Drainage Area	Land Acquisition (ha)	House Evacuation (unit)
Eastern Semarang Area	62.15	239
- Siringin River	26.82	81
- Tenggang River	35.33	158
Central Semarang Area	15.38	494
- Semarang River	5.61	165
- Banger River	7.75	239
- Bulu River	2.02	90
Western Semarang Area	5.88	189
- Ronggolawe River	2.87	100
- Karangayu River	1.54	69
- Tawang River	0.0	0
- Silandak Channel	1.47	20
Total	83.41	922

On the other hand, the Urban Drainage Master Plan should reduce inundation and inundation damage on life and assets which would enhance economic activities in Semarang City and reduce epidemics.

5.2.8 Selection of Priority Project

As the result of economic evaluation, the most beneficial area was identified as the Central Semarang Area. Therefore, first priority shall be given to Central Semarang Area.

Planned or ongoing projects by related agencies are already existing in the area and such projects will be disregarded from the projects proposed in this study for the area. Accordingly, the following projects in Central Semarang Area were identified as priority projects (refer to Fig. 5.12).

(1) Pump drainage works for Bandarharjo West area of 0.58 km^2;

(2) Pump drainage works for the Asin river basin of 4.252 km^2;

(3) Pump drainage works for Bandarharjo East area of 1.490 km^2;

(4) Raising of earth dike (Type B, L = 2.36 km) and retaining wall (Type C, L = 0.54 km) of Semarang River from the river mouth to the national railway crossing;

(5) Construction of a gate structure in Baru River;

(6) Raising of retaining wall (Type D, L = 800 m) of Baru River from Ring Road crossing to the junction with Semarang River; and

(7) Dredging of Semarang River (approx. V = 87,000 m^3) from the river mouth to Jl. Pandanaran crossing (L = 6.9 km).

5.3 Water Resources Development Plan

5.3.1 Planning Criteria

The major planning criteria to study the Water Resources Development Master Plan are as follows:

(1) Future water demand is composed of public water, irrigation water and river maintenance flow, which will be set up taking the future conditions into account;

(2) 5-day discharge which is converted from daily discharge is used in the water balance analysis;

(3) Water balance analysis is performed by sequential analysis using the said 5-day discharge of 30 years;

(4) Each of the water supply alternatives is evaluated in a 10-year drought cycle; and

(5) Target year is set at the year 2015.

5.3.2 Selection of Water Sources

There are three (3) available sources for water supply in the study area; namely, spring, groundwater and river surface water. The situation of springs and groundwater in this area is rather tight; therefore, it is desirable to limit the water supply source to the river surface water to meet future demand.

For river surface water development, the following seven (7) potential reservoir sites have been identified in the study area by using the aerophotographs and the topographic maps on the scale of 1:50,000 ,and through geological reconnaissance, taking topographical and geological conditions for dam design into consideration (refer to Fig. 5.13).

Potential Dam Sites

Reservoir	River System/ River	Catchment Area(km^2)	Topographic Condition
Babon	Babon/Penggaron	51.9	Hilly Land
Garang	Garang/Garang	70.9	Gorge
Mundingan	Garang/Kreo	45.7	Valley
Jatibarang	Garang/Kreo	53.0	Gorge
Kripik	Garang/Kripik	30.0	Gorge
Blorong	Blorong/Blorong	50.5	Gorge
Kedung Suren	Blorong/Blorong	146.5	Hilly Land

Among the seven (7) potential dam sites above, four (4) dams, Babon, Mundingan, Jatibarang and Kedung Suren, have been selected as possible dam sites for water sources taking geological conditions, gross storage capacity, sedimentation volume, etc., into account.

5.3.3 Future Water Demand Projection

In the study area, the future water demand which the Water Resources Development Master Plan ought to meet in the target year is composed of public water, irrigation water and river maintenance flow.

Public Water

Population and industrial area projection in the target area are the most important factors to estimate the future demand of public water use. The population in Semarang City has been projected at 5-year intervals from 1990 to 2015 (refer to Table 5.8).

The industrial areas including Kec. Sayung in Kab. Demak have been projected at 5-year intervals from 1990 to 2015 by five subdivisions as shown in Table 5.9.

All of the parameters relevant to water demand such as per capita domestic use, service ratio and so on, have been set up. The future public water demand in Semarang City has been computed at 12.12 m^3/s, as shown in Table 5.10.

Irrigation Water

The potential dam sites are located in the Babon, Garang and Blorong river basins. The target areas to be ensured irrigation water supply can be specified in the downstream of these dam sites and hydraulic structures. Considering the location between the potential dam site and the irrigation area, the related irrigation areas are limited to the Babon and Blorong river basins (refer to Figs. 5.13 and 5.14).

The results of the estimation of irrigation water demand by the related weir are summarized in the following table.

Irrigation Water Demand in 2015

Weir	Irrigation Area (ha)	Average Required Discharge (m^3/s)	Water Demand (MCM/yr)
Babon River Basin:			
- Pucang Gading	126	0.097	3.1
Blorong River Basin:			
- Sulem	11	0.009	0.3
- Pengilon	3,145	2.608	82.2
Total		2.714	

River Maintenance Flow

The low flow of the river ought to be maintained to conserve or improve the present natural and social conditions. In this connection, river maintenance flow shall be secured in Babon River, Garang River and Blorong River where the proposed reservoirs are to be located.

River maintenance flow has been determined as follows:

(1) Babon River

River maintenance flow is determined to be 0.5 m^3/s for both East Floodway and Babon River.

(2) Garang River

The average value of 1.0 m^3/s in the 99% discharge is recommended as river maintenance flow in Garang River.

(3) Blorong River

River maintenance flow is determined to be 0.6 m^3/s in Blorong River, derived from the minimum value of 99% discharge in a 10-year drought cycle.

The maintenance flow is summarized below.

Babon River	0.5 m^3/s
Garang River	1.0 m^3/s
Blorong River	0.6 m^3/s
Total	2.1 m^3/s

5.3.4 Alternative Water Supply Plan

Alternative Plan for Water Resources Development

Four (4) reservoirs have been selected for the Water Resources Development Master Plan. The following three (3) schemes are proposed as alternative plans, as shown in Fig. 5.15:

Scheme 1: Babon, Jatibarang, Mundingan and Kedung Suren reservoirs are operated individually.

Scheme 2: Jatibarang and Mundingan reservoirs are operated together.

Scheme 3: In addition to the above-mentioned situation, interbasin transfer is considered to supplement the reservoir storage function by conveyance of surplus water from the upstream of the Blorong river basin to the Mundingan reservoir.

The possible water supply draft for each scheme has been calculated in the water balance study and the results are given in the following table.

Possible Water Supply Draft
(Unit: m^3/s)

Component	Scheme 1-1	1-2	2	3
Babon Reservoir	1.9	1.9	1.9	1.9
Jatibarang Reservoir	1.5	-	-	-
Mundingan Reservoir	-	2.6	-	-
Series of Reservoirs	-	-	3.2	-
Series of Reservoirs & Interbasin Transfer	-	-	-	4.1
Kedung Suren Reservoir	5.2	5.2	5.2	4.9
Total	8.6	9.7	10.3	10.9

Note: Excluding water supply for existing public water; including irrigation water and river maintenance flow.

Regarding the future water demand for public water and river maintenance flow in 2015, the quantity of water supply capacity to be developed is given as follows:

(1) Future Water Demand

Public Water Supply	:	12.12 m^3/s
Irrigation Water	:	2.71 m^3/s
River Maintenance Flow	:	2.10 m^3/s
Total (1)	:	16.93 m^3/s

(2) Existing and Ongoing Water Supply Programme

Existing Water Supply	:	1.56 m^3/s
Water Supply Programme by Jratunseluna Project	:	5.00 m^3/s
Total (2)	:	6.56 m^3/s

(3) Water Supply Capacity to be Developed

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

In accordance with the possible water supply draft by each scheme, Scheme 3 can satisfy the future water demand of 10.37 m^3/s. Therefore, Scheme 3 is selected as the optimum plan.

5.3.5 Optimum Water Supply Plan

Water Supply Plan

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

The cost efficiency of each dam has been examined as summarized below. From the estimated cost efficiency among the reservoirs and the anticipated social impact such as compensation for assets and relocation, Jatibarang Reservoir can be proposed as a first priority project. Furthermore, interbasin transfer should be implemented after the completion of Mundingan Reservoir, because the purpose of the facilities is to supplement refilling the reservoir storage with the surplus water of Blorong River.

		Cost Efficiency (Rp./m^3/Yr.)
(1)	Jatibarang Reservoir	860
(2)	Mundingan Reservoir	1,130
(3)	Interbasin Transfer	-
(4)	Kedung Suren Reservoir	1,510
(5)	Babon Reservoir	4,770

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

Optimum Water Development Programme

Unit: m^3/s

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

The public water supply programme is proposed, as shown in Fig. 5.16, so that the future water demand could be assured at any stage.

5.3.6 Implementation Schedule

The implementation schedule for the water resources development plan has been prepared under the same concept mentioned in Section 5,1, Flood Control Plan, as presented in Fig. 5.17.

5.3.7 Cost Estimate

Project cost of the Water Resources Development Plan has been estimated under the same conditions mentioned in Section 5.1, Flood Control Plan, as summarized below.

Summary of Project Cost
for Water Resources Development Plan

(Unit: Mill. Rp.)

Name of Dam	Flood Control	Water Supply	Total
Babon	-	291,391	291,391
Jatibarang	23,413	40,064	63,477
Mundingan	-	115,560	115,560
Interbasin Transfer	-	7,772	7,772
Kedung Suren	86,305	175,380	261,685
Conveyance Channel	-	8,854	8,854
Total	109,718	639,021	748,739

Note: Price Contingency and Value Added Tax are excluded.

Since Jatibarang and Kedung Suren dams are multipurpose dams, the project cost of each dam is allocated for the flood control and water supply purposes. The disbursement schedule is given in Table 5.11

5.3.8 Project Evaluation

Economic Evaluation

(1) Basic Conditions

The basic conditions for the economic evaluation of water resources are the same as those mentioned in Section 5.1, Flood Control Plan.

(2) Annual Average Benefit

The conditions and methodology for the calculation of economic benefit are the same as those mentioned in Section 5.1, Flood Control Plan.

Annual benefit has been considered as the incremental water supply at the water sources for public water, the average annual shortage reduction for irrigation water, and the abandonment of public water for maintenance flow.

The total average annual benefit of each water resource is given as follows:

	Water Source	Average Annual Benefit (mill. Rp.)
(a)	Kedung Suren Reservoir	22,013
(b)	Jatibarang Reservoir Mundingan Reservoir Interbasin Transfer	34,248
(c)	Babon Reservoir	17,030

(3) Economic Project Cost

The principles for the calculation of economic project cost in Section 5.1, Flood Control Plan, are adopted for the Water Resources Development Plan. The economic project cost is estimated as follows:

	Project	Economic Project Cost (mill. Rp.)
(a)	Kedung Suren Reservoir	168,731
(b)	Jatibarang Reservoir	37,008
	Mundingan Reservoir	106,296
	Interbasin Transfer	7,157
(c)	Babon Reservoir	267,154

(4) Cost-Benefit Analysis

The water resources development projects have been evaluated in terms of Economic Internal Rate of Return (EIRR) and Benefit-Cost Ratio (B/C), as shown in Table 5.12 and summarized in the following table.

	Project	EIRR (%)	B/C	NPV (mill.Rp.)
(a)	Kedung Suren Reservoir	9.5	0.93	-4,545
(b)	Jatibarang Reservoir Mundingan Reservoir Interbasin Transfer	16.1	1.79	72,955
(c)	Babon Reservoir	4.9	0.46	-35,410

The Water Resources Development Master Plan shows 11.4% of EIRR (refer to Table 5.13).

Social and Environmental Impact

The implementation of the Water Resources Development Master Plan will not bring about any significant impact on the natural environment. However, regarding social impact, the implementation will need a large number of land acquisition and house evacuation as summarized below.

Name of Dam	Land Acquisition (ha)	House Evacuation (unit)
Babon	485	1,330
Jatibarang	136	0
Mundingan	315	470
Kedung Suren	1,160	1,470
Total	2,096	3,270

On the other hand, the plan will increase the public water supply capacity and ensure the river maintenance flow.

The increment of public water supply capacity will prevent waterborne disease and promote the economic activities in the study area as well as Central Jawa Province. Furthermore, industrial water which solely depends on deep wells in Semarang City at present that will inevitably cause land subsidence resulting in inundation by normal tide level can change its supply source to the public water supply.

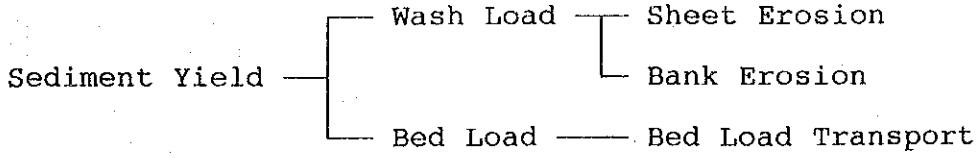
5.3.9 Selection of Priority Project

The Master Plan of Water Resources Development is composed of four (4) dams and one (1) interbasin transfer. Through the prioritization and implementation schedule discussed in foregoing sections, the highest priority is placed on Jatibarang Dam, because of highest cost efficiency and minimum social impact. Jatibarang Dam is, therefore, selected as the first priority project.

5.4 Sediment Control Plan

5.4.1 Analysis on Sediment Yield

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



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

Wash Load

(1) Sheet Erosion

The Universal Soil Loss Equation (USLE) which is broadly applied, is adopted to the estimation of sheet erosion volume.

(2) Bank Erosion

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

Sediment Yield by Bank Erosion
Per Unit Channel Length

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

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

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

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

Bed Load

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

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

- Flow Discharge : adopted from the average flow regime

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

The estimated volume of bed load transport at the reference points of each river are given below.

River	Reference Point	Bed Load Transport ($10^3 m^3$/Yr.)
Babon River	Pucang Gading Weir	16.3
East Floodway	National Road Bridge	0.4
Garang River	Simongan Weir	3.0
Silandak River	National Road	1.7
Bringin River	Dondong Bridge	1.1
Blorong River	Pengilon Weir	41.1

5.4.2 Analysis on Sediment Balance

Sediment balance was studied from the upstream to the downstream. The sediment balance analysis in each river basin was conducted using the amounts of wash load and bed load obtained in the preceding section.

Based on the results, net quantities of sediment discharge into the lower reaches of the respective rivers and sediment inflow into the potential reservoirs are summarized below.

Sediment Discharge into Lower Reaches

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

Sediment Inflow into Potential Reservoirs

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

5.4.3 Sediment Control Plan

Sediment Control for Reservoir Watershed

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

(1) Forest Conservation

Only a small forest reserve area is to be designated to preserve plants in the watershed of the proposed reservoirs. The forest areas, however, remain in the headwaters of each river basin. The forest area is effective in preventing sediment yield by sheet erosion. From this point of view, the forest and plantation areas to be densely covered by trees shall be conserved continuously as a forest conservation area (refer to Fig. 5.18). These efforts will affect water conservation as well as soil conservation by the increase in low

flow discharge in streams and groundwater recharge.

