is no appropriate site for a retarding basin.

Details of these possible flood control measures are described below.

(1) River Improvement

River improvement is required in all alternative flood control plans for all objective river stretches. Enumerated below are the standard flood discharges and the corresponding river improvement length for each objective river.

Name of River	Catchment Area (km^2)	Standard Flood Discharge (m^3/s)	River Improvement Length (km)
Blorong River	157.0	630	15.00
Bringin River	32.1	320	5.04
Silandak River	8.5	120	5.31
West Floodway/ Garang River	204.0	980	9.54
East Floodway	29.7	350	12.00
Babon River	77.0	630	17.40
Total	508.3		64.29

The above standard flood discharge and improvement length are the design conditions applied to the alternative plan without any other supporting flood control measures such as flood control dam and floodway, and require the maximum river improvement work volume.

When flood control dam or floodway is included in the alternative plan, the design flood discharge as well as the work volume for the associated river improvement is reduced due to the flood regulation effect of such supporting flood control measures. In this connection, the typical cross sections for variable design flood discharges are estimated in accordance with the aforesaid planning criteria (refer to Table V.3.3).

These typical cross sections are used to carry out a comparative study on the work volume/project cost for alternative flood control plans and to determine the optimum river improvement plan.

(2) Flood Control Dam

The allocation of flood storage capacity to the multipurpose dam reservoir is one of the effective features of the Flood Control Master Plan.

There are four (4) possible dam sites, namely, the Kedung Suren dam site in the Blorong river basin, the Mundingan and Jatibarang dam sites in the Garang river basin, and the Babon dam site in the Babon river basin. The alternative flood storage volume and the corresponding downstream design discharge in these dam sites show a good relationship as shown in Table V.3.4. The critical minimum design discharge for downstream river improvement and the corresponding required maximum flood storage volume are given below.

Name of Dam	Standard Flood Discharge (m^3/s)	Minimum Design Flood Discharge (m^3/s)	Required Dam Storage Volume (Mill. m^3)
Kedung Suren	630	57	15.32
Jatibarang	980	728	7.93
Mundingan	980	766	5.13
Babon	630	276	8.55
		(66)	

Note: Figure in parentheses is the design discharge after subtracting the discharge of 210 m^3/s to be diverted into the proposed floodway.

The above relationship is used as the basic data to conduct the comparative study on the alternative plans and to select the optimum flood control storage capacity/Surcharge Water Level (SWL).

In this study, the alternative flood storage volumes are, in principle, assumed to be above the Normal Water Level (NWL) proposed in SECTOR VII, WATER RESOURCES DEVELOPMENT PLAN. As for Jatibarang Dam, however, since it is difficult to allocate a flood control storage volume above the NWL (EL. 155 m) due to the limited topographic maximum dam height (EL. 162 m), the NWL was made variable assuming the alternative flood storage volume to be below the fixed possible highest SWL which is determined at EL. 157 m in due consideration of the topographic maximum dam height and the necessary clearance to accommodate the dam design discharge. Consequently, the NWL for Jatibarang Dam needs to be lower than that proposed in SECTOR VII, WATER RESOURCES DEVELOPMENT PLAN provided that the optimum design discharge for the downstream river improvement is reduced to less than 845 m^3/s (refer to Table V.3.4).

(3) Floodway

The following two (2) floodways are proposed for Bringin River and Babon River, respectively so as to reduce the design flood discharge for the river improvement works.

Bringin Floodway

The floodway for Bringin River is to divert the flood discharge from the confluence of two tributaries, Klombrok River and Ingas River, into the sea through the existing river channel of Tapak River. The floodway length is 4.5 km, which could be shorter than the existing river channel length of 8.0 km stretching between the diversion point and the river mouth.

The catchment area of the proposed floodway is about 23.9 km^2, which corresponds to 74.5% of the whole catchment area of Bringin River, and out of the standard flood discharge of 320 m^3/s for Bringin River (50-year return period), the maximum discharge of 240 m^3/s could be diverted into the floodway.

However, it will be difficult to construct the floodway along the section of about 2.5 km from the diversion point which has an extremely steep ground slope of 1/20 to 1/80, and this will require particular river structures such as groundsills to make the channel slope less steep and to limit the excessive channel flow velocity.

Babon Floodway

The Jratunseluna Project proposed the floodway for Babon River to divert the flood run-off discharge from Penggaron River into Dombo/Sayung River with the diversion discharge of 210 m^3/s. The diversion point is just upstream of Pucang Gading Weir, while the river improvement sections proposed in this Study are along the downstream of Pucang Gading Weir. Accordingly, the design discharge for the proposed river improvement works could be reduced by the said diversion discharge of 210 m^3/s.

The detailed design for the floodway has already been completed, and the project completion time is projected to be the year 2000. Therefore, it was agreed with the Government of Indonesia that the floodway plan will be applied, in principle, as a condition to all alternative flood control plans for this Study.