(2) Small-Scale Level Terraces

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

Sediment Control for River Channel Siltation

Heavy siltation has occurred in the middle reaches of East Floodway and the lower reaches of Silandak River. However, the diversion gate of East Floodway at Pucang Gading Weir is planned to be closed in the Master Plan. Therefore, the siltation problem in East Floodway will not develop further.

On the other hand, at present, heavy siltation has occurred at just the lower portion of the diversion point between Silandak River and Silandak Floodway. Therefore, sediment control measures are needed to be introduced in the Silandak river basin to keep the design channel cross section. The detailed basin condition and the proposed sediment control measures are as follows:

(1) Identification of Devastated Areas

Through the field and aerophotographic investigations, two devastated areas are

identified in the basin. One is the bare land in the headwaters having an area of approximately 20 ha. The other is the quarry at just the down part of the hilly area of approximately 40 ha. These areas are shown in Fig. 5.19.

(2) Proposed Countermeasures

In the upper reaches of Silandak River, stepped gabion dams are proposed to trap the wash load by utilizing their permeability (refer to Fig. 5.20).

Sedimentation basin is proposed at the quarry to settle down the eroded materials by raindrop. The standard features of the proposed sedimentation basin is presented in Fig. 5.21.

5.5 Dam Engineering

5.5.1 Preliminary Screening of Possible Dam Sites

Through field reconnaissance and scrutiny on the topographic map on the scale of 1:50,000, seven (7) dam sites are selected in the respective major rivers of Blorong, Kreo, Kripic, Garang and Babon. The locations of the seven dam sites are indicated in Fig. 5.13, and the principal features are given as follows:

Principal Features of Seven Dams

Name of Dam	River	Maximum Dam Height (m)	Possible Storage Capacity (MCM)	Width at Dam Crest (m)
Blorong	Blorong	55	5	118
Kedung Suren	Blorong	46	83	1,000
Jatibarang	Kreo	77	24	180
Mundingan	Kreo	50	35	480
Kripic	Kripic	60	48	535
Garang	Garang	75	13	180
Babon	Babon	45	46	1,550

From the topographical and geological points of view, Kedung Suren Dam, Jatibarang Dam, Mundingan Dam and Babon Dam are selected as possible dam sites.

5.5.2 Dam Development Plan

From the results of the study on the Flood Control Plan and the Water Resources Development Plan, the purposes of the possible dams are allocated as follows:

Dam	Purpose
Kedung Suren	Flood Control and Water Supply
Jatibarang	Flood Control and Water Supply
Mundingan	Water Supply
Babon	Water Supply

The principal reservoir features for dam design are given in the following table (refer to Fig. 5.22).

Principal Reservoir Features for Dam Design

Reservoir	Babon	Jatibarang	Mundingan	Kedung Suren
Purpose	Water Supply	Flood Control & Water Supply	Water Supply	Flood Control & Water Supply
Surcharge Water Level (SWL)	---	EL. 157.0 m	---	EL. 71.0 m
Normal Water Level (NWL)	EL. 69.4 m	EL. 153.0 m	EL. 224.6 m	EL. 69.7 m
Low Water Level (LWL)	EL. 55.7 m	EL. 138.2 m	EL. 207.9 m	EL. 60.3 m
Foundation Level	EL. 30.0 m	EL. 85.0 m	EL. 180.0 m	EL. 30.0 m
Required Capacity				
Flood Control	---	4.3 MCM	---	10.7 MCM
Water Supply	35.7 MCM	12.6 MCM	27.6 MCM	52.4 MCM
Sediment	10.2 MCM	6.8 MCM	7.4 MCM	19.7 MCM

5.5.3 Geological Condition of Dam Sites

The geological conditions of the four dam sites are summarized as follows:

Babon Dam

Babon Dam is located at a hilly region upstream of the diversion point of Babon River and East Floodway. The width of the valley is about 1,300 m at 40 m from the riverbed. The foundation rock covered by river and flood plain deposits consists of claystone and limestone belonging to Kalibiuk Formation.

Foundation characteristics show insufficient shearing strength to construct a relatively high concrete dam.

As for permeability, it is necessary to consider water leakage protection works because of the distribution of limestone.

Jatibarang Dam

This dam is located downstream of Kreo River near the national park (Goa Kreo). Around the dam axis is a gorge 155 m wide at 70 m from the riverbed. The left bank has a ridge less than 100 m wide above EL. 160.0 m.

The foundation rock consists of alternating beds of volcanic breccia and tuffaceous sandstone belonging to Notopuro Formation. The foundation rock is fresh from the riverbed up to EL. 140.0 m, slightly weathered from EL. 140.0 m to EL. 160.0 m, and heavily weathered above EL. 160.0 m.

Mundinqan Dam

This dam is located upstream of Jatibarang Dam on Kreo River. From around the dam axis to the downstream, a gorge is formed with distributed volcanic breccia. On the other hand, an alluvial plain widely extends upstream of the dam axis.

The dam axis is 15.0 m wide at the riverbed and 400.0 m wide at 45 m above the riverbed, and has a flat plain above EL. 235.0 m. The foundation rock has the same characteristics as that of Jatibarang Dam, but shearing strength is lower. In case of a concrete gravity dam, it is necessary to widen the bottom plane of contact with the foundation rock to secure the required strength.

Kedung Suren Dam

This dam is located at a hilly region downstream of the confluence of Glagah River and Blorong River. The width of the valley is about 800 m at the proposed elevation of the dam crest. The height of both hills is not enough to plan a high dam. Rock is exposed at both side hills.

The foundation rock consists of tuffaceous sandstone intercalated with conglomerates belonging to Damar Formation. Foundation characteristics show stability for only the construction of a fill dam less than 50 m in height, because the soundness of tuffaceous sandstone at the dam site is not so high.

5.5.4 Structural Design

Principal features of the four dams are given in Fig. 5.23.

From the geological and geographical point of view, the applicable dam types are determined, as follows:

Dam Type

Name of Dam	Dam Type
Babon	Rockfill with Center Core
Jatibarang	Concrete Gravity
Mundingan	Concrete Gravity
Kedungsuren	Rockfill with Center Core

5.6 Hydropower Generation Plan

As described in Section 5.3, Water Resources Development Plan, four (4) reservoirs in three rivers are proposed for water supply. The development of the reservoirs also makes possible the development of hydropower generation.

These four reservoirs have the surplus storage capacity exceeding the future water demand, and the surplus capacity is allocated to two (2) reservoirs, Jatibarang and Mundingan, because of the poor flow regime due to the small catchment areas. The other two reservoirs also have potential hydropower generation by using water released for water supply.

The objective of the hydrological study in this section is to estimate the hydropower generation potential in each of the four reservoirs proposed in the Water Resources Development Master Plan.

Annual generated energy has been computed for the proposed four reservoirs, as presented in Table 5.14, as summarized in the following table:

Summary of Hydropower Potential

Reservoir	Installed Capacity (kW)	Annual Energy Production (MWh)	Annual Plant Factor (%)
Jatibarang:			
- Stage I	1,050	5,800	63
- Stage II	1,050	6,100	66
- Stage III	2,510	11,400	52
Mundingan:			
- Stage II	650	3,700	65
- Stage III	1,540	7,100	53
Kedung Suren	1,840	10,800	67
Babon	310	2,400	88

Note:

Stage I : Operation with Jatibarang Reservoir only.

Stage II : Operation as series reservoirs with Jatibarang and Mundingan reservoirs.

Stage III: Operation as series reservoirs and receiving water through interbasin transfer from Blorong River.

The annual plant factor is the ratio of annual energy production of a power plant to the amount of energy calculated by multiplying the installed capacity by the total hours a year, and the ratio is usually expressed in percent. This factor is slightly higher than the conventional standard values of 40 to 50% for small-scale hydropower plants.

5.7 Organization for Operation and Maintenance

5.7.1 Basic Concept

The ministerial law on government organization states that responsibilities on operation/maintenance of public works facilities should be decentralized and entrusted to related provincial government agencies (refer to Law No. 5 on Regional Government Administration). In accordance with this law, future operation/maintenance works will be transferred gradually from central government agencies to local government agencies.

In line with the decentralization policy, an institutional setup for all-inclusive water resources management works was proposed in Java Irrigation Improvement and Water Resources Management Project (JIWMP) in January 1993. Previously, operation/maintenance for public works facilities has been executed under the hierarchy classified into the

central level, the provincial level and the district level. In addition to these existing organization levels, the basin-wide management level was newly proposed by the JIWMP to have an integrated approach to basin-wide water management works. The territorial jurisdiction of the basin-wide management level is placed within the watershed boundary (called "SWS" in the Indonesian term), so that it does not necessarily coincide with the existing administrative boundary.

Correspondingly, the hierarchy of the institutional setup proposed by JIWMP is classified into the central level, the provincial level, the basin-wide management level, and the district level. In this hierarchy, emphasized are the roles of the basin-wide management level and/or the district level to promote the decentralization process.

The basic concept of the institutional setup proposed by JIWMP is believed to be suitable to formulate the operation/maintenance master plan in the present study. Furthermore, the particular names or abbreviations for the organizational units introduced in the JIWMP are commonly used by Indonesian government agencies, so that they are also adopted in this study.

5.7.2 Outline of Proposed Organization for Flood Control and Water Resources Development Facilities

The organization for operation/maintenance of flood control and water resources development facilities is proposed in this study, as shown in Fig. 5.24. In this organization, each of the organization hierarchy levels will undertake the following roles in general:

(1) The central level will set up the national regulations specifying the technical and/or administrative standards for operation/maintenance of objective facilities.

(2) The provincial level will undertake the overall supervisory and coordination tasks for the objective operation/maintenance works.

(3) The basin-wide management level will execute the operation/maintenance for major facilities such as dams, weirs, and river channels which have strategic importance in the basin and/or require highly developed technology.

(4) The district level will execute the operation/maintenance for minor facilities other than the objects of the above basin-wide management level.

In the Master Plan, the proposed basin-wide management level will have an integrated approach on operation/maintenance for the six (6) objective river basins, namely, Blorong, Bringin, Silandak, West Floodway/Garang, East Floodway and Babon. In addition to these river basins, the service area of the Jratunseluna Project will be included. Thus, the basin-wide management level will have a single management body for the six (6) river basins and the objective river basins of Jratunseluna Project. All dam reservoirs, weirs on the main stream and river channels located in the above river basins will then be operated and maintained in the basin-wide management level.

As for the district level, five (5) districts will be involved in the organization for operation/maintenance, namely, Kabupaten Kendal,

Kotamadya Semarang, Kabupaten Semarang, Kabupaten Demak and Kabupaten Grobogan. All minor flood control and water resources development facilities installed in these districts will be operated and maintained by each district government office.

5.7.3 Outline of Proposed Organization for Urban Drainage Facilities

The organization for operation/maintenance of urban drainage facilities is proposed, as shown in Fig. 5.25. The service area for the proposed urban drainage facilities is located within the administrative boundary of Kotamadya Semarang; therefore, the basin-wide management level is no longer required for the operation/maintenance of urban drainage facilities. In view of the exclusion of the basin-wide management level, the district office of Kotamadya Semarang will execute all operation/maintenance work for urban drainage facilities.

CHAPTER 6 FEASIBILITY STUDY

6.1 Priority Projects for Feasibility Study

In the master plan study, priority projects have been selected for the feasibility study on Flood Control Plan, Urban Drainage Plan and Water Resources Development Plan. The projects selected in each plan are listed below.

Flood Control Plan

(1) Construction of Jatibarang Dam on Kreo River (multipurpose dam combined with Water Resources Development Plan); and

(2) Improvement of West Floodway/Garang River for the stretch of 9.54 km from the river mouth.

Urban Drainage Plan

(1) Construction of three (3) pumping stations with retarding ponds:

	Pumping Station	Retarding Basin
Bandarharjo West Pumping Station	Q=0.8 m^3/s	V=16,700 m^3
Asin River Basin Pumping Station	Q=5.7 m^3/s	V=80,000 m^3
Bandarharjo East Pumping Station	Q=2.0 m^3/s	V=28,000 m^3

(2) Improvement of Semarang River (L=6.9 km);

(3) Improvement of Baru River (L=0.8 km); and

(4) Reconstruction of Gate Structure (1 unit).

Water Resources Development Plan

(1) Construction of Jatibarang Dam on Kreo River (multipurpose dam combined with Flood Control Plan).

6.2 Flood Control Plan

6.2.1 Planning Criteria

Objective Protected Area

The objective area is placed within a 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.

Target Completion Year

The completion year is set at the year 2000 as proposed in the Master Plan.

Design Scale

The design scale for the objective flood control measures is set at 100-year return period as proposed in Master Plan. The standard flood discharge is estimated as below:

(1) Jatibarang Dam Site : 280 m^3/s
(2) River Channel Improvement Section : 980 m^3/s

Dam Flood Regulation Method

Flood control by Jatibarang Dam has been 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.

Priority for Allocation of Flood Control Capacity in Jatibarang Dam Reservoir

The storage capacity of Jatibarang Dam reservoir is allocated for flood control, public water supply and hydropower generation. Among them, flood control capacity is given the highest priority.

6.2.2 Alternative Plan

Alternative Flood Control Measures

Flood control by the construction of Jatibarang Dam and the river improvement for West Floodway/Garang River have been identified as the possible flood control measures for Feasibility Study. The following alternative flood control plans have been selected:

Alt. 1 : The river improvement with the flood control by Jatibarang Dam.

Alt. 2 : The river improvement without the flood control by Jatibarang Dam.

Alternative Dam Flood Control Capacity and Design Discharge for River Improvement Section

Boring tests and the development of topographic map on the scale of 1:10,000 were newly undertaken during the Master Plan and Feasibility Study stages.

As the results of these new boring tests and topographic map, 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.

On the premise of the optimum design flood water level (DFWL) of 162 m, the alternative flood control capacity of Jatibarang Dam and its corresponding design flood discharge for the downstream river improvement section were estimated by the flood routine simulation as shown in Table 6.1.

The cost for each alternative flood control plan was estimated as shown in Table 6.2, from which the cost relation between the dam flood control capacity and the downstream river improvement was developed as shown in Fig. 6.1.

6.2.3 Optimum Plan

Selection of the Optimum Plan

The entire project cost, expressed as the total of dam cost allocated for flood control and downstream river improvement cost, tends to increase as the design discharge for river improvement is increased as shown in Fig. 6.1. Particularly, when the design discharge on the river improvement exceeds around 800 m^3/s, project cost drastically increases.

The dominant factor for the above increment of project cost is attributed to project compensation cost associated with the upgrading of river improvement works. The design discharge of more than about 800 m^3/s requires a large number of house evacuation and the 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;

(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 for the river improvement in the optimum plan is as described in CHAPTER 7. As for the dam component in the optimum plan, the following features have been determined. The details of the optimum dam features are described in Section 5.5.

(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

Flood Regulation Effect of the Optimum Plan

The present channel of West Floodway/Garang River has been estimated to start overflow from about 5 to 10-year return period, 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:

Return Period (year)	Inundation Area Relieved				Houses/ Buildings Relieved (houses)
	Residential (ha)	Industrial (ha)	Business (ha)	Total (ha)	
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. 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 the with- and the 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.

6.2.4 Cost Estimate

The project cost of the optimum Flood Control Plan has been estimated on the following conditions:

(1) Price Level

Unit costs are expressed on the price level of July 1992.

(2) Currency Conversion Rate

Currency conversion rates are assumed at US$1.00 = Rp. 2,033 and ¥1.00 = Rp. 16.20,

The total project cost is estimated at Rp. 231,123 million, and the breakdown of the cost is shown in the table below.

(Unit: Mill. Rp.)

Cost Item	River Improvement for West Floodway/ Garang River	Jatibarang Dam*
1. Construction Base Cost	45,049	59,793
2. Compensation Cost	0	5,582
3. Administration Cost	3,154	4,576
4. Engineering Service Cost	8,969	17,579
5. Price Contingency	17,996	29,399
6. Physical Contingency	7,025	10,989
7. Value Added Tax	8,219	12,793
Total	90,412	140,711

* Cost includes flood control, water resources development and hydropower generation.

The project costs mentioned in the above table were allocated to the Flood Control Plan, the Water Resources Development Plan and the Hydropower Generation Plan, as shown in the following table:

(Unit: Mill. Rp.)

Purpose	Project Cost
1. Flood Control	132,223
- River Improvement for West Floodway/Garang River	90,412
- Jatibarang Dam	41,811
2. Water Resources Development (Jatibarang Dam)	79,881
3. Hydropower Generation	19,019
Total	231,123

The detailed breakdown of the project cost is presented in Table 6.3, and the disbursement schedule is shown in Table 6.4.

6.2.5 Project Evaluation

Economic Evaluation

The annual average benefit and economic project cost of the priority project are calculated at Rp. 27,264 million and Rp. 84,390 million, respectively.

The economic evaluation aims to clarify economic viability of the priority project of the Flood Control Plan. The evaluation was conducted through economic cost-benefit analysis, and the economic viability was assessed by means of Economic Internal Rate of Return (EIRR), Benefit-Cost Ratio (B/C) and Net Present Value (NPV).

To calculate EIRR, B/C and NPV, the annual cost-benefit flow is estimated as shown in Table 6.5

The economic viability of the Flood Control Plan is figured out as follows:

EIRR : 16.2%
B/C : 1.90
NPV : Rp. 51,626 million

Social and Environmental Impact

In general, implementation of the priority project of the Flood Control Plan, the improvement of West Floodway/Garang River and the construction of Jatibarang Dam, will not cause any significant impact on the natural environment including Goa Kreo. However, regarding social impact, land acquisition for Jatibarang Dam consisting of 128.2 ha of paddy fields and upland cultivation is necessary. No house evacuation is necessary for both river improvement and dam construction.

On the other hand, the project will bring about the following positive impact which could not be evaluated in monetary terms. The reduction of inundation would result in the saving of life, the mitigation of epidemics and the enhancement of economic activities. The improvement of flow regime by introducing maintenance flow will improve conditions along Semarang River.

6.2.6 Sensitivity Analysis by Project Implementation

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. 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 in the following table:

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 Subsection 6.2.1. 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 only 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.

6.3 Urban Drainage Plan

6.3.1 Planning Criteria

Target Year

The target completion year of the priority project for the Feasibility Study is set at 2005 on the premise that the project implementation period is 10 years.

Design Scale of Semarang River Improvement

For the identified priority project of Semarang River improvement, which consists of the dredging work of 6.9 km and the raising of embankment or retaining wall of 2.9 km, a 5-year return period flood is proposed for the design flood.

Other Criteria

Other criteria such as design flood level, design rainfall, freeboard, etc., follow those of the Master Plan.

6.3.2 Alternative Plan

Pump drainage alternative study has been carried out for two (2) drainage areas, Asin River basin and Bandarharjo East.

Asin River Basin

(1) Alternative A-1

Pumping station (Q=5.7 m^3/s) with retarding pond (V=80,000 m^3) is planned to be constructed. The construction cost and number of house evacuation are estimated to be Rp. 12,200 million and 94 houses, respectively.

(2) Alternative A-2

Pumping station (Q=5.7 m^3/s) with retarding pond (V=40,000 m^3; 50% of Alternative A-1) and the remaining retarding pond (V=40,000 m^3) with a daily dewatering pumping station (Q=0.5 m^3/s)

are planned to be constructed. The construction cost and number of house evacuation are estimated to be Rp. 13,915 million and 94 houses, respectively.

(3) Alternative A-3

This is basically the same as Alternative A-1, however, additional channel improvement works for Semarang River (shift of river channel) are considered for less land acquisition and house evacuation. The construction cost and number of house evacuation are estimated to be Rp. 11,702 million and 52 houses, respectively.

Although construction base cost of Alternative A-3 is higher than that of Alternative A-1, Alternative A-3 is recommended because of its lowest total construction cost and least number of house evacuation.

Bandarharjo East Area

(1) Alternative B-1

Pumping station ($Q=2.0\ m^3/s$) with retarding pond ($V=28,000\ m^3$) including connection channel ($L=600$ m) between the existing secondary channel and the retarding pond are planned to be constructed. The construction cost and number of house evacuation are estimated to be Rp. 7,202 million and 4 houses, respectively.

(2) Alternative B-2

Almost 30% of Baru River's cross section is planned for use as a diversion channel ($Q=6.0\ m^3/s$, $L=600$ m). The remaining 70% of

the cross section is used for the proposed pumping station (Q=2.0 m^3/s) and retarding pond (V=28,000 m^3). The construction cost and number of house evacuation are estimated to be Rp. 7,485 million and 0 (zero) house, respectively.

Although the total cost of Alternative B-2 is only 4% higher than Alternative B-1, Alternative B-2 is recommended in due consideration of the difficulty of land acquisition and house evacuation.

6.3.3 Optimum Plan

Pump Drainage Plan

Based on the existing drainage system and the results of comparative study on the alternative plans, construction of the three (3) pumping stations are proposed as follows (refer to Fig. 5.12):

Bandarharjo West P.S. (Q=0.8 m^3/s)	:	Right bank of Semarang River upstream from the North Ring Road crossing
Asin River P.S. (Q=5.7 m^3/s)	:	At the confluence with Asin and Semarang Rivers
Bandarharjo East P.S. (Q=2.0 m^3/s)	:	Baru River upstream from the North Ring Road crossing

Channel Improvement Plan

Channel improvement plans have been prepared for the following primary and secondary channels (refer to Fig. 6.2):

Semarang River, 6.9 km
Asin River, 1.3 km
Baru River, 0.8 km
Secondary Channel of Bandarharjo West, 0.8 km
Secondary Channel of Bandarharjo East, 0.7 km

6.3.4 Cost Estimate

The project cost of the priority project for the Urban Drainage Plan has been estimated on the same basis mentioned in Subsection 6.2.4. The total project cost is estimated to be Rp. 67,740 million, and the breakdown is shown in the table below.

(Unit: Mill. Rp.)

Cost Item	Urban Drainage Plan
1. Construction Base Cost	27,844
2. Compensation Cost	1,429
3. Administration Cost	2,050
4. Engineering Service Cost	4,180
5. Price Contingency	17,855
6. Physical Contingency	4,931
7. Value Added Tax	5,829
Total	64,118

The detailed breakdown of the project cost is presented in Table 6.6, and the disbursement schedule is shown in Table 6.7.

6.3.5 Project Evaluation

Economic Evaluation

The annual average benefit and economic project cost of the priority project are calculated at Rp. 10,059 million and Rp. 34,025 million, respectively.

The economic evaluation has been conducted in the same procedure mentioned in Subsection 6.2.5.

The annual cost-benefit flow for the Urban Drainage Plan has been estimated as shown in Table 6.8.

The economic viability of the Urban Drainage Plan is figured out as follows:

EIRR : 15.7%
B/C : 1.81
NPV : Rp. 14,872 million

Social and Environmental Impact

Implementation of the priority project of the Urban Drainage Plan will not cause any significant impact on the natural environment, since the project area is a fully developed urban area. However, regarding social impact, land acquisition of 5.1 ha and house evacuation of 82 units are necessary. On the other hand, the project will bring about a positive impact as mentioned in Subsection 6.2.5.

6.4 Water Resources Development Plan

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

6.4.1 Planning Criteria

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

(1) Priority for Allocation of Reservoir Storage

The effective storage capacity of the Jatibarang reservoir will be allocated for flood control, public water supply including river maintenance flow and hydropower generation. In due consideration of the importance and necessity of the above purposes, the priority order to allocate reservoir storage will be placed on (1) flood control, (2) water supply and (3) hydropower generation.

(2) Other Criteria

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

6.4.2 Alternative Plan

Allocated Reservoir Storage for Water Supply

According to the results of the comparative study, the storage of 16.7 MCM among the total storage capacity of 27.8 MCM of the Jatibarang reservoir is allocated for water supply including hydropower generation.

Alternatives for Water Supply and Hydropower Generation

Considering the above-mentioned conditions, the objective to allocate the storage for water supply of 16.7 MCM is to seek the optimum allocation of the storage between the purposes of water supply and hydropower generation, through the water balance analysis as shown by the model in Fig. 6.3. To compare the economic efficiency between water supply and hydropower generation, three alternatives are set up as follows:

(1) Alternative 1

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

(2) Alternative 2

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

(3) Alternative 3

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

The three alternatives are summarized below:

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

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

Comparison Among the Alternatives

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

6.4.3 Optimum Plan

The principal features of the optimum plan in the Jatibarang reservoir are proposed as follows:

Principal Features of Jatibarang Reservoir
for Water Resources Development

Normal Water Level	EL. 155.3 m
Gross Storage Capacity	27.8 MCM
Flood Control Capacity	4.3 MCM
Water Conservation Storage	16.7 MCM
Low Water Level	EL. 136.6 m
Dead Storage	6.8 MCM
Total Water Supply Capacity	2.54 m^3/s
- Public Water	1.46 m^3/s
- Existing Public Water	0.58 m^3/s
- River Maintenance Flow	0.50 m^3/s
Hydropower Generation, Max. Dis.	2.87 m^3/s
- Installed Capacity	1,500 kW
- Annual Energy Production	6,710 MWh

6.4.4 Cost Estimate

Since the priority project for the Water Resources Development Plan consists of the construction of Jatibarang Dam, the project cost is mentioned in Subsection 6.2.4. The total project cost of Jatibarang Dam is estimated to be Rp. 140,711 million and Rp. 79,881 million is allocated to water resources as tabulated in Subsection 6.2.4.

6.4.5 Project Evaluation

Economic Evaluation

The annual average benefit and economic project cost of the priority project are calculated at Rp. 18,543 million and Rp. 50,517 million, respectively.

The economic viability of the Water Resources Development Plan is figured out as follows

EIRR : 28.8%
B/C : 3.81
NPV : Rp. 96,030 million

The annual cost-benefit flow for the calculation of EIRR, B/C and NPV is estimated as shown in Table 6.9

Social and Environmental Impact

As mentioned in Subsection 6.2.5, the construction of Jatibarang Dam will not cause any significant impact on the natural environment or the national park Goa Kreo (Kreo Cave). It has been noted that the project does not need any house evacuation, although it needs land acquisition of 128.2 ha.

On the other hand, the implementation of the project will secure public water for Semarang City. Public water supply will prevent the outbreak of waterborne diseases, and land subsidence by changing the industrial water source from deep wells.

Furthermore, increment of supply capacity of public water should promote economic activities in and around Semarang City.

6.5 Construction of Jatibarang Dam

6.5.1 Topography and Geology

Topography

A wide valley upstream of the dam site changes into a V-shaped valley at the dam site. The riverbed at the

dam axis is approximately only 15 m in width at EL. 90.0 m.

The left bank at the dam axis takes a ridge less than 100 m in width above EL. 160.0 m. A relatively large saddle portion exists on the right bank of the reservoir immediately upstream of the dam site. The lowest elevation of this portion is EL. 163.7 m.

The Goa Kreo (Goa Cave) park exists on a residual hill projecting from the right bank. The Goa Cave at EL. 162.4 m in this park is very famous as a sacred place of Islam.

Geology

Volcanic breccia is exposed above EL. 105.0 m and below EL. 85.0 m. These layers consist of tuffaceous sand matrix and various andesitic gravels composed of granule to boulder with bad sorting. Unconfined compression strength ranges from about 71 to 120 kg/cm^2.

Tuffaceous sandstone is exposed at the riverbed with a thickness of about 25 m, and at EL. 120.0 m with thickness of about 10 m in the right bank. Unconfined compression strength ranges from 35 to 82 kg/cm^2.

The shear strength of fresh volcanic breccia is expected to be about 90 t/m^2, but tuffaceous sandstone will be 70 t/m^2.

Permeability is low without distribution of sheeting joints around EL. 65 m to EL. 75 m in the riverbed. Since joints and cracks have developed in the weathered zone, the permeability of weathered rock is high above the water table at both banks.

6.5.2 Structural Design

Design Criteria

For the design of Jatibarang Dam, the following criteria are given:

Design Discharge	:	Probable Maximum Flood
Sedimentation	:	Horizontal sedimentation of the estimated volume of sediment for 50 years of project life.
Seismic Coefficient	:	0.12

Dam Crest Level

The crest level has been decided at EL. 164.0 m after a comparative study on the effective storage capacity and the construction cost.

Selection of Dam Type

Judging from the topographic and geological conditions at the Jatibarang dam site, concrete gravity and rockfill types are applicable.

The construction cost of both types have been estimated as follows:

Concrete Gravity Type:		Rp. 49,936 million
Rockfill Type	:	Rp. 60,092 million

Accordingly, the concrete gravity type is selected to be the most applicable type for Jatibarang Dam.

Reservoir Capacity Allocation

Reservoir storage capacity is allocated to sediment capacity, water supply capacity and flood control capacity as follows (refer to Fig. 6.4).

Sediment Capacity	:	6.8 MCM
Water Supply Capacity	:	16.7 MCM
Flood Control Capacity	:	4.3 MCM
Gross Storage Capacity	:	27.8 MCM

Preliminary Design

(1) Dam Structure

The layout of Jatibarang Dam is shown in Figs. 6.5 to 6.8.

(2) Stability Analysis

Stability analysis is carried out for the preliminary design of typical section. Safety against shear and tensile stress of the upstream face are examined. Stability calculation is made for the following three cases:

(a) Normal water level with 100% of standard seismic intensity;

(b) Surcharge water level with 50% of standard seismic intensity; and

(c) Design flood water level without standard seismic intensity.

The results of the stability analysis are as follows:

(a) Safety Factor n = 4.06 > 4 (Stable)
(b) Safety Factor n = 4.46 > 4 (Stable)
(c) Safety Factor n = 5.01 > 4 (Stable)

6.5.3 Cost Estimate

The project cost of Jatibarang Dam Project including the hydropower generation plan has been estimated on the basis mentioned in Subsection 6.2.4 at Rp. 140,711 million, as shown in Table 6.3(2/2).

6.5.4 Economic Evaluation

To calculate EIRR, B/C and NPV of the Dam Construction Project, the annual cost-benefit flow has been calculated by summation of the annual costs and benefits of the Flood Control Project, the Water Resources Development Project and the Hydropower Generation Project, as shown in Table 6.10.