The design scale for this Study is, however, upgraded to 50-year return period from the 25-year return period applied to the floodway plan. To cope with the upgraded design scale, a minor modification for the floodway plan is required. The modification will be made by expanding the width of the diversion fixed weir for Babon River but maintaining the weir crest elevation of EL. 19.93 m [= El. 21.7 m above Datum of Semarang Peil Baru (SPB)] so as to fulfill the existing irrigation requirement. The modified width of the diversion weir is estimated according to the alternative design flood discharges effected by the control of the upstream Babon Dam as below:

Plan	Design Discharge (Weir Inflow) (m3/s)	Pier Width (m)	Net Weir Width (m)	Total Weir Width (m)
Original Plan	250	0.8	19.9	20.7
Alternative Plan	150	0.8	11.9	12.7
	200	0.8	15.9	16.7
	300	0.8	23.9	24.7
	420	0.8	32.6	33.4

Alternative Flood Control Plans

The following alternative flood control plans are selected for each objective river stretch in due consideration of the combination of the aforesaid possible flood control measures:

(1) Blorong River

Alt. A-1: River improvement without any other flood control measure.

Alt. A-2: River improvement with flood control by Kedung Suren Dam.

(2) Bringin River

Alt. B-1: River improvement without any other flood control measure.

Alt. B-2: River Improvement with flood diversion by a floodway.

(3) Silandak River

Alt. C-1: Improvement of the existing floodway and its upstream existing river channel without any other supporting flood control measure.

Alt. C-2: Improvement of the existing floodway and its upstream existing river channel together with the river improvement of Siangker River.

(4) West Floodway/Garang River

Alt. D-1: River improvement without any other flood control measure.

Alt. D-2: River improvement with flood control by Jatibarang Dam.

Alt. D-3: River improvement with flood control by Mundingan Dam.

(5) East Floodway

Alt. E-1: Improvement of the existing floodway with closure of diversion channel from Babon/Penggaron River as proposed in the Jratunseluna Project.

(6) Babon River

Alt. F-1: River Improvement on the premise of flood diversion into Dombo/Sayung River.

Alt. F-2: River Improvement on the premise of flood diversion into Dombo/Sayung River and flood control by Babon Dam.

3.3 Optimum Plan

The comparative study on the above-mentioned alternative plans was made on the basis of the project cost, the annual operation and maintenance cost, and the quantity of the necessary compensation works (refer to Table V.3.5 and Fig. V.3.2). As a result, the optimum plan for each objective river was selected as summarized in Table V.3.6. The distribution of the proposed design flood discharge for the optimum plan is as shown in Fig. V.3.3. Correspondingly, the typical cross sections and longitudinal profiles for the optimum plan are proposed as shown in Figs. V.3.4 and V.3.5, respectively. The details of the selected optimum plan are given below.

(1) Blorong River

The river improvement plan with the design flood discharge of less than 100 m^3/s controlled by Kedung Suren Dam (Alternative A-2) tends to require less project cost and operation/maintenance cost as compared with the river improvement plan solely done without the flood control by Kedung Suren Dam (Alternative A-1). Moreover, the number of house evacuation also tends to be reduced when the flood control effect of Kedung Suren Dam is included in the plan. The tendency is attributed to the following factors:

(a) The existing channel of Blorong River has a extremely small flow capacity of less than 2-year return period, therefore, upgrading the design scale of the river improvement requires a huge incremental work volume;

(b) Since Kedung Suren Dam is located just upstream of the objective river improvement stretch, a considerable part of flood discharge flowing into the objective river stretch could be regulated by the dam; and

(c) Kedung Suren Dam is effective to check the sediment flowing into the objective river stretch and, therefore, could reduce the load of annual river channel operation/maintenance work.

Thus, the combination plan of river improvement and flood control of Kedung Suren Dam (Alternative A-2) is preferred as compared with the river improvement work solely done without flood control by Kedung Suren Dam (Alternative A-1).

The least cost for construction works as well as annual operation/maintenance cost is obtained when the design flood discharge for the river improvement works is reduced to 100 m^3/s from the standard flood discharge of 630 m^3/s by the flood regulation effect of Kedung Suren Dam (refer to Fig. V.3.6 (1/2)). The required river improvement stretch also could be reduced to 6.5 km from the entire objective river stretch of 15.0 km in length. From these viewpoints, Alternative Plan A-2 with the design flood discharge of 100 m^3/s for river improvement is selected as the optimum plan.

(2) Bringin River

The combination plan of river channel improvement and construction of a floodway (Alternative Plan B-2) is estimated to require higher construction cost and annual operation/maintenance cost compared with the river improvement without the floodway (Alternative Plan B-1). The principal reason on the higher cost of the floodway could be attributed to the extremely steep ground slope of 1/20 to 1/80 along the floodway section of about 2.5 km starting from the diversion point where several groundsills are required to make the channel slope less steep and to limit the excessive channel flow velocity. Furthermore, the floodway needs to run through Tapak Village, resulting in almost the same number of house evacuation required between the plans with- and without-floodway.

From the above points of view, the river improvement plan without construction of the floodway (Alternative Plan B-1) is selected as the optimum flood control plan.

(3) Silandak River

Alternative Plan C-2 proposes to use Siangker River running along the east side of Ahmad Yani Airport as a diversion channel of Silandak River (refer to Section 2.1). The Ministry of Transportation is, however, planning to expand the existing runway of the airport crossing Siangker River.

According to the plan, Siangker River will be used as a principal drainage channel for the storm rainfall of the airport leading to the difficulty in accommodating the excessive flood discharge from Silandak River. Furthermore, Siangker River is to be reformed to a box culvert at the portion of about 200 m in length overlapped by the runway. The declogging of deposits in the box culvert is virtually difficult, when Siangker River is used as the diversion channel for Silandak River, and excessive sediment could be transported from Silandak River and deposited in the box culvert.

Due to the above-mentioned conditions, it is virtually difficult to use Siangker River as the diversion channel for Silandak River. Therefore, Alternative Plan C-2 is excluded from the possible flood control plan. Instead, improvement of the existing Silandak Floodway/River (Alternative C-1) is preferred as the optimum plan.

(4) West Floodway/Garang River

The entire project cost, expressed as the total of the costs for flood control dam and river improvement, tends to increase with the reduction of cost for flood control dam and the corresponding increment of river improvement cost. Particularly, when the design flood discharge on the river improvement portion exceeds 800 m^3/s, the project cost drastically increases.

The dominant factor for the above increment of project cost is attributed to the project compensation cost associated with the upgraded river improvement works. The river improvement works with the design discharge of more than 800 m^3/s will require a large number of house evacuation and the relocation of road in the densely populated area along the river improvement section.

Thus, the combined plans of flood control dam and river improvement (Alternative Plan D-2 and D-3) is preferred to the river improvement plan without the flood control dam (Alternative Plan D-1). Furthermore, Alternative Plan D-2 that applies Jatibarang Dam as its flood control dam could require less project cost and number of house evacuation as compared with Alternative Plan D-3 that applies Mundingan Dam. From this viewpoint, Alternative Plan D-2 is selected as the optimum plan.

The design flood discharge for the river improvement work proposed in the optimum plan (Alternative Plan D-2) is determined at 770 m^3/s in due consideration of the following items:

(a) The design flood discharge of 770 m^3/s is proposed as the design scale for the Urgent River Improvement Project on the premise that its target completion year is the year 2000.

(b) Among alternative design flood discharges for the river improvement, the least project cost of Rp. 83,147 million is estimated in case of the design flood discharge of 740 m^3/s. The least cost is, however, evaluated to have no substantial difference compared with the project cost of Rp. 85,053 million for the design flood discharge of 770 m^3/s.

The difference between the standard flood discharge of 980 m^3/s and the design flood discharge of 770 m^3/s for the optimum river improvement plan is brought about by the flood control effect of Jatibarang Dam. The flood control capacity allocated to Jatibarang Dam is 4.3 MCM, which has the flood control effects shown in Fig. V.3.6 (2/2).

(5) East Floodway

Channel improvement including embankment works and channel excavation works is solely proposed as the optimum plan, since it is virtually difficult to introduce any other alternative flood control measures such as flood control dams and flood retarding basins.

The channel improvement will be made on the premise that the diversion weir for East Floodway at Pucang Gading is closed at the time of flood, and no flood discharge is to be diverted from Penggaron River into East Floodway as proposed by the Jratunseluna Project.

The existing diversion channel is herein defined to stretch from the Pucang Gading Weir up to the upmost point of East Floodway (the confluence of Kedungmundu River, major tributary of East Floodway). After completion of the improvement of East Floodway, the diversion channel is to be used only as waterway for maintenance flow during the dry season. Accordingly, the diversion channel is excluded from the stretch for the proposed channel improvement work.

(6) Babon River

The river improvement plan without flood control of Babon Dam in the upstream (Alternative Plan F-1) tends to require less project cost and annual operation/maintenance cost than the river improvement plan with flood control of Babon Dam (Alternative Plan F-2). Thus, the cost for flood control by Babon Dam is evaluated to be rather costly compared with the river improvement work and, from this viewpoint, Alternative Plan F-1 is selected as the optimum plan.

The selected optimum plan is subject to the flood diversion effect of Babon Floodway proposed by the Jratunseluna Project. Out of the standard flood discharge of 630 m^3/s, the floodway is to divert the flood discharge of 210 m^3/s into Dombo/Sayung River, therefore, the design flood discharge for the downstream river improvement could be reduced into 420 m^3/s. All works related to the floodway except the minor modification of the diversion weir will be undertaken by Jratunseluna Project and completed in the year of 2000, while other works other than the construction of the floodway are to be implemented through this Master Plan with completion set at the year 2010.