The economic viability of Jatibarang Dam Project is figured out as follows:

EIRR : 23.2%
B/C : 2.84
NPV : Rp. 115,352 million

6.6 Hydropower Generation Plan

6.6.1 Hydropower Potential at Jatibarang Dam

According to the study results of Section 5.6, Hydropower Generation Plan, the optimum hydropower generation plan of the Jatibarang reservoir is determined as the run-off-river type without a hydropower storage from the economical point of view. Namely, only the discharge from the reservoir for water supply purpose is utilized for power generation.

The principal features of Jatibarang Power Station have been estimated as summarized below.

NWL	EL.155.3 m
LWL	EL.136.6 m
Tail Water Level	EL. 90.0 m
Head Loss	2.0 m
Effective Maximum Head	63.3 m
Maximum Discharge for Hydropower	2.87 m^3/s
Installed Capacity	1,500 kW
Annual Energy Production	6,710 MWh
Annual Plant Factor	51 %

6.6.2 Facilities Planning

General Concept of Jatibarang Hydropower Plan

Water resources development on Kreo River is divided into two phases. The first phase consists of the construction of Jatibarang Dam, and the second phase consists of the construction of Mundingan Dam and the interbasin transfer. Therefore, available water for the hydropower generation will be increased stepwisely.

From this implementation situation, power generating equipment and appurtenant equipment will be installed in the two phases. The other facilities such as intake, penstock and power station will be installed or constructed so as to meet the second phase requirement.

Location and Layout of Hydropower Station

(1) Location

The location of the hydropower station is proposed at the immediate downstream of the dam on the right bank of Kreo River at about EL. 95 m.

(2) Layout

The layout of the hydropower station is shown in Figs. 6.6 and 6.9

Planning of Generation Facilities

(1) Selection of Major Equipment

(a) Turbine

In due consideration of the installed capacity, effective head and discharge amount, the horizontal shaft type of 750 rpm Francis turbine is selected.

(b) Generator

The synchronous type of generator, 3 phase, 50 Hz, 6.6 kV, 1,700 kVA is selected.

(c) Main Transformer

Outdoor type of AC transformer with a capacity of 1,700 kVA, 3 phase, 50 Hz is selected.

6.6.3 Cost Estimate

The construction base cost of the hydropower generation plan has been estimated on the basis mentioned in Subsection 6.2.4 at Rp. 9,857 million.

The cost is included in the project cost of Jatibarang Dam as shown in Table 6.3(2/2).

6.6.4 Economic Evaluation

The economic evaluation for the hydropower generation plan has been conducted in the same procedure mentioned in Subsection 6.2.5.

The annual cost-benefit flow has been estimated as shown in Table 6.11.

The economic viability of the hydropower generation plan is figured out as follows:

EIRR : 5.9%
B/C : 0.66
NPV : Rp. -3,410 million

6.7 Implementation Schedule

The target year of the Feasibility Study has been set at the year 2005. However, the completion year of

the priority projects of the Flood Control Plan and the Water Resources Development Plan is set at the year 2000 as proposed in the Master Plan.

The implementation schedule of the priority projects for the Feasibility Study are presented in Fig. 6.10.

6.8 Economic Evaluation of Priority Projects as a Whole

An integrated economic evaluation for all of the priority projects for the Feasibility Study has been carried out. The annual cost-benefit flow was calculated by the summation of annual costs and benefits derived from priority projects of the Flood Control Plan, the Urban Drainage Plan, the Water Resources Development Plan and the Hydropower Generation Plan, as shown in Table 6.12.

The economic viability of the priority projects as a whole is figured out as follows:

EIRR : 19.8%
B/C : 2.35
NPV : Rp. 160,463 million

CHAPTER 7 URGENT PROJECT

In January 1990, flood discharge overflowed along West Floodway/Garang River leading to flood damage associated with the destruction of a considerable part of the river bank. The serious flood overflow occurred particularly along the downstream of Garang River between the confluence with Kreo River and Simongan Weir, and the following flood damage were 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

Following the recent disaster on West Floodway/Garang River, the Indonesian government decided to conduct a feasibility study on the urgent flood control of the river to prevent recurrence of the disaster. This Chapter presents the results of the Feasibility Study on West Floodway/Garang River.

7.1 Present Channel Flow Capacity

The probable high water level for the existing river channel was estimated by non-uniform calculation method using the results of channel survey made in 1991 under the "Central Jawa River Improvement and Maintenance Project." The conditions for the non-uniform calculation are presented in the following table.

Return Period (year)	Probable Discharge (m3/s)	Water Level* River** Mouth (EL. m)	Water Level* 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. 7.1). 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., upstream of Simongan Weir, an earth dike is now being constructed 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. 7.2).

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. 7.2).

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 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.

7.2 Formulation of Urgent Project

7.2.1 Planning Criteria

Target Completion Year

The target completion year of the Urgent Project is set at 2000 on the premise that project implementation period is six (6) years starting from 1994.

Objective River

As mentioned above, West Floodway/Garang is the objective river.

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.

Design Scale

The design scale for the Urgent Project is set at 25-year return period.

Design High Water Level

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

(a)	Design Discharge (25-yr. Return Period)	:	770 m^3/s (refer to Table 4.3)
(b)	Design High Water Level at River Mouth	:	EL. 0.6 m (MHWL at Semarang Harbor)
(c)	Manning's Roughness Coefficient	:	0.035

7.2.2 Alternative Flood Control Plans

Considering the urgency of the project, such alternative measures as new dam or floodway

construction were not conceived because of extensive land acquisition and prolonged implementation period for these measures. Alternative plans were prepared and evaluated for West Floodway and Garang River, including Simongan Weir, respectively.

West Floodway

(1) Alternative 1A (Excavation of High-Water Channel)

Taking the existing 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 20 m width of the high-water channel. Since excavation of the riverbed is not planned, the existing riverbed profile is preserved.

(2) Alternative 1B (Raising Existing Dike)

Embankment work to raise the existing dike crown level is adopted as the alternative river improvement plan for West Floodway. The existing riverbed profile is also preserved.

Garang River and Simongan Weir

(1) Alternative 2A (Excavation of Riverbed)

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, and the existing high-water channel width is less than 20 m on both 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.

The alternative plan for deepening the river channel will include excavation of the riverbed, construction of groundsills and reconstruction of Simongan Weir as major work items. The existing Simongan Weir is proposed to be reconstructed into a fully movable gate weir with the following structural features after a comparative study on gate type (refer to Table 7.1):

Gate Crest Elevation	:	El. 5.6 m
Gate Slab Elevation	:	El. 1.5 m
Entire Weir Width	:	80.8 m

(2) Alternative 2B (Embankment of Garang River)

River improvement of Garang River is now being implemented principally by means of embankment. In due consideration of the lower construction cost, continuation of the ongoing embankment works is selected as one of the alternative river improvement plans.

Since the existing Simongan Weir is overages, it would be reconstructed with the same fixed type because of lower construction cost. The structural features of the new fixed type weir are given below.

Fixed Weir Crest Elev.	:	El. 5.6 m
Weir Bottom Elev.	:	El. 4.0 m
Fixed Weir Width	:	63.8 m
Movable Gate Width	:	13.0 m

7.2.3 Optimum Plan

Optimum Plan for West Floodway

Alternative 1B takes a remarkably higher project cost compared with Alternative 1A (Excavation Plan) as estimated below:

(1) Alt. 1A (Excavation) : $10,511 \times 10^6$ Rp.
(2) Alt. 1B (Dike Raising): $20,876 \times 10^6$ Rp.

In addition to the above disadvantage on project cost, Alternative 1B has another disadvantage in such that the design high water is set higher than that of Alternative 1A, with a higher flood damage potential.

In due consideration of these disadvantages, Alternative 1B is not considered, and instead, Alternative 1A is preferred as the optimum river improvement plan for West Floodway. The longitudinal profile, typical cross-sections and alignment proposed for the optimum plan are as shown in Figs. 7.3 and 7.4.

Optimum Plan for Garang River

The project cost of Alternative 2B is lower than that of Alternative 2A. However, the difference in cost is limited to 2,600 million Rp. which corresponds to only 8% of the entire project cost for Alternative 2B estimated as follows:

(1) Alt. 2A (Excavation) : $33,891 \times 10^6$ Rp.
(2) Alt. 2B (Embankment) : $31,307 \times 10^6$ Rp.

The design high water level of Alternative 2B tends to be much higher than the hinterland ground level. On the other hand, Alternative 2A could lower the

design high water level and minimize the potential for flood damage caused by channel overflow.

In due consideration of these disadvantages or advantages, Alternative 2A is preferred as the optimum river improvement plan for Garang River. The longitudinal profile, typical cross-sections and alignment proposed for the optimum plan are as shown in Figs. 7.3 and 7.5.

7.3 Preliminary Design

7.3.1 Structural Design

Basic Design Concept

The following basic design concepts, criteria and standards are to be applied for all the related structures in the Urgent Project.

(1) Proposed structures are to be designed based on a structural plan of 25-year return period.

(2) The Design Criteria for Irrigation Structures prepared by Directorate General of Water Resources Development, Government of Indonesia is to be applied.

(3) The Technical Standard for River and Sabo Facilities prepared by the Ministry of Construction, Japan is to be applied.

(4) In designing structures, locally based structural materials are to be used as much as possible.

(5) Structures are to be designed in consideration of previous and ongoing flood control plans.

(6) Review and re-evaluation of existing main riparian structures will be done.

Structural Design for Optimum Plan

Structural design is carried out for the following flood control structures to be provided for the optimum plan.

(1) Earth Dike

Earth dike is applied for sections where enough right-of-way or easy land acquisition is expected. The standard design of earth dike is shown in Fig. 7.6.

(2) Revetment

To prevent scouring of dike slope, three (3) types of revetment as shown in Fig. 7.6 are proposed.

(3) Retaining Wall

Five (5) types of retaining wall as shown in Fig. 7.7 are proposed.

(4) Groundsill

There are two (2) types of groundsill, namely, with head and without head. Groundsill with head is proposed to moderate the bed slope for stabilization of the riverbed. Groundsills without head are proposed at the downstream side of the Toll Road Bridge in Garang River

and the point where the tributaries join Garang River to maintain the existing riverbed elevation.

Standard designs of groundsills are shown in Fig. 7.8.

(5) Simongan Weir

Reconstruction of the existing fixed type Simongan Weir to a movable weir with gates is proposed from the evaluation of existing weir. A general view of the existing Simongan Weir is shown in Fig. 7.9.

In order to select the most suitable gate type for the reconstruction of Simongan Weir, the following four (4) alternatives are proposed:

Alternative 1	:	Roller Gate
Alternative 2	:	Radial Gate
Alternative 3	:	Rubber Gate
Alternative 4	:	Tilting Gate

Comparative study is made from various viewpoints as shown in Table 7.1. Through the above study, roller gate is selected as the optimum type (refer to Fig. 7.10), taking the advantages of lower cost, structural reliability, easier control of upstream water level and so on into consideration.

(6) Intake Structures

The intake structures at the right bank of Semarang River and the left bank of the irrigation channel are also designed for reconstruction (refer to Fig. 7.10).

(7) Railroad Bridge

A railroad bridge is presently located at 3.6 km from the river mouth. The bridge is to be reconstructed to have a clearance of 1.0 m above the high water level of a 25-year return period flood, because the present clearance of 30 cm is too small (refer to Fig. 7.11).

(8) Flap Gate

Some of the outlets of the existing drainage culverts along West Floodway/Garang River are equipped with wooden flap gates, and other culverts are not equipped with flap gates. Since the wooden flap gates attached to the existing culverts do not function well due to overage, these flap gates are to be replaced with aluminum flap gates. Aluminum flap gates are also to be installed at culverts without flap gates to prevent reverse flow to the landside area.

7.3.2 Implementation Schedule

The implementation schedule of the Urgent Project on West Floodway/Garang River has been prepared as shown in Fig. 7.12.

7.3.3 Cost Estimate

Project cost, composed of construction cost, compensation cost, administration cost, engineering service cost, physical contingency, price escalation and value added tax, is estimated under the same

conditions mentioned in Subsection 5.1.5. The project cost for the Urgent Project is summarized below. The breakdown of project cost and the annual disbursement schedule are shown in Tables 7.2 and 7.3, respectively.

Description	Amount (Mill.Rp.)
Construction Base Cost	45,049
Compensation Cost	0
Administration Cost	3,154
Engineering Service Cost	8,969
Price Contigency	17,996
Physical Contingency	7,025
Value Added Tax	8,219
Total	90,412
Total in US$ (1,000 US$)	44,473
Total in Japanese Yen (Mill. Yen)	5,581

7.4 Project Evaluation

7.4.1 Economic Evaluation

Basic Conditions

The Urgent Project has been formulated to protect the flood-prone area along West Floodway/Garang River from a 25-year return period flood, and its economic viability was assessed from the annual average benefit and economic project cost. The basic conditions for the economic evaluation on the Urgent Project are as mentioned in Subsection 5.1.6, except the target year which is the year 200 for the Urgent Project.

Annual Average Benefit

Flood control benefit is defined as the reduction of potential flood damage attributed to the design works. The reduction is obtained as the difference between the estimated flood damage under the with- and the without-the-project situations. The annual average benefit of the Urgent Project is estimated at 16,683 million rupiah.

Economic Project Cost

Economic costs of the project are nominal figures that duly reflect the true economic value of goods and services involved. These costs are used only for the economic evaluation of the Project.

Transfer items such as taxes imposed on construction materials and equipment and contractor profit are excluded from the elements of financial cost. Economic wage of unskilled laborers employed for construction works of the Project is assumed to be 80% of the actual market wage, taking account of the employment opportunity of laborers in Indonesia. The economic project cost is thus estimated at 57,952 million rupiah.

The estimated administration and engineering service costs are applied as the economic cost. Price contingency is not considered in the economic cost, while physical contingency is included.

Cost-Benefit Analysis

To calculate the Economic Internal Rate of Return (EIRR), Benefit-Cost Ratio (B/C) and Net Present Value (NPV) of the Urgent Project, the annual

cost-benefit flow is estimated based on the implementation schedule, as shown in Table 7.4. The results of the economic analysis are given as follows:

EIRR : 15.9%
B/C : 1.79
NPV : 31,152 million rupiah

Sensitivity Analysis

Sensitivity analysis of the above-mentioned economic analysis was carried out on several cases of changes in the project benefit or economic project cost as summarized in the following table.

Case	EIRR (%)	B/C	NVP (mil.Rp.)
(a) Project Benefit, 5% down	15.2	1.70	27,422
(b) Project Benefit, 10% down	14.6	1.60	23,714
(c) Project Cost, 5% up	15.3	1.71	29,191
(d) Project Cost, 10% up	14.8	1.63	27,230

Economic Justification

The EIRR of the Urgent Project shows 15.9%, and in any case of the sensitivity analysis, it is over 10% as presented above. The Urgent Project is, therefore, evaluated to have adequate economic viability.

7.4.2 Social and Environmental Impact

Since the Urgent Project is planned within the present right-of-way of West Floodway/Garang River, no house evacuation and land acquisition are

necessary and there will be no negative social impact due to house evacuation and land acquisition.

Generally, the study area is covered with small vegetation and provided with a few kinds of wildlife. Therefore, the realization of the master plan will have a little impact on the natural environment in the study area.

On the other hand, the implementation of the Urgent Project will have a favorable social impact which could not be evaluated in monetary terms to save human lives that may possibly be lost by flooding, to prevent possible injuries, and to prevent diseases.

7.5 Recommendations

For the smooth and effective implementation of the Urgent Project, the following are recommended.

(1) Coordination with Other Government Agencies

The Urgent Project involves construction or reconstruction of structures along West Floodway/Garang River which do not belong to the DGWRD such as the intake facilities of PDAM, discharge culverts of drainage channels, railway and road bridges, etc. It is then essential to maintain a close coordination with related government agencies and others for the smooth implementation of the project.

(2) Reforestation or Regreening of Upper Stream Area

Presently, there are many places devoid of trees in the hilly area, the upper watershed of

West Floodway/Garang River. These places are vulnerable to slope erosion or collapse caused by intensive rainfall, and the subsequent sedimentation on the downstream stretches of the river will remarkably reduce the flood discharge capacity of the river channel.

To protect the slopes and prevent sedimentation, structural and non-structural measures can be applied on the watershed and the river stretch. One of the non-structural measures is reforestration or regreening, which is the most effective and economical measure from the long term point of view. To promote reforestration or regreening, consultation and close coordination with the related govenment agencies and others are necessary.

(3) Development Control of the Watershed

The area surrounding Semarang City is being developed and the city urban area is expanding toward the east, west and south to absorb the growing population. The hilly land in the south is being developed mainly for residential purposes with minimal control or restriction by the central or local government. Such uncontrolled development could result in slope erosion and increment of flood run-off which are both harmful to flood control. For the harmonious development of the area, development activities are required to be controlled or restricted by the central or local government by enacting necessary laws or regulations.

CHAPTER 8 FINANCIAL AFFORDABILITY OF PROPOSED PROJECT

8.1 Basic Concept

The optimum plans for flood control, urban drainage and water resources development have been formulated in this Study on the major premise that all proposed work items are to be completed in the following target completion years:

(a) Master Plan Projects : 2015

(b) Priority Project for Feasibility Study : 2005

(c) Urgent Project : 2000

The proposed implementation schedules of the optimum plans have been prepared to accord with the above target completion years, and the annual disbursement costs of the optimum plans have been estimated in accordance with the implementation schedule.

However, it may be difficult to realize the annual disbursement schedule of costs due to budgetary constraints. On this consideration, a supplementary financial assessment is made to evaluate the financial affordability of the Government of Indonesia for the proposed optimum plans.

The financial assessment is based on the budget projected in the Sixth Five-Year National Development Plan (Repelita VI) for 1994 to 1999. The projection was on the preliminary level, and the budget was expressed only as the national and/or provincial value without any itemized statements. Therefore, only a rough supplementary financial assessment is made in this Study.

8.2 Affordability for Proposed Flood Control and Water Resources Development Projects

8.2.1 Projected Budget

The costs for flood control and water resources development will be provided by the Directorate General of Water Resources Development (DGWRD) as allocated. In Repelita VI, the total budget of DGWRD for nationwide flood control and water resources development is projected at Rp. 4,925,000 million, which is divided into Rp. 1,805,000 million for flood control works and Rp. 3,120,000 million for construction of large dams (refer to Table 8.1).

According to the interview survey with the DGWRD, about five (5) percent of the above national budget could be allocated for projects in and around the study area. The value allocated is equivalent to about Rp. 246,000 million, and may be regarded as the highest possible amount to be budgeted for the proposed project works in the five-year period from 1995 to 1999.

8.2.2 Evaluation

The proposed disbursement schedule for the optimum flood control and water resources development plans is shown in Table 8.2. The proposed disbursement cost is estimated at Rp. 1,176,945 million, which corresponds to about five (5) times of the aforesaid highest possible five-year budget. This means that it will take about twenty-five (25) years to complete all proposed work items, unless a supplementary budget could be allocated. In such budgetary conditions, the completion year is assumed to be 2019

which is five (5) years behind the target completion year mentioned before (refer to Table 8.3).

The priority project is composed of the river channel improvement of West Floodway/Garang River and the construction of Jatibarang Dam, and proposed to be completed during the period of Repelita VI (1994 to 1999). The required cost for the priority project is estimated to be Rp. 231,123 million, which is still within the highest possible five-year budget of Rp. 246,000 million. Accordingly, the priority project could be implemented as proposed, if most of the highest possible budget could be allocated for the proposed project (refer to Table 8.3).

On the other hand, the amount remaining from the highest possible budget after allocating the required cost for the urgent project is very small, and there may come a need for funds for projects other than those proposed in this Study. In this case, a staged implementation is unavoidably required for the priority project.

8.3 Affordability for the Proposed Urban Drainage Project

8.3.1 Projected Budget

The cost for the urban drainage project will be provided mainly from the Central Jawa Provincial Government (Jawa Tengah). In Repelita VI, the provincial budget for the urban drainage project in Central Jawa is preliminarily projected at Rp. 88,351 million.

Out of the provincial budget, 25.5 percent equivalent to Rp. 22,516 million is allocated for Semarang City and could be regarded as the available

budget for the urban drainage plan proposed in this Study (refer to Table 8.4).

8.3.2 Evaluation

The proposed disbursement schedule for the optimum urban drainage plan is shown in Table 8.5. The total disbursement cost is estimated at Rp. 199,810 million, which corresponds to about nine (9) times of the budget projected in Repelita VI (refer to Table 8.3.2). This means that it will take about forty five (45) years to complete all proposed work items, unless a supplementary budget could be allocated. In such case, the completion year is assumed to be 2039 which is twenty-five (25) years behind the target completion year of 2014 mentioned before (refer to Table 8.6).

The proposed urban drainage plan includes the ongoing project implemented from 1993 to 1998 under the Semarang Surakarta Urban Development Project (SSUDP) with financial assistance from IBRD. The cost of the project was originally projected at Rp. 50,714 million, which substantially exceeds the above available budget of Rp. 22,516 million. Thus, it is difficult to afford the whole cost of the ongoing project proposed in SSUDP.

In this Study, however, the work proposed in SSUDP has been modified, and the project cost is reduced to Rp. 25,553 million. Out of this reduced cost, Rp. 4,989 million has already been disbursed in 1993/1994, and the remaining amount of Rp. 20,564 million will come from the five-year budget of Repelita VI.

In this Study, the priority project is proposed to be implemented simultaneously with the above ongoing project from 1993 to 1998. However, most of the five-year budget projected in Repelita VI (1993-1999) will be disbursed for the ongoing project. Unless a supplementary budget is included in Repelita VI, such simultaneous implementation will be practically difficult, and completion of the priority project will be delayed for ten years, from the target year 2004 to the year 2014 (refer to Table 8.6).

TABLES

Table 2.1 MONTHLY RAINFALL AT SEMARANG AND UNGARAN STATIONS

SEMARANG STATION

(mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1980			340		190	17	120	191	33	80	276	321	-
1981	824	576	199	355	71	134	137	47	162	89	195	534	3323
1982	726	374	112	261	66	108	13	2			201	155	-
1983	299		79	94	304	15	8	0	3				
1984	391	301	364	204	109	60	87	10	321	176	301	615	2939
1985	283	554	243	219	256	126	92	165	60	241	178	60	2477
1986	521	161	216	131	43	216	66	66	173	150			
1987				81	133	79	9	12	0	32	145	246	-
1988	423	305	463										
1989													
Average	495	379	252	192	147	94	67	62	107	128	216	322	2460

UNGARAN STATION

(mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1980		427	280	279	104	12	93	26	3	147	334	622	
1981									169				
1982													
1983													
1984													
1985			194	298	215	54	85	70	116	219	123	239	
1986	431	150	283	143	26	132		52	98	156	197	257	
1987	332	390	145	108	54	35	18		0	23	191	370	
1988	293	388	254	243	170	52	40	79	73		45	362	
1989	138	46	103	84	63	242					261		
Average	299	280	210	193	105	88	59	57	77	136	192	370	2065

Table 2. 2 MONTHLY DISCHARGE AND ANNUAL MAXIMUM PEAK DISCHARGE AT AUTOMATIC WATER LEVEL RECORDER

(Garang River Gauging Station A=185.2km2) Unit : m3/sec

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Anual Max Peak Dis.	Specific Runoff
1986	28.9	34.5	35.3	37.2	5.2	8.1	5.1	3.6	3.9	3.2	8.1	11.1	480.0	2.59
1987	23.1	29.7	24.7	12.1	6.4	5.1	3.5	2.5	1.9	2.1	3.8	8.9	318.0	1.72
1988	16.2	20.7	22.7	10.7	6.7	2.9	2.5	1.7	1.8	3.5	4.2	11.4	368.0	1.99
1989	9.9	49.1	16.5	10.6	9.4	10.2	3.9	3.0	1.9	4.1	7.4	15.2	549.0	2.96
1990	17.5	12.5	12.7	7.8	7.1	5.2	3.6	3.1	2.2	1.7	2.6	13.5	1022.0	5.52
Average	19.1	29.3	22.4	15.7	6.9	6.3	3.7	2.8	2.3	2.9	5.2	12.0		

Annual Averag 10.7 m3/sec
(Specific Runoff 0.057 m3/sec/km2)

(Blorong River Gauging Station A=157.9km2) Unit : m3/sec

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Anual Max Peak Dis.	Specific Runoff
1980	13.6	9.4	15.3	11.5	9.0	3.2	2.5	2.9	1.5	2.4	4.0	9.7	268.5	1.70
1981	27.8	21.7	14.3	14.8	10.8	7.9	10.5	2.8	2.8	1.8	3.1	19.3	193.9	1.23
1982	27.6	23.6	13.8	14.7	4.0	2.7	2.0	1.1	0.9	0.8	1.0	3.5	196.8	1.25
1983	15.6	10.4	7.9	9.3	13.1	4.2	1.8	1.1	0.7	3.9	8.0	7.6	141.7	0.90
1984	11.5		14.9		5.9				6.6	2.7	4.0		130.7	0.83
1985	26.8			13.5	7.1	6.1	3.7	2.0	2.1	4.1			265.7	1.68
1986			20.9	13.5	5.9	6.1			2.2	1.4	6.6	6.7	126.0	0.80
1987	13.4	14.6	12.8	7.6	5.9	2.7	2.7	1.0	0.7	0.7	1.5	6.2	115.0	0.73
1988	7.3	11.1	9.5	6.9	4.6	2.8	2.2	1.7	1.3	3.2	3.6	13.6	177.0	1.12
1989	10.0	22.6	11.6	13.8	9.0	8.3	4.7	2.5	1.5	3.2	6.1	32.5	93.8	0.59
1990	23.9	13.3	9.4	5.6	6.9	3.9	2.8	3.5	1.7	1.1	1.1	6.0	101.0	0.64
Average	17.7	15.8	13.0	11.1	7.5	4.8	3.6	2.1	2.0	2.3	3.9	11.7		

Annual Averag 8.0 m3/sec
(Specific Runoff 0.051 m3/sec/km2)

Table 2.3 POPULATION IN THE STUDY AREA (1990)

	Kecamatan	Village/ Kelurahan	Area (km2)	Total Population	Population Density (person/km2)
I	Semarang City (Kodya.)				
1	Central Semarang	16	2.79	58,727	21,049
2	North Semarang	16	11.93	159,638	13,381
3	East Semarang	20	28.90	221,724	7,672
4	South Semarang	35	63.02	227,743	3,614
5	West Semarang	36	31.27	268,960	8,601
6	Genuk	16	60.35	160,362	2,657
7	Gunung Pati	15	51.46	46,362	901
8	Mijen	13	67.46	40,324	598
9	Tugu	10	56.48	65,390	1,158
	Other *	-	-	1,741	
	Subtotal	177	373.66	1,250,971	3,348
II	Kabupaten Kendal				
10	Brangsong	12	34.53	38,092	1,103
11	Kaliwungu	15	107.70	83,736	777
12	Singorojo	14	124.55	42,181	339
13	Boja	18	64.10	51,329	801
14	Limbangan	16	71.71	26,182	365
15	Pegandon	24	66.00	61,577	933
	Subtotal	99	468.59	303,097	647
III	Kabupaten Semarang				
16	Ungaran	22	73.94	94,079	1,272
17	Klepu	21	125.68	75,423	600
	Subtotal	43	199.62	169,502	849
	Grand Total	319	1,041.87	1,723,570	1,654

Sources : - Kodya Semarang in Figure 1990
- Kabupaten Kendal & Kabupaten Semarang in Figure 1990
- Central Jawa Population : Complete result of 1990 Census, Central Jawa Statistics Office, February 1991.

Note : *Including sailors and homeless

Table 2.4 NUMBER OF HOUSEHOLD IN THE STUDY AREA (1990)

Location	Area (km2)	Population	Population Density (persons/km2)	Number of Household	Household Size (persons/hh)
Semarang City	373.66	1,250,971	3,348	268,797	4.7
Kab. Kendal	468.59	303,097	647	69,338	4.4
Kab. Semarang	199.62	169,502	849	34,771	4.9
Study Area	1,041.87	1,723,570	1,654	372,906	4.6

Source : - Central Jawa in Figures 1991
- Kodya Semarang in Figures 1990
- Kabupaten Kendal in Figures 1990
- Kabupaten Semarang in Figures 1990
- 1990 Population Cencus by Central Jawa Statistics Office, February 1991

Table 2.5 POPULATION PROJECTION IN THE STUDY AREA (1990-2015)

	Kecamatan	1990	1995	2000	2005	2010	2015
I	Semarang City						
	1 Central Semarang	58,727	62,243	65,971	69,922	74,109	78,547
	2 North Semarang	159,638	169,198	179,330	190,069	201,452	213,516
	3 East Semarang	221,724	235,002	249,075	263,991	279,800	296,556
	4 South Semarang	227,743	241,381	255,836	271,157	287,396	304,606
	5 West Semarang	268,960	285,067	302,138	320,231	339,408	359,734
	6 Genuk	160,362	169,965	180,143	190,932	202,365	214,484
	7 Gunung Pati	46,362	49,138	52,081	55,200	58,506	62,009
	8 Mijen	40,324	42,738	45,298	48,011	50,886	53,933
	9 Tugu	65,390	69,305	73,456	77,855	82,518	87,459
	Other	1,741	1,845	1,956	2,073	2,197	2,329
	Subtotal	1,250,971	1,325,882	1,405,284	1,489,441	1,578,637	1,673,173
II	Kabupaten Kendal						
	10 Brangsong	38,092	40,373	42,791	45,353	48,069	50,948
	11 Kaliwungu	83,736	88,751	94,065	99,698	105,669	111,997
	12 Singorojo	42,181	44,707	47,384	50,222	53,229	56,417
	13 Boja	51,329	54,403	57,661	61,114	64,774	68,653
	14 Limbangan	26,182	27,750	29,412	31,173	33,040	35,018
	15 Pegandon	61,577	65,265	69,173	73,315	77,705	82,359
	Subtotal	303,097	321,249	340,486	360,875	382,486	405,392
III	Kabupaten Semarang						
	16 Ungaran	94,079	99,713	118,410	112,013	118,721	125,831
	17 Klepu	75,423	79,940	84,727	89,801	95,178	100,878
	Subtotal	169,502	179,653	203,137	201,814	213,899	226,709
	Grand Total	1,723,570	1,826,784	1,948,907	2,052,130	2,175,022	2,305,274