In the objective river improvement stretch is the Karangroto Weir, 4.42 km upstream of the river mouth. The weir is now being used as irrigation intake facility, but needs to be either reconstructed or provided with a substitute intake facility due to the proposed river improvement work. In the optimum plan, reconstruction of the weir is evaluated to be costly and, instead, the riverside irrigation channel (foreland channel) is proposed as the substitute facility to convey the water of Babon River from about 4.0 km upstream of the existing weir site (refer to SECTOR X, RIPARIAN STRUCTURE DESIGN).

3.4 Selection of Priority Project

The priority project is selected from among the optimum flood control plans for the six (6) objective rivers in due consideration of the economic viability, the previous flood damage conditions, and other related development plans.

The economic viability could be evaluated on the basis of the economic internal rate of return (EIRR). As estimated in SECTOR XIV, ECONOMIC EVALUATION, the following values are estimated as the EIRR for the optimum plans of each objective river, and the highest value of EIRR is given to the plan for West Floodway/Garang River.

(1)	Blorong River	:	10.5%
(2)	Bringin River	:	6.1%
(3)	Silandak River	:	12.8%
(4)	West Floodway/Garang River	:	16.8%
(5)	East Floodway	:	14.9%
(6)	Babon River	:	13.8%

West Floodway/Garang River is located in the densely populated urban area possessing the highest annual average flood damage among the objective rivers in the year 2015, as estimated below:

(1)	Blorong River	:	Rp. 10,314 million
(2)	Bringin River	:	Rp. 1,816 million
(3)	Silandak River	:	Rp. 1,628 million
(4)	West Floodway/ Garang River	:	Rp. 27,264 million
(5)	East Floodway	:	Rp. 5,239 million
(6)	Babon River	:	Rp. 17,753 million

Furthermore, in the January 1990 flood, 47 deaths were recorded as the flood calamity of West Floodway/Garang River.

The optimum plan for West Floodway/Garang River requires the flood control capacity of Jatibarang Dam as its project component to upgrade the design scale to 100-year return period. The water supply capacity of Jatibarang Dam is also required as priority for the water resources development plan to meet the incremental water demand of the Study Area (refer to SECTOR VII, WATER RESOURCES DEVELOPMENT PLAN). Therefore, a more detailed study on the flood control effect of Jatibarang Dam is deemed to be urgently necessary.

On the basis of the evaluation on the above conditions, the optimum flood control plan for West Floodway/Garang River is recommended as the priority project and to be the objective of the feasibility study. The required works for the optimum plan is composed of the river improvement and the allocation of flood control capacity to Jatibarang Dam.

CHAPTER 4 FEASIBILITY STUDY

4.1 Planning Criteria

Objective Protected Area

In accordance with the priority project selected in the Master Plan, the objective area is placed within the probable flood inundation area along West Floodway/Garang River of 9.54 km in length starting from the river mouth up to the confluence with Kreo River. The objective area is administratively within the limits of Kec. Semarang Barat in Kota. Semarang.

Target Completion Year

As proposed in the Inception Report, the target completion year of the aforesaid flood control measure was preliminarily assumed to be the year 2005. The completion year is, however, advanced to the year of 2000, as proposed in the Master Plan, due to the following reasons:

(1) Jatibarang Dam needs to be completed in the year 2000 to cope with the incremental water demand of Semarang City as projected in SECTOR VII, WATER RESOURCES DEVELOPMENT PLAN.

(2) The river channel improvement of West Floodway/Garang River needs to be completed as Urgent Project before the year 2000 so as to reduce the extremely high flood damage potential as agreed in the "Minutes of Meeting" between DGWRD and JICA in 1991.

Design Scale

The design scale for the objective flood control measure is set at 100-year return period as proposed in the Master Plan. Based on the design scale, the standard flood discharge is estimated as below (refer to SECTOR I, METEOROLOGY AND HYDROLOGY).

Jatibarang Dam Site	:	280 m^3/s
River Channel Improvement Section	:	980 m^3/s

Dam Flood Regulation Method

The flood control by Jatibarang Dam is studied on the premise of the natural flood regulation method by non-gated spillway in due consideration of easier operation and maintenance.

River Improvement

The criteria for river improvement are basically the same as those applied in the Master Plan. The main objectives of the river improvement are to make the design high water level below the hinterland ground level and to prepare the appropriate flood control measures for the tributaries/drainage channels. These objectives are proposed to prevent the recurrence of the flood damage experienced in the January 1990 flood.

Priority for Allocation of Flood Control Capacity in Jatibarang Dam Reservoir

Jatibarang Dam as well as the river improvement will be the main flood control measure for West Floodway/Garang River. Therefore, the storage capacity of the Jatibarang dam reservoir is allocated to flood control, public water supply, and hydropower generation. Among these allocated capacities, the flood control capacity is indispensable to reduce the design discharge for the downstream river improvement plan so as to avoid the extensive relocation of houses along the river improvement section as described in Master Plan (refer to Section 3.3). As for the public water supply, however, the deficit in the water supply from the Jatibarang dam reservoir could be supplemented by the Mundingan dam reservoir as projected in the Water Resources Development Plan (refer to SECTOR VII). The storage capacity for hydropower generation could also be compensated by other alternative thermal power generation.