Table 2.6 GROSS DOMESTIC PRODUCT (GDP) OF INDONESIA AT CURRENT MARKET PRICES BY INDUSTRIAL ORIGIN

(Unit : Rp. Billion)

Industry	Year						Average Annual Growth Rate (%) (1985-1990)
	1985	1986	1987	1988	1989	1990	
1. Agriculture, Forestry & Fishery	22,413.2 (23.7)	24,750.5 (24.1)	29,116.0 (23.3)	34,277.9 (24.1)	39,547.0 (23.6)	43,062.1 (21.8)	14.0
2. Mining & Quarrying	15,403.6 (16.3)	11,502.8 (11.2)	17,266.8 (13.8)	17,161.8 (12.1)	22,140.4 (13.2)	28,748.2 (14.5)	13.3
3. Manufacturing Industries	12,903.8 (13.6)	17,184.7 (16.8)	21,150.4 (16.9)	26,252.4 (18.5)	30,573.3 (18.3)	38,601.5 (19.5)	24.5
4. Electricity, Gas & Water Supply	781.3 (0.8)	647.1 (0.6)	746.9 (0.6)	869.0 (0.6)	1,008.3 (0.6)	1,258.1 (0.6)	10.0
5. Construction	5,301.8 (5.6)	5,313.8 (5.2)	6,087.4 (4.9)	7,169.2 (5.0)	8,884.2 (5.3)	10,827.8 (5.5)	15.4
6. Trade, Hotel & Restaurant	14,697.5 (15.5)	17,083.4 (16.7)	21,048.3 (16.9)	24,379.2 (17.2)	28,330.4 (16.9)	32,153.7 (16.3)	16.9
7. Transportation & Communication	6,050.5 (6.4)	6,406.9 (6.2)	7,442.6 (6.0)	8,139.6 (5.7)	9,305.5 (5.6)	11,040.9 (5.6)	12.8
8. Banking & Other Financial Intermediaries	2,802.4 (3.0)	4,058.8 (4.0)	4,795.1 (3.8)	5,322.4 (3.7)	6,550.8 (3.9)	7,902.3 (4.0)	23.0
9. Ownership of Dwelling	2,443.0 (2.6)	2,976.0 (2.9)	3,349.1 (2.7)	3,736.0 (2.6)	4,151.1 (2.5)	4,890.8 (2.5)	14.9
10. Public Administration & Defence	7,925.1 (8.4)	8,307.3 (8.1)	8,911.8 (7.1)	9,446.2 (6.6)	11,174.2 (6.7)	12,801.4 (6.5)	10.1
11. Service	3,998.6 (4.2)	4,314.6 (4.2)	4,902.5 (3.9)	5,351.1 (3.8)	5,829.5 (3.5)	6,434.1 (3.3)	10.0
G D P	94,720.8 (100.0)	102,545.9 (100.0)	124,816.9 (100.0)	142,104.8 (100.0)	167,494.7 (100.0)	197,720.9 (100.0)	15.9

Sources : Statistical Year Book of Indonesia, 1991, Biro Pusat Statistik
Note : Figures in Parenthesis Indicate Distribution in Percent

Table 2.7 BUDGET OF CENTRAL GOVERNMENT OF INDONESIA

(Unit : Rp. Billion)

Fiscal Year	Receipt			Expenditure		
	Routine	Development	Total	Routine	Development	Total
1895/86	19,252	3,572	22,824	11,951	10,873	22,824
1986/87	16,141	5,752	21,893	13,559	8,332	21,891
1987/88	20,803	6,158	26,961	17,482	9,477	26,959
1988/89	23,004	9,991	32,995	20,739	12,251	32,990
1989/90	28,740	9,429	38,169	24,331	13,834	38,165
1990/91	39,546	9,905	49,451	29,998	16,656	46,654
Average Annual Growth Rate (%)	15.5	22.6	16.7	20.2	8.9	15.4

Sources : Statistical Year Book of Indonesia, 1991, Biro Pusat Statistik

Table 2.8 TREND OF EXTERNAL TRADE OF INDONESIA (1980-1991)

(Unit : Million US$)

Year	Including Petroleum and Gas			Excluding Petroleum and Gas		
	Export (1)	Import (2)	Balance (3)-(1)-(2)	Export (4)	Import (5)	Balance (6)-(4)-(5)
1980	23,950.4	10,834.4	13,116.0	6,168.8	9,085.9	(2,917.1)
1981	25,164.5	13,272.1	11,892.4	4,501.3	11,550.4	(7,049.1)
1982	22,328.3	16,858.9	5,469.4	3,929.2	13,314.1	(9,384.9)
1983	21,145.9	16,351.8	4,794.1	5,005.3	12,207.0	(7,201.7)
1984	21,887.8	13,882.1	8,005.7	5,869.7	11,185.3	(5,315.6)
1985	18,586.7	10,259.1	8,327.6	5,868.8	8,987.5	(3,118.7)
1986	14,805.0	10,718.4	4,086.6	6,528.4	9,632.0	(3,103.6)
1987	17,135.6	12,370.3	4,765.3	8,579.5	11,302.3	(2,722.8)
1988	19,218.5	13,248.5	5,970.0	11,536.9	12,339.4	(802.5)
1989	22,158.9	16,359.6	5,799.3	13,480.1	15,164.4	(1,684.3)
1990	25,675.3	21,837.1	3,838.2	14,604.2	19,916.6	(5,312.4)
1991	29,620.3	25,906.4	3,713.9	18,190.2	24,066.2	(5,876.0)

Source : Statistical Year Book of Indonesia, 1991, Biro Pusat Statistik
Note : Figures in parenthesis indicate negative

Table 2.9 GROSS REGIONAL DOMESTIC PRODUCT OF CENTRAL JAWA PROVINCE AT CURRENT MARKET PRICES

(unit: Rp. Billion)

Industrial Sector	1985	1986	1987	1988	1989	Annual Growth Rate (%)
1. Agriculture	3,034.1 (30.0)	3,560.4 (31.0)	4,064.8 (29.9)	5,370.2 (32.7)	6,015.5 (32.0)	18.7
2. Mining & Quarring	50.4 (0.5)	57.2 (0.5)	68.5 (0.5)	84.0 (0.5)	99.2 (0.5)	18.4
3. Manufacturing Industries	2,118.5 (20.9)	2,391.5 (20.8)	3,117.8 (22.9)	3,681.5 (22.4)	4,464.6 (23.8)	20.5
4. Electricity, Gas & Water Supply	65.0 (0.6)	83.6 (0.7)	98.5 (0.7)	101.1 (0.6)	133.1 (0.7)	19.6
5. Construction	517.7 (5.1)	543.0 (4.7)	588.6 (4.3)	774.0 (4.7)	750.5 (4.0)	9.7
6. Wholesail & Retail Trade	1,881.7 (18.6)	2,127.6 (18.5)	2,544.9 (18.7)	2,910.2 (17.7)	3,436.2 (18.3)	16.2
7. Transport & Communication	391.5 (3.9)	442.2 (3.8)	498.6 (3.7)	592.4 (3.6)	693.2 (3.7)	15.4
8. Banking & Other Financial Intermediary	151.4 (1.5)	179.4 (1.6)	228.1 (1.7)	293.2 (1.8)	367.8 (2.0)	24.8
9. Ownership of Dwelling	346.5 (3.4)	365.6 (3.2)	392.9 (2.9)	423.4 (2.6)	471.0 (2.5)	8.0
10. Public Administration	1,269.3 (12.5)	1,421.2 (12.4)	1,617.4 (11.9)	1,782.6 (10.9)	1,918.8 (10.2)	10.9
11. Service	298.1 (2.9)	325.7 (2.8)	373.7 (2.7)	410.2 (2.5)	432.4 (2.3)	9.7
Gross Regional Domestic Product (GRDP)	10,124.2 (100.0)	11,497.4 (100.0)	13,593.8 (100.0)	16,422.8 (100.0)	18,782.3 (100.0)	16.7

Sources : Central Jawa in Figures 1991

Table 4.1 (1/2) ANNUAL MAXIMUM RAINFALL INTENSITIES

(Semarang Meteorological Station : BMG)

(1) Rainfall Depth

Unit : mm

No.	Year	Duration (Minutes) 5'	10'	15'	30'	45'	60'	120'	180'	360'	720'	1Day	2Days
1	1959	20	25	30	50	53	53	55	55	55	55	75	-
2	1960	18	22	32	46	46	47	51	57	67	71	87	115
3	1961	21	26	28	40	43	44	50	66	87	116	124	-
4	1962	11	20	25	30	35	38	45	52	73	76	100	-
5	1963	22	-	25	38	40	40	44	62	70	118	120	-
6	1964	21	31	42	62	78	80	89	91	98	100	100	-
7	1965	11	15	18	28	38	40	41	44	91	125	166	270
8	1966	27	30	34	43	50	54	72	80	90	91	-	-
9	1976	17	20	32	43	59	75	107	107	135	183	206	249
10	1978	17	25	36	60	72	85	98	102	115	115	115	149
11	1979	15	24	29	37	50	56	99	114	126	126	126	126
12	1980	14	28	62	82	82	91	175	185	192	192	192	192
13	1981	20	40	50	65	70	80	113	120	204	228	253	260
14	1982	10	10	16	47	-	69	80	103	131	131	157	247
15	1983	18	36	54	73	-	93	93	96	96	96	96	116
16	1984	16	27	35	47	61	67	79	83	85	91	91	128
17	1985	15	25	35	55	71	96	149	149	149	247	253	282
18	1986	31	46	62	72	-	100	105	123	129	130	130	130
19	1987	27	32	37	60	-	88	93	93	96	138	138	155
20	1988	15	26	36	51	71	81	102	101	117	174	174	198
21	1989	16	26	30	44	55	80	100	100	108	142	142	226
22	1990	10	21	31	52	59	59	65	68	81	100	115	123
23	1991	12	20	31	41	48	50	62	89	130	137	137	185
24	1992	16	22	32	58	80	85	92	100	103	104	104	135
25	1993	24	32	43	80	90	98	116	118	151	211	276	429
	MAX	31	46	62	82	90	100	175	185	204	247	276	429

(2) RAINFALL INTENSITY

Unit : mm/hr

No.	Year	Duration (Minutes) 5'	10'	15'	30'	45'	60'	120'	180'	360'	720'	1Day	2Days
1	1959	240	150	120	100	71	53	27	18	9	5	3	-
2	1960	218	132	128	92	61	47	26	19	11	6	4	2
3	1961	247	154	111	80	57	44	25	22	15	10	5	-
4	1962	130	120	101	60	47	38	23	17	12	6	4	-
5	1963	266	-	100	76	53	40	22	21	12	10	5	-
6	1964	250	187	166	125	103	80	45	30	16	8	4	-
7	1965	132	88	73	57	51	40	21	15	15	10	7	6
8	1966	318	178	137	86	67	54	36	27	15	8	-	-
9	1976	204	120	126	86	79	75	53	36	22	15	9	5
10	1978	204	147	144	120	96	85	49	34	19	10	5	3
11	1979	182	141	116	74	67	56	49	38	21	11	5	3
12	1980	166	167	248	163	109	91	88	62	32	16	8	4
13	1981	240	240	200	130	93	80	56	40	34	19	11	5
14	1982	119	57	65	95	-	69	40	34	22	11	7	5
15	1983	218	218	218	145	-	93	46	32	16	8	4	2
16	1984	193	161	140	94	82	67	39	28	14	8	4	3
17	1985	180	150	140	109	94	96	75	50	25	21	11	6
18	1986	371	278	247	144	-	100	53	41	22	11	5	3
19	1987	329	192	146	120	-	88	47	31	16	12	6	3
20	1988	180	155	144	101	94	81	51	34	20	15	7	4
21	1989	192	156	120	88	73	80	50	33	18	12	6	5
22	1990	125	124	124	103	78	59	33	23	14	8	5	3
23	1991	149	122	125	81	64	50	31	30	22	11	6	4
24	1992	192	132	128	116	107	85	46	33	17	9	4	3
25	1993	288	192	172	160	120	98	58	39	25	18	12	9
	MAX	371	278	248	163	120	100	88	62	34	21	12	6

Table 4.1 (2/2) ANNUAL MAXIMUM RAINFALL INTENSITIES

(Kaligading Automatic Rainfall Gauging Station)

(1) Rainfall Depth

Unit : mm

No.	Year	Duration (Minutes) 5'	10'	15'	30'	45'	60'	120'	180'	360'	720'	1Day	2Days
1	1980						98	103	103	113	113	216	226
2	1981						69	108	133	145	145	201	234
3	1982						64	80	115	143	143	158	270
4	1983						97	129	130	163	175	175	193
5	1984						75	95	101	113	144	144	171
6	1985						71	96	97	97	156	159	192
7	1986						77	85	87	90	109	113	173
8	1987						58	87	106	117	126	126	218
9	1988						63	63	-	-	-	-	-
10	1990						66	94	98	139	150	150	170
11	1991						89	121	127	128	128	128	128
12	1992						54	90	90	90	90	90	120
13	1993						41	61	87	158	219	232	440
	MAX						98	129	133	163	219	232	440

(2) Rainfall Intensity

Unit : mm/hr

No.	Year	Duration (Minutes) 5'	10'	15'	30'	45'	60'	120'	180'	360'	720'	1Day	2Days
1	1980						98	51	34	19	9	9	5
2	1981						69	54	44	24	12	8	5
3	1982						64	40	38	24	12	7	6
4	1983						97	64	43	27	15	7	4
5	1984						75	48	34	19	12	6	4
6	1985						71	48	32	16	13	7	4
7	1986						77	42	29	15	9	5	4
8	1987						58	44	35	19	11	5	5
9	1988						63	63	-	-	-	-	-
10	1990						66	47	33	23	12	6	4
11	1991						89	61	42	21	11	5	3
12	1992						54	45	30	15	8	4	3
13	1993						41	31	29	26	18	10	9
	MAX						98	64	44	27	15	9	6

Table 4.2 MODEL HYETOGRAPH

Semarang Meteorological Station
(5-Minute Interval)