In due consideration of these conditions, the highest priority for allocation of reservoir capacity is placed on flood control. Thus, the allocation for public water supply capacity has the second priority next to the flood control capacity. However, the deficit in public water supply is going to be more serious in Semarang City and from this viewpoint, it is premised in this Feasibility Study that the public water supply capacity allocated to Jatibarang Dam in the Master Plan should at least be ensured so as to cope with the water shortage, working together with the public water supply from Mundingan Dam.

4.2 Alternative Plan

4.2.1 Alternative Flood Control Measures

The possible flood control measures were scrutinized through the results of the detailed field reconnaissance and the topographic map on the scale of 1:10,000 which was newly developed by the JICA Study Team in the feasibility study stage. As a result, it was concluded that the flood control measures to be examined in Feasibility Study are the flood control by Jatibarang Dam and the river improvement for West Floodway/Garang River, and the following alternative flood control plans are selected as the combination of possible flood control measures:

Alt. 1 : River improvement with flood control by Jatibarang Dam.

Alt. 2 : River improvement without flood control by Jatibarang Dam.

Should the river improvement with flood control by Jatibarang Dam (Alt. 1) be preferred than the river improvement without flood control by Jatibarang Dam (Alt. 2), it is further necessary to determine the optimum flood control capacity and the corresponding design scale of the river improvement. Such comparative study was preliminarily made in the Master Plan, and further clarified and optimized on the basis of the results of the detailed topographic survey and boring test newly conducted.

4.2.2 Alternative Dam Crest Elevations and Optimization

The crest elevation of Jatibarang Dam was preliminarily assumed at EL. 162.0 m in the Master Plan. The crest elevation proposed in the Master Plan is, however, based on the topographic maps on the scale of 1:50,000 prepared in 1944, while the boring tests and the development of topographic map on the scale of 1:10,000 were newly undertaken during the Feasibility Study stage. From these new boring tests and topographic map, it was clarified that the possible dam height could extend to EL. 170.0 m (refer to SECTOR IX, DAM ENGINEERING).

Due to the above findings, it was firstly necessary to determine the optimum dam crest elevation, and after determining the optimum dam crest elevation, the optimum flood control capacity could be allocated, or the inefficiency of the flood control capacity could be evaluated on the basis of comparison between the allocated cost for flood control capacity and the cost for river improvement.

To clarify the optimum dam crest elevation, the relationship between the alternative surcharge water level and its corresponding dam crest elevation was studied on the following conditions.

(1) The alternative dam crest elevations are within the upper limits of EL. 170 m.

(2) Jatibarang Dam is a multipurpose dam, and its reservoir capacity is for the purpose of flood control, water supply and hydropower generation. Among these purposes, highest priority is given to flood control capacity which could control the standard flood discharge of 980 m^3/s into the design discharge of 770 m^3/s at the river channel improvement section. This priority order is in accordance with the planning criteria as described in Section 4.1. The design discharge of 770 m^3/s is proposed as the optimum value in the Master Plan (refer to Section 3.3).

(3) The dam body will have three kinds of spillway, namely, (a) the flood control outlet, (b) the main spillway, and (c) the auxiliary spillway (refer to SECTOR IX, DAM ENGINEERING). The flood control outlet is proposed on the main dam to protect the lower reaches by controlling the

dam inflow discharge below 100-year return period design flood, while the main and auxiliary spillways are proposed on the main and sub-dam, respectively, to protect the dam body against the probable maximum flood (PMF). The width of main and auxiliary spillways are 60 and 150 m, respectively, as designed in SECTOR IX, DAM ENGINEERING.

On the above conditions, the dam flood routine simulation was carried out using the dam flood inflow of 100-year return period and probable maximum flood. As a result, the relationship between the alternative surcharge water level and its corresponding dam crest elevation was estimated, as shown in Table V.4.1. Then, based on the relationship, the optimum dam crest elevation was determined at EL. 164 m and correspondingly, the design flood water level (DFWL) of the Jatibarang dam reservoir was determined at EL. 162 m. The details are described in SECTOR IX, DAM ENGINEERING.

4.2.3 Alternative Dam Flood Control Capacity

On the premise of the optimum design flood water level (DFWL) of 162 m, the alternative flood control capacity of Jatibarang Dam and the corresponding design flood discharge for the downstream river improvement section were estimated by the flood routine simulation, as shown in Table V.4.2.

Then, the cost for each alternative flood control plan was estimated as shown in Table. V.4.3, and the cost relation curve between the dam flood control capacity and the downstream river improvement was estimated as shown in Fig. V.4.1.

4.3 Optimum Plan

4.3.1 Selection of the Optimum Plan

The entire project cost, expressed as a total of the dam cost allocated for flood control and the downstream river improvement cost, tends to increase as the design discharge for the river improvement is increased, as shown in Fig. V.4.1. Particularly, when the design discharge on the river improvement exceeds 800 m^3/s, the project cost drastically increases.

The dominant factor for the above increment of the project cost is attributed to the project compensation cost associated with upgrading of the river improvement works. The design discharge of more than about 800 m^3/s requires a large number of house evacuation and relocation of road in the densely populated area. Due to this condition, the combination plan of flood control dam and river improvement (Alt. 1) is selected as the optimum plan. The design discharge for the river improvement in the optimum plan is determined at 770 m^3/s in due consideration of the following items:

(1) The design flood discharge of 770 m^3/s is proposed as the design scale of 25-year return period for the Urgent Project independent of the flood control by Jatibarang Dam (refer to Section 5.2).

(2) The least project cost is estimated at Rp. 89,037 million in case of the design discharge of 740 m^3/s. The least cost is, however, evaluated to have no substantial difference from the project cost of

Rp. 90,867 million for the design discharge of 770 m^3/s.

The design features of the river improvement in the optimum plan is as described in CHAPTER 5. As for the dam component in the optimum plan, the following features are determined. The details on the optimum dam features are described in SECTOR IX, DAM ENGINEERING.

(1)	Dam Crest Elevation	:	EL. 164.0 m
(2)	Design Flood Water Level	:	EL. 162.0 m
(3)	Surcharge Water Level	:	EL. 158.8 m
(4)	Normal Water Level	:	EL. 155.3 m
(5)	Width of Flood Control Outlet	:	10.0 m
(6)	Flood Control Capacity	:	4,300,000 m^3

4.3.2 Flood Regulation Effect of the Optimum Plan

The present channel of West Floodway/Garang River is estimated to start overflow from about 5 to 10-year return period flood as described in Section 2.4, while the optimum flood control plan will cope with the flood of 100-year return period. The following area/houses will be relieved, by the optimum plan, from the probable flood damage under the land use condition in 2015 (refer to SECTOR XIV, ECONOMIC EVALUATION).

Return Period (year)	Inundation Area Relieved: Residential (ha)	Industrial (ha)	Business (ha)	Total (ha)	Houses/ Buildings Relieved (houses)
10	68	24	64	156	2,154
25	176	60	104	340	4,501
50	252	108	144	504	6,436
100	416	156	164	736	9,274

The optimum flood control plan is composed of the flood control by Jatibarang Dam and the river channel improvement. The flood control effect of each component is evaluated as below.

(1) Effect of River Improvement

River dredging and reconstruction of the existing Simongan Weir as proposed in the Urgent Project will lower the design high water level to the hinterland ground level and minimize the potential flood damage caused by the channel overflow (refer to CHAPTER 5). Furthermore, installation of 32 flap gates/culverts are proposed at the outlet points of tributaries/drainage channels connected to West Floodway/Garang River. Such gate facilities together with the lowering of the design water level at the main stream will be useful to prevent the tributaries/drainage channels from channel overflow affected by the backwater effect of the main stream.

(2) Effect of Jatibarang Dam

To evaluate the dam flood regulation effect, the following were estimated under with- and without-dam condition:

Return Period (year)	Peak Discharge*		Overflow Volume**	
	Without Dam (m^3/s)	With Dam (m^3/s)	Without Dam (1000 m^3)	With Dam (1000 m^3)
5	520	410	0	0
10	630	490	319	0
25	770	590	1,173	131
50	880	670	1,915	514
100	980	770	2,915	1,160

* Probable peak discharge at the river improvement section.

** Probable overflow volume exceeding the existing minimum channel flow capacity of 520 m^3/s at the proposed river improvement section.

4.3.3 Remarks on Simultaneous Implementation Proposed in the Optimum Plan

The optimum plan is subject to the simultaneous implementation of river improvement and the construction of Jatibarang Dam so as to realize the target completion year of 2000 (refer to SECTOR XI, CONSTRUCTION PLAN). Instead of simultaneous implementation, however, staged implementation will give an advantage in minimizing the annual disbursement amount for implementation. The economic viability of the staged implementation is, however, not lower than that of the simultaneous implementation as estimated below (refer to SECTOR XIV, ECONOMIC EVALUATION for details):

	Item	Year of Full Benefit	EIRR (%)
(a)	Parallel Implementation	2000	16.2
(b)	Staged Implementation (Case 1)		16.5
	- River Improvement	2000	
	- Dam Construction	2005	
(c)	Staged Implementation (Case 2)		20.9
	- Dam Construction	2000	
	- River Improvement	2005	

In spite of the above advantages of the staged implementation, the simultaneous implementation is proposed for the optimum plan in due consideration of the following:

(1) The construction of Jatibarang Dam and the river improvement of West Floodway/Garang River need to be implemented simultaneously to complete all project works in the year 2000 as premised in the design criterion in Section 4.1. Particularly, the river improvement must be completed as Urgent Project before the year 2000 so as to avoid the recurrence of the flood death calamity caused by the channel overflow experienced in the January 1990 flood. The target year of the Urgent Project is set in accordance with the Minutes of Meeting on Scope of Works for the Project in 1991.