Time	Rainfall Distribution in Return Period								
(min)	2-year (mm)	5-year (mm)	10-year (mm)	20-year (mm)	25-year (mm)	30-year (mm)	50-year (mm)	100-year (mm)	200-year (mm)
5	1.1	2.0	2.3	2.9	3.0	3.1	3.4	3.8	4.3
10	1.2	2.1	2.5	3.0	3.1	3.3	3.6	4.0	4.5
15	1.3	2.2	2.6	3.2	3.3	3.5	3.8	4.2	4.7
20	1.4	2.4	2.8	3.4	3.5	3.7	4.0	4.4	5.0
25	1.6	2.6	3.0	3.6	3.8	3.9	4.2	4.7	5.3
30	1.8	2.8	3.2	3.9	4.1	4.2	4.6	5.1	5.6
35	2.0	3.1	3.6	4.3	4.5	4.6	5.0	5.5	6.1
40	2.4	3.5	4.0	4.7	5.1	5.1	5.5	6.1	6.7
45	3.0	4.1	4.6	5.4	5.9	5.8	6.3	6.9	7.6
50	3.9	5.1	5.6	6.5	7.3	6.9	7.4	8.1	8.9
55	5.6	6.8	7.4	8.4	10.3	8.9	9.5	10.3	11.2
60	10.0	11.9	12.7	14.0	29.2	14.6	15.3	16.5	17.7
65	16.0	21.6	24.8	28.4	14.0	30.4	32.7	36.0	39.3
70	7.2	8.6	9.2	10.3	8.4	10.8	11.4	12.4	13.4
75	4.6	5.8	6.3	7.3	6.5	7.7	8.2	9.0	9.9
80	3.4	4.5	5.0	5.9	5.4	6.3	6.8	7.4	8.2
85	2.7	3.8	4.3	5.1	4.8	5.4	5.8	6.5	7.1
90	2.2	3.3	3.8	4.5	4.3	4.8	5.2	5.8	6.4
95	1.9	2.9	3.4	4.1	3.9	4.4	4.8	5.3	5.9
100	1.7	2.7	3.1	3.8	3.6	4.1	4.4	4.9	5.4
105	1.5	2.5	2.9	3.5	3.4	3.8	4.1	4.6	5.1
110	1.4	2.3	2.7	3.3	3.2	3.6	3.9	4.3	4.8
115	1.2	2.1	2.5	3.1	3.0	3.4	3.7	4.1	4.6
120	1.2	2.0	2.4	2.9	2.9	3.2	3.5	3.9	4.4
Total	80.3	110.7	124.7	145.5	146.6	155.5	167.1	183.8	202.1

Semarang Meteorological Station
(1-Hour Interval)

Time	Rainfall Distribution in Return Period								
(hour)	2-year (mm)	5-year (mm)	10-year (mm)	20-year (mm)	25-year (mm)	30-year (mm)	50-year (mm)	100-year (mm)	200-year (mm)
1	2.8	3.7	3.9	4.7	4.5	4.7	5.2	5.3	6.2
2	3.3	4.4	4.6	5.6	5.4	5.6	6.3	6.4	7.5
3	4.0	5.4	5.7	7.0	6.8	7.1	7.9	8.2	9.6
4	5.2	7.2	7.8	9.6	9.5	9.8	11.0	11.4	13.4
5	7.7	11.5	13.0	16.3	16.3	16.8	19.0	20.1	23.9
6	68.0	88.0	97.6	113.7	114.5	117.7	128.7	136.5	153.2
7	10.6	17.8	21.1	26.8	27.1	28.1	31.8	34.2	40.6
8	6.2	8.8	9.7	12.0	11.9	12.3	13.8	14.5	17.1
9	4.5	6.1	6.6	8.1	7.9	8.2	9.2	9.5	11.1
10	3.6	4.8	5.1	6.2	6.1	6.2	7.0	7.2	8.4
11	3.1	4.0	4.2	5.1	4.9	5.1	5.7	5.8	6.8
12	2.7	3.5	3.6	4.4	4.2	4.4	4.9	4.9	5.8
Total	121.7	165.2	182.8	219.8	219.2	226.0	250.5	264.2	303.7

Kaligading Automatic Rainfall Gauging Station
(1-Hour Interval)

Time	Rainfall Distribution in Return Period								
(hour)	2-year (mm)	5-year (mm)	10-year (mm)	20-year (mm)	25-year (mm)	30-year (mm)	50-year (mm)	100-year (mm)	200-year (mm)
1	3.0	3.5	3.9	4.2	4.4	4.5	4.7	4.9	5.2
2	3.6	4.1	4.6	5.0	5.2	5.3	5.5	5.8	6.2
3	4.4	5.1	5.6	6.1	6.4	6.6	6.8	7.1	7.6
4	6.0	6.8	7.5	8.1	8.4	8.7	9.1	9.4	10.1
5	9.8	10.7	11.8	12.9	13.4	13.9	14.4	15.0	16.0
6	74.8	86.7	95.2	102.9	106.4	108.9	113.7	120.5	127.6
7	15.4	16.2	17.9	19.6	20.5	21.3	22.1	22.7	24.3
8	7.4	8.2	9.1	9.9	10.3	10.6	11.0	11.5	12.3
9	5.1	5.8	6.4	7.0	7.2	7.5	7.8	8.1	8.6
10	4.0	4.6	5.0	5.5	5.7	5.9	6.1	6.4	6.8
11	3.3	3.8	4.2	4.6	4.7	4.9	5.1	5.3	5.7
12	2.8	3.3	3.6	3.9	4.1	4.2	4.4	4.6	4.9
Total	139.6	158.8	174.8	189.7	196.7	202.3	210.7	221.3	235.3

Table 4.3 PROBABLE RUN-OFF DISCHARGE BASED ON OBSERVED DATA AT SIMONGAN WEIR

Return Period (Year)	Probable Discharge (m3/s)
2	350
5	520
10	630
20	740
25	770
30	800
40	840
50	880
70	920
80	940
100	980
150	1,040
200	1,080
300	1,140
500	1,220

Table 4. 4 CONSTANTS FOR STORAGE FUNCTION MODEL

Constants for Sub-Basin

River Sub-Basin	K	p	Tl (hr)	Fl	A (km2)	Base Flow (m3/s)
Babon R.						
BAB-1	9.20	0.60	0.39	0.86	38.80	2.0
BAB-2	7.90	0.60	0.34	0.86	13.10	0.7
BAB-3	8.60	0.60	0.37	0.86	25.10	1.3
East Floodway						
EAB-1	8.40	0.60	0.33	0.86	19.80	1.1
EAB-2	7.60	0.60	0.30	0.86	9.90	0.5
Garang R.						
GAB-1	10.00	0.60	0.54	0.86	70.90	3.4
GAB-2	8.00	0.60	0.43	0.86	14.00	0.9
GAB-3	9.00	0.60	0.48	0.86	34.00	1.8
GAB-4	5.90	0.60	0.32	0.86	1.60	0.1
GAB-5	9.40	0.60	0.50	0.86	45.70	2.4
GAB-6	7.30	0.60	0.39	0.86	7.30	0.5
GAB-7	7.60	0.60	0.41	0.86	10.40	0.6
GAB-8	5.70	0.60	0.31	0.86	1.30	0.1
GAB-9	8.30	0.60	0.45	0.86	18.80	0.6
Silandak R.						
SIB-1	7.40	0.60	0.27	0.86	8.50	0.4
Bringin R.						
BRB-1	7.80	0.60	0.31	0.86	12.00	0.6
BRB-2	7.80	0.60	0.31	0.86	11.90	0.6
BRB-3	7.40	0.60	0.30	0.86	8.20	0.4
Blorong R.						
BLB-1	9.50	0.60	0.51	0.86	50.50	3.0
BLB-2	9.40	0.60	0.59	0.86	46.50	2.6
BLB-3	8.40	0.60	0.45	0.86	20.40	1.0
BLB-4	8.70	0.60	0.47	0.86	29.10	1.3
BLB-5	7.90	0.60	0.42	0.86	10.50	0.6

Constants for River Channel

River Channel	K	P	Tl (hr)
Babon R.			
BAR-1	2.13	0.60	0.13
BAR-2	6.04	0.60	0.28
BAR-3	3.91	0.60	0.18
East Floodway			
EAR-1	4.81	0.60	0.28
Garang R.			
GAR-1	4.73	0.60	0.24
GAR-2	5.85	0.60	0.24
GAR-3	2.80	0.60	0.17
GAR-4	2.47	0.60	0.13
GAR-5	4.83	0.60	0.24
GAR-6	4.01	0.60	0.16
GAR-7	1.45	0.60	0.05
GAR-8	0.93	0.60	0.02
GAR-9	7.26	0.60	0.17
Silandak R.			
SIR-1	1.74	0.60	0.20
Bringin R.			
BRR-1	2.28	0.60	0.16
BRR-2	1.11	0.60	0.08
BRR-3	2.48	0.60	0.17
Blorong R.			
BLR-1	4.18	0.60	0.25
BLR-2	10.93	0.60	0.14
BLR-3	2.74	0.60	0.26
BLR-4	11.45	0.60	0.77
BLR-5	4.11	0.60	0.16

Table 4.5 PROBABLE MAXIMUM PRECIPITATION (PMP) FOR JATIBARANG DAM CATCHMENT AREA ESTIMATED BY HERSHFIELD METHOD

Description		1-hour Rainfall	6-hour Rainfall	24-hour Rainfall
1. Annual Maximum Point Rainfall Observed at Kaligading Gauging Station	Year			
	1980	98 mm	113 mm	216 mm
	1981	69 mm	145 mm	201 mm
	1982	64 mm	143 mm	158 mm
	1983	97 mm	163 mm	175 mm
	1984	75 mm	113 mm	144 mm
	1985	71 mm	97 mm	159 mm
	1986	77 mm	90 mm	113 mm
	1987	58 mm	117 mm	126 mm
	1990	66 mm	139 mm	150 mm
	1991	89 mm	128 mm	128 mm
2. Average of Observed Annual Maximum Point Rainfall				
2.1 For all observed data series	(Xn, n=10)	76.40 mm	124.80 mm	157.00 mm
2.2 Exclude the highest observed data	(Xm, m= 9)	74.00 mm	120.56 mm	150.44 mm
2.3 Xm/Xn		0.97	0.97	0.96
3. Adjustment of Xn				
3.1 Adjustment factor effected by the highest observed data		1.05	1.05	1.04
3.2 Adjustment factor effected by the observed data length		1.05	1.05	1.05
3.3 Adjusted Xn ((2.1) x (3.1) x (3.2))		84.23 mm	137.59 mm	171.44 mm
4. Standard Deviation of Observed Annual Maximum Point Rainfall				
4.1 For all observed data series	(Sn, n=10)	13.18 mm	21.76 mm	31.15 mm
4.2 Exclude the highest observed data	(Sm, m= 9)	11.63 mm	18.60 mm	25.46 mm
4.3 Sm/Sn		0.88	0.85	0.82
5. Adjustment of Sn				
5.1 Adjustment factor effected by the highest observed data		1.07	1.03	1.00
5.2 Adjustment factor effected by the observed data length		1.30	1.30	1.30
5.3 Adjusted Sn ((4.1) x (5.1) x (5.2))		18.33 mm	29.13 mm	40.49 mm
6. Point PMP				
6.1 Statistical Coefficient Km		6	10	13
6.2 Unadjusted Point PMP ((3.3) + (6.1) x (5.3))		194 mm	429 mm	698 mm
6.3 Adjustment for fixed observational time interval		1.13	1.02	1.01
6.4 Adjusted Point PMP ((6.2) x (6.3))		219 mm	437 mm	705 mm
7. Areal Average PMP for Jatibarang Dam Watershed				
7.1 Areal Reduction Factor (53 km2)		0.90	0.97	0.98
7.2 Areal Average PMP ((6.4) x (7.1))		198 mm	424 mm	691 mm

Table 4.6 HOURLY DISTRIBUTION OF PROBABLE MAXIMUM PRECIPITATION (PMP) AND PROBABLE MAXIMUM FLOOD RUNOFF DISCHARGE (PMF)

Time (hour)	Probable Maximum Rainfall (mm/hr)	Probable Maximum Flood (m3/s)	Time (hour)	Probable Maximum Rainfall (mm/hr)	Probable Maximum Flood (m3/s)
1	10	4	25	-	147
2	11	11	26	-	104
3	12	36	27	-	73
4	13	76	28	-	55
5	14	109	29	-	43
6	15	140	30	-	35
7	17	176	31	-	28
8	20	215	32	-	24
9	25	264	33	-	20
10	32	335	34	-	17
11	51	479	35	-	15
12	198	1429	36	-	14
13	76	1777	37	-	12
14	39	1092	38	-	11
15	28	702	39	-	10
16	22	509	40	-	9
17	19	399	41	-	8
18	16	336	42	-	8
19	15	284	43	-	7
20	13	253	44	-	7
21	12	225	45	-	6
22	11	206	46	-	6
23	11	189	47	-	6
24	10	175	48	-	6

Table 4.7 (1/3) MONTHLY BASIN RAINFALL BABON RIVER BASIN

Year	Monthly Rainfall (mm)												Annual Rainfall (mm)
	1	2	3	4	5	6	7	8	9	10	11	12	
1958	294	590	304	250	170	107	217	154	60	140	167	234	2,687
1959	337	324	350	210	187	90	177	10	50	137	47	347	2,266
1960	420	514	394	227	220	77	53	33	60	77	244	130	2,449
1961	537	150	220	120	214	0	30	0	37	10	140	194	1,652
1962	364	570	324	404	227	40	43	63	30	60	187	257	2,569
1963	697	254	330	190	27	7	0	0	0	87	50	154	1,796
1964	314	287	180	277	140	80	13	77	63	227	163	127	1,948
1965	634	303	520	150	40	43	7	33	0	27	120	227	2,104
1966	404	364	410	210	63	83	10	0	53	217	117	214	2,145
1967	304	417	297	367	70	0	0	0	0	13	90	340	1,898
1968	497	280	273	300	200	227	164	110	77	43	200	274	2,645
1969	344	530	564	570	20	67	43	0	13	127	170	334	2,782
1970	340	234	334	274	194	137	120	0	97	90	294	577	2,691
1971	590	390	347	320	167	227	23	0	43	210	247	227	2,791
1972	490	254	414	60	117	13	0	0	0	0	137	180	1,665
1973	383	170	260	177	157	87	107	17	113	247	297	247	2,262
1974	417	197	507	240	117	13	33	57	77	284	163	334	2,439
1975	290	197	427	267	170	50	0	20	217	207	337	210	2,392
1976	697	330	490	53	17	27	3	13	0	50	207	173	2,060
1977	324	240	467	163	120	87	0	0	0	0	120	350	1,871
1978	580	354	334	73	83	110	67	33	163	107	114	200	2,218
1979	454	474	330	357	200	97	33	17	83	87	163	127	2,422
1980	544	244	247	310	190	0	53	93	27	130	287	427	2,552
1981	307	290	70	0	144	83	150	0	0	0	50	320	1,414
1982	274	204	464	394	0	0	0	0	0	0	97	190	1,623
1983	330	163	150	230	267	17	0	0	0	267	220	70	1,714
1984	177	394	187	104	50	57	70	40	320	70	184	304	1,957
1985	53	190	124	167	27	0	73	63	87	160	194	224	1,362
1986	450	194	430	160	57	180	37	73	97	73	117	147	2,015
1987	564	480	220	43	93	40	53	0	0	7	223	564	2,287
1988	427	440	347	257	143	27	27	53	23	167	154	657	2,722
1989	287	934	390	264	187	170	93	10	40	120	260	274	3,029
1990	564	187	230	127	73	127	43	60	40	40	140	464	2,095
Average	415	338	331	222	126	72	53	31	57	105	173	276	2,198