(2) Storm rainfall is a natural phenomenon. Flood control by Jatibarang Dam could not be effective when the dominant storm rainfall area is biased to the non-catchment area of the dam.

Thus, the flood control by Jatibarang Dam is unreliable unless the river channel improvement is completed.

(3) The existing channel condition tends to cause the flood water stage of the main channel to be much higher than the hinterland ground level. Such excessively high flood water stage of the main channel could induce the reverse flow toward the tributaries/drainage channels and the high water stage along the backwater sections of the tributaries/drainage channels. Despite the reverse flow associated with high flood water stage, the existing tributaries/drainage channels were provided with a complete levee and/or well-functioning reverse flow check facilities. Accordingly, unless the river channel improvement is not implemented, the flood control effect by Jatibarang Dam could not relieve the great risk of channel overflow along the tributaries/drainage channels connected to the main stream.

CHAPTER 5 URGENT PROJECT FOR WEST FLOODWAY/GARANG RIVER

5.1 Introduction

5.1.1 Background of the Urgent Project

The flood of January 1990 caused overflow along West Floodway/Garang River resulting in the enormous flood damage in Semarang City and suburbs. With this as a turning point, it was agreed between DGWRD and JICA that the Urgent Project for West Floodway/Garang River should be studied to facilitate the immediate formulation and implementation of river channel improvement works and prevent the recurrence of overflow of the river channel as described in the Minutes of Meeting on Scope of Works on December 14, 1991.

The overall optimum plan for West Floodway/Garang River is recommended in the Feasibility Study to consist of the flood control by Jatibarang Dam and the river channel improvement on the design scale of 100-year return period (refer to CHAPTER 4). The details of the flood control by Jatibarang Dam were therefore clarified at the feasibility study level as described in CHAPTER 4.

As for the river improvement plan for West Floodway/Garang River, the details are herein formulated as a part of the overall optimum plan proposed in the Feasibility Study. At the same time, the river improvement plan herein formulated will form the Urgent Project. Independent of the flood control effect by Jatibarang Dam, the design scale of the Urgent Project is set at 25-year return period.

5.1.2 Detailed Clarification on Present Channel Flow Capacity

The probable high water level for the existing river channel is estimated in this study by the non-uniform calculation method using the results of the channel survey made in 1991 under the Central Jawa River Improvement and Maintenance Project. The results of the channel survey present the existing longitudinal profile of West Floodway and Garang River as shown in Fig. V.5.1. The conditions for the non-uniform calculation are presented in the following table.

		Water Level*		
Return Period (year)	Probable Discharge (m3/s)	River** Mouth (EL. m)	Simongan*** Weir (EL. m)	Manning's Roughness Coefficient
100	980	0.60	9.77	0.035
25	770	0.60	9.11	0.035
10	630	0.60	8.63	0.035

* All elevations are based on the datum of Mean Sea Level at Tanjung Priok in Jakarta.
** Mean high water level (MHWL) observed at Semarang Harbor in 1991.
*** Waterhead of overflow discharge at the weir.

The non-uniform calculation confirms that a probable high water level of 25-year return period exceeds the existing dike crown level of West Floodway at several sections [refer to Fig. V.2.6(4/7)]. Accordingly, the existing channel flow capacity of West Floodway is evaluated to be less than a 25-year return period.

As for Garang River, i.e., the upstream of Simongan Weir, an earth dike is now being constructed at about 2 to 4 km upstream of the weir, and its crown level is fairly higher than the probable high water level of even a 100-year return period flood [refer to Fig. V.2.6(5/7)].

A concrete retaining wall is also being constructed to protect the stretch of about 2 km from Simongan Weir. The crown elevation of the concrete retaining wall is lower than that of the earth dike, but still about 1 m higher than the high water level of a 25-year return period flood [refer to Fig. V.2.6(5/7)].

In view of the aforesaid dike height, the new dike apparently accommodates a probable flood discharge of 100-year return period for the earth dike section and 25-year return period for the concrete retaining wall section. It is, however, noted that the new dike crown elevation tends to be much higher than the ground level of the hinterland. Accordingly, when the flood water level exceeds the dike crown level, the dike may be destroyed by channel overflow and the excessive flood discharge will surge into the protected lowland leading to a flood disaster similar to the one experienced in the 1990 flood.

Furthermore, a considerable part of the new concrete retaining wall is more than 2 m high above the ground level, while its penetration depth is less than 1 m and no major foundation works are provided. Therefore, it may be difficult to use the existing concrete retaining wall as the main levee unless supplementary reinforcement works are provided.

Moreover, there still exist non-embanked portions where the river bank level is lower than the probable high water level of even a 10-year return period flood. The length of the remaining embankment works is about 1,500 m at the left side bank and 400 m at the right side bank.

5.2 Planning Criteria

Target Completion Year

The target completion year of the Urgent Project is set at the year 2000 on the premise that project implementation period is six (6) years starting from 1994. The project works include detailed design, tender procedure and construction works.

Objective River Stretch

The urgent flood control works are to be executed to protect the river stretch of 9.54 km in length starting from the river mouth up to the confluence with Kreo River in due consideration of the following conditions:

(1) A densely populated area spreads out along the river stretch with a high flood damage potential; and

(2) The upstream from the confluence with Kreo River flows in a hilly/mountainous area, therefore, serious channel overflow has not been experienced. On the other hand, the downstream from the confluence with Kreo River flows on a low-lying area with a high potential of channel overflow.

Design Scale

The design scale for the Urgent Project is set at 25-year return period taking into account the aforesaid existing river channel flow capacity and the design scale of the proposed flood control project for East Floodway/Babon River. The proposed flood control project is going to be executed under the "Dolok

Penggaron Drainage Design Project" with the design scale of 25-year return period and the target completion year of 2000 (refer to Section 2.1).

Design High Water Level

The following items are adopted to determine the design high water level:

(1)	Design Discharge (25-yr. Return Period)	:	770 m^3/s (refer to SECTOR I)
(2)	Design High Water Level at River Mouth	:	EL. 0.6 m (MHWL in 1991)
(3)	Manning's Roughness Coefficient	:	0.03 for low water channel and 0.04 for high water channel

5.3 Alternative Flood Control Plans

The alternative river improvement plans for the Urgent Project consist of four (4) items as described below. Among them, two (2) items are prepared for Garang River and the reconstruction of Simongan Weir. The weir is now being used as the intake facility for municipal water supply (PDAM) and for maintenance discharge of Semarang River and some other small irrigation channels. In spite of such important function, the weir remains as it was constructed at the end of the 19th century and thus considered as an overage facility.

(1) Alternative 1A (Excavation of West Floodway)

The average width of the existing high-water channel at the left side bank is limited to about 15 m, while the rather spacious high-water channel of about 47 m wide on an average at the right side bank is preserved. It is confirmed through non-uniform calculation that the channel flow capacity of West Floodway will increase to accommodate the design discharge when the existing high-water channel of 45 m wide on the right side bank is excavated to become 20 m wide on an average. The excavation work will lower the design high water level to about 1 m below the existing dike crown level for the entire stretch (refer to Figs. V.5.2 and V.5.3).

The design high water level can be lowered further by more extensive excavation of the high-water channel so as to reduce the flood damage potential. However, such lowering of the design high water level is not adopted in due consideration of the following viewpoints:

(a) The lowest design high water level is attained when the existing compound cross-section channel is re-formed into a single cross-section by excavation of the entire high-water channel. However, such lowest design high water level is only about 0.5 m lower than the design water level made by the aforesaid excavation work leaving the high-water channel of 20 m in width (refer to Fig. V.5.2).

(b) Excavation of the more extensive high-water channel reduces the open space on the high-water channel which is presently used as recreation ground and other related facilities.

Instead of widening the river channel as mentioned above, deepening of the river channel by riverbed excavation is also generally adopted to lower the design high water level. However, this is not feasible in the case of West Floodway due to its almost flat riverbed level for the entire stretch (refer to Fig. V.5.1).

Taking the aforesaid conditions of West Floodway into consideration, one of the leading alternative river improvement plans is assumed, i.e., widening the low water channel and preserving the high-water channel of 20 m in width.

(2) Alternative 1B (Embankment of West Floodway)

Raising of the existing dike crown level was done as the principal river improvement measure for West Floodway due to the rather immediate effect of increasing the channel flow capacity. Besides, the measure could also preserve the open space of the existing high-water channel as it is. From these points of view, the embankment work to raise the existing dike crown level is adopted as the alternative river improvement plan for West Floodway.

(3) Alternative 2A (Excavation of Garang River)

As described in Subsection 5.1.2., the present flood water level tends to be fairly higher than the existing ground level of the hinterland thus possessing a high flood damage potential. From this viewpoint, an alternative plan is conceived with particular attention to lowering the design high water level.

The upstream of Simongan Weir has a riverbed level of more than 4 m higher than the downstream (refer to Fig. V.5.1). Accordingly, deepening of the river channel is effective to lower the design high water level. In case of deepening of the riverbed, the existing earth dike and concrete wall will be used as the freeboard rather than the main levee.

However, widening the low water channel is not considered as one of the available measures on account of the limited space of the present high-water channel and difficulty in expanding the present right-of-way of the river because the average width of the high-water channel is less than 20 m on both right and left banks.

Taking the above conditions into consideration, an alternative plan is employed, i.e., deepening of the river channel but maintaining the present riverbed slope at 1:1,250 which is adopted as the stable slope from the following viewpoints:

(a) Secular variation of the channel bed elevation is not seen according to the channel cross-section survey at the objective river stretch (refer to Fig. V.5.4).

(b) The field reconnaissance survey confirms that no notable channel erosion and sedimentation is generated on the objective river section.