Table 4.7 (2/3) MONTHLY BASIN RAINFALL GARANG RIVER BASIN

Year	Monthly Rainfall (mm)												Annual Rainfall (mm)
	1	2	3	4	5	6	7	8	9	10	11	12	
1958	308	621	319	277	173	111	228	160	63	150	182	262	2,854
1959	349	344	362	224	192	94	181	9	52	146	54	384	2,391
1960	437	531	415	251	237	78	62	36	63	83	261	139	2,593
1961	554	158	238	127	224	0	35	0	37	12	146	214	1,745
1962	384	596	348	423	237	48	44	67	32	65	201	275	2,720
1963	725	267	345	210	27	6	0	0	0	91	51	168	1,890
1964	330	301	190	288	144	86	15	78	72	238	174	128	2,044
1965	664	317	549	156	45	46	9	38	0	29	129	245	2,227
1966	432	386	418	215	70	87	9	0	59	229	127	227	2,259
1967	318	432	312	381	69	0	0	0	0	15	93	357	1,977
1968	517	306	285	304	217	238	176	113	83	45	212	293	2,789
1969	353	556	578	592	23	68	44	0	15	136	177	344	2,886
1970	359	246	343	281	205	142	124	0	102	92	301	599	2,794
1971	614	404	354	336	173	239	24	0	44	218	254	247	2,907
1972	509	261	432	65	122	15	0	0	0	0	139	195	1,738
1973	402	177	279	178	160	92	109	18	117	257	317	254	2,360
1974	437	211	531	249	122	19	42	58	86	292	172	348	2,567
1975	297	206	436	284	180	45	0	24	231	213	362	229	2,507
1976	730	348	517	59	18	27	3	15	0	54	219	182	2,172
1977	346	258	496	169	120	93	0	0	0	0	120	371	1,973
1978	586	370	347	77	92	112	78	33	169	118	127	208	2,317
1979	477	499	346	369	212	101	32	18	88	91	174	129	2,536
1980	564	250	264	321	203	0	55	98	29	139	302	442	2,667
1981	326	296	76	0	164	91	164	0	0	0	57	330	1,504
1982	286	214	480	407	0	0	0	0	0	0	103	204	1,694
1983	352	172	155	238	279	18	0	0	0	286	231	77	1,808
1984	196	416	195	111	56	55	78	44	336	77	194	319	2,077
1985	64	198	133	175	33	0	76	65	90	172	215	253	1,474
1986	476	209	445	173	58	182	43	84	107	80	123	156	2,136
1987	583	502	226	47	100	39	58	0	0	6	234	591	2,386
1988	450	466	366	268	155	27	27	59	28	181	165	689	2,881
1989	297	978	406	275	202	182	100	12	41	131	272	285	3,181
1990	592	204	241	130	83	138	47	66	45	45	162	482	2,235
Average	434	355	346	232	133	75	56	33	60	112	183	292	2,312

Table 4.7 (3/3) MONTHLY BASIN RAINFALL BLORONG RIVER BASIN

Year	Monthly Rainfall (mm)												Annual Rainfall (mm)
	1	2	3	4	5	6	7	8	9	10	11	12	
1958	296	417	306	306	202	158	257	249	122	168	207	256	2,944
1959	331	176	320	384	187	143	143	12	114	97	114	386	2,407
1960	454	431	356	324	286	121	48	39	63	110	507	229	2,968
1961	620	373	244	168	259	33	50	3	0	25	160	203	2,138
1962	351	545	465	386	246	109	174	128	36	122	235	436	3,233
1963	608	250	356	222	66	94	0	11	11	70	168	194	2,050
1964	313	251	170	209	223	116	74	34	137	445	151	318	2,441
1965	623	194	240	102	47	31	48	0	0	0	113	300	1,698
1966	358	376	328	206	162	77	6	0	56	137	277	318	2,301
1967	306	496	404	300	51	0	0	0	0	79	311	492	2,439
1968	314	523	616	264	307	282	196	121	58	28	301	509	3,519
1969	360	349	397	445	51	82	36	0	17	125	377	137	2,376
1970	413	531	540	391	51	111	0	0	69	107	491	336	3,040
1971	522	326	285	312	201	201	87	3	0	402	274	358	2,971
1972	495	228	457	170	233	0	0	0	0	26	119	197	1,925
1973	334	384	259	289	366	171	34	19	244	194	261	231	2,786
1974	410	264	270	252	185	98	136	182	303	219	276	335	2,930
1975	368	324	286	164	170	18	61	47	331	264	279	217	2,529
1976	321	190	288	199	69	11	4	45	0	93	262	254	1,736
1977	269	175	270	146	56	247	0	0	8	19	162	225	1,577
1978	382	197	291	145	182	185	124	145	221	177	138	330	2,517
1979	248	309	313	499	178	165	28	34	177	113	246	422	2,732
1980	354	261	509	213	238	0	109	18	26	155	337	428	2,648
1981	544	291	287	371	210	155	302	62	171	82	132	464	3,071
1982	515	344	247	457	37	53	9	4	0	0	160	299	2,125
1983	501	392	309	256	347	47	0	0	0	268	454	228	2,802
1984	404	485	323	203	115	88	80	58	318	133	188	482	2,877
1985	342	462	452	324	212	42	61	35	61	374	240	299	2,904
1986	469	280	563	287	156	174	150	11	125	122	322	362	3,021
1987	433	307	383	211	136	33	15	0	16	58	214	532	2,338
1988	309	242	528	34	90	39	23	19	0	239	210	310	2,043
1989	332	565	163	272	261	123	105	60	104	168	270	282	2,705
1990	949	239	201	123	147	32	28	39	35	22	106	512	2,433
Average	420	339	346	262	174	98	72	42	86	141	244	330	2,552

Table 4.8 FLOW REGIME AND BALANCE IN OBSERVED RECORDS

River	Year	No. of Records	Flow Regime (m3/s) Maximum	25%	50%	75%	95%	99%	Minimum	Mean Discharge (m3/s)	Annual Run-off (mm)	Annual Rainfall (mm)	Annual Loss (mm)	Run-off Ratio
Babon	1985	365	14.00	2.34	1.42	0.89	0.11	0.00	0.00	1.85	758	1,362	604	0.557
(C.A= 77.0km2)	1986	364	11.00	2.11	0.88	0.59	0.25	0.11	0.04	1.58	647	2,015	1,368	0.321
	1987	334	39.50	2.45	1.09	0.22	0.00	0.00	0.00	2.83	1,159	2,287	1,128	0.507
	1988	350	163.20	2.14	0.95	0.30	0.01	0.00	0.00	2.53	1,039	2,722	1,683	0.382
	1989	272	35.30	1.84	0.99	0.25	0.00	0.00	0.00	1.46	598	3,029	2,431	0.197
	1990	363	354.06	1.78	0.97	0.37	0.06	0.01	0.01	4.27	1,749	2,095	346	0.835
Garang	1987	357	99.20	10.50	5.12	2.45	1.77	1.64	1.50	9.65	1,643	2,386	743	0.689
(C.A=185.2km2)	1988	344	123.00	10.70	4.37	2.10	1.44	1.16	0.38	8.54	1,458	2,881	1,423	0.506
	1990	341	74.40	9.14	5.56	2.50	1.40	1.30	1.30	6.88	1,172	2,235	1,063	0.524
Blorong	1980	351	31.50	8.11	4.68	2.10	1.20	1.02	1.00	6.34	1,083	2,648	1,565	0.409
(C.A=157.0km2)	1981	342	47.30	14.40	6.64	2.62	1.49	1.15	1.07	10.01	1,705	3,071	1,366	0.555
	1982	349	65.00	11.20	2.13	0.99	0.67	0.55	0.52	6.77	1,153	2,125	972	0.543
	1983	352	39.00	9.06	4.53	1.61	0.70	0.59	0.57	6.62	1,127	2,802	1,675	0.402
	1984	328	49.20	7.84	4.36	2.29	1.48	1.21	1.07	6.91	1,180	2,877	1,697	0.410
	1985	329	67.50	10.60	5.68	2.93	1.28	0.98	0.89	7.64	1,301	2,904	1,603	0.448
	1986	331	44.90	10.80	5.38	2.61	1.16	0.92	0.85	7.89	1,344	3,021	1,677	0.445
	1987	359	42.40	8.20	3.05	1.03	0.51	0.43	0.40	5.77	983	2,338	1,355	0.420
	1988	349	53.90	7.72	3.60	1.86	1.03	0.85	0.35	5.58	953	2,043	1,090	0.466
	1989	322	93.80	10.20	8.20	2.50	1.28	1.22	1.22	9.32	1,587	2,705	1,118	0.587
	1990	344	57.20	8.92	3.92	2.02	0.78	0.57	0.54	6.50	1,107	2,433	1,326	0.455

Note : Annual Run-off=Mean Discharge(m3/s)x365or366(day)x86,400/C.A(km2)/1,000

Table 4.9 (1/3) FLOW REGIME CALCULATED BY TANK MODEL SIMULATION BABON RIVER : PUCANGGADING WEIR (C.A=77.0km2)

Year	Flow Regime (m3/s)															Annual Rainfall (mm)
	Maximum	5%	15%	25%	35%	45%	50%	55%	65%	75%	85%	95%	99%	Minimum	Mean	
1961	24.75	6.02	3.23	2.43	2.12	2.00	1.77	1.52	1.10	0.64	0.34	0.13	0.09	0.09	2.15	1,652
1962	21.55	7.95	5.41	4.10	3.08	2.50	2.36	2.22	1.86	1.51	1.12	0.85	0.82	0.80	3.18	2,569
1963	79.73	6.75	4.43	2.82	2.33	2.03	1.75	1.48	1.08	0.59	0.25	0.11	0.09	0.07	2.61	1,796
1964	14.31	5.20	3.26	2.29	1.56	1.37	1.24	1.16	0.95	0.68	0.61	0.56	0.39	0.21	1.81	1,948
1965	26.38	10.64	4.60	2.94	2.23	1.87	1.64	1.48	1.04	0.69	0.30	0.13	0.08	0.07	2.76	2,104
1966	15.28	6.54	4.24	2.96	2.17	1.90	1.79	1.62	1.23	0.88	0.63	0.47	0.40	0.38	2.38	2,145
1967	50.65	6.46	4.17	2.90	2.22	1.90	1.72	1.65	1.20	0.71	0.23	0.00	0.00	0.00	2.38	1,898
1968	28.09	7.45	4.52	3.51	2.73	2.22	2.07	2.03	1.92	1.62	1.49	1.21	1.16	1.15	3.10	2,645
1969	32.57	12.25	7.03	5.02	3.55	3.20	2.99	2.77	2.27	1.75	1.36	1.16	1.11	1.09	4.24	2,782
1970	30.26	7.04	5.18	4.22	3.49	3.05	2.79	2.57	2.40	2.04	1.61	1.26	1.15	1.11	3.48	2,691
1971	19.71	10.79	7.18	5.60	4.61	3.61	3.49	3.30	2.93	2.41	2.04	1.68	1.63	1.62	4.47	2,791
1972	35.44	7.85	4.86	2.96	2.62	2.35	2.09	1.86	1.30	0.83	0.40	0.20	0.10	0.08	2.73	1,665
1973	25.54	5.53	3.53	2.55	1.88	1.55	1.46	1.43	1.32	1.09	0.90	0.68	0.65	0.64	2.19	2,262
1974	20.21	8.32	5.35	4.12	3.02	2.59	2.40	2.19	1.87	1.56	1.27	1.15	1.01	0.96	3.24	2,439
1975	18.19	6.75	4.77	3.86	3.08	2.58	2.51	2.41	2.09	1.79	1.53	1.34	1.27	1.26	3.07	2,392
1976	35.42	10.86	5.60	3.60	3.06	2.55	2.29	2.05	1.55	1.09	0.71	0.47	0.38	0.37	3.38	2,060
1977	18.54	6.65	3.75	2.52	1.94	1.76	1.57	1.41	1.06	0.63	0.27	0.04	0.00	0.00	2.13	1,871
1978	18.86	7.61	4.20	2.64	2.07	1.83	1.77	1.66	1.42	1.14	0.98	0.86	0.79	0.78	2.59	2,218
1979	23.77	8.37	5.52	4.18	3.18	2.71	2.52	2.33	1.90	1.42	1.18	1.01	0.97	0.95	3.30	2,422
1980	67.97	7.24	5.07	3.83	2.93	2.38	2.27	2.13	1.84	1.48	1.19	0.80	0.62	0.61	3.23	2,552
1981	11.05	5.16	3.29	2.45	1.95	1.67	1.60	1.44	1.33	0.81	0.35	0.00	0.00	0.00	1.88	1,414
1982	27.35	6.78	3.43	2.02	1.72	1.38	1.18	1.00	0.61	0.25	0.02	0.00	0.00	0.00	1.89	1,623
1983	14.89	5.06	2.97	1.87	1.45	1.21	1.08	0.99	0.80	0.46	0.23	0.02	0.00	0.00	1.58	1,714
1984	8.64	4.96	3.15	1.91	1.34	1.25	1.12	1.05	0.85	0.69	0.54	0.48	0.34	0.33	1.68	1,957
1985	15.64	3.43	1.66	1.16	1.09	1.00	0.93	0.85	0.55	0.45	0.26	0.10	0.00	0.00	1.11	1,362
1986	25.45	6.38	3.75	2.63	1.95	1.71	1.64	1.54	1.28	0.99	0.75	0.62	0.58	0.56	2.30	2,015
1987	29.87	9.15	5.17	3.32	2.11	1.89	1.76	1.61	1.22	0.84	0.33	0.00	0.00	0.00	2.87	2,287
1988	24.40	9.90	6.20	4.48	3.32	2.65	2.52	2.29	1.86	1.42	1.02	0.77	0.72	0.72	3.54	2,722
1989	41.07	11.36	6.67	5.15	4.31	3.66	3.43	3.30	2.92	2.40	1.94	1.58	1.54	1.51	4.70	3,029
1990	33.28	6.68	4.70	3.39	2.78	2.53	2.42	2.28	1.91	1.48	1.05	0.71	0.64	0.60	3.04	2,095
Average	27.96	7.50	4.56	3.25	2.53	2.16	2.01	1.85	1.52	1.14	0.83	0.61	0.55	0.53	2.77	2,171

Table 4.9 (2/3) FLOW REGIME CALCULATED BY TANK MODEL SIMULATION GARANG RIVER : PANJANGAN (C.A-185.2km2)

Year	Flow Regime (m3/s)															Annual Rainfall
	Maximum	5%	15%	25%	35%	45%	50%	55%	65%	75%	85%	95%	99%	Minimum	Mean	(mm)
1961	64.23	16.19	9.62	7.46	5.80	4.35	3.92	3.43	2.53	1.55	0.88	0.01	0.00	0.00	5.69	1,745
1962	55.85	22.08	15.79	12.15	9.37	7.17	6.04	5.07	4.34	3.51	2.33	1.64	1.54	1.51	8.68	2,720
1963	199.58	19.34	12.63	8.74	5.47	4.36	3.86	3.37	2.25	1.18	0.33	0.00	0.00	0.00	6.80	1,890
1964	38.20	14.73	9.80	6.82	5.00	3.53	3.06	2.81	2.21	1.59	1.18	0.99	0.63	0.25	4.98	2,044
1965	70.60	29.37	13.83	8.89	4.85	4.20	3.86	3.42	2.47	1.49	0.70	0.03	0.00	0.00	7.38	2,227
1966	42.29	19.09	12.38	9.47	6.75	4.60	4.13	3.77	3.04	2.25	1.29	0.82	0.54	0.53	6.54	2,259
1967	61.90	17.38	12.24	8.76	6.55	4.65	4.16	3.53	2.34	1.17	0.26	0.00	0.00	0.00	6.01	1,977
1968	71.38	21.43	13.60	10.18	8.14	6.71	6.14	5.61	4.55	4.06	3.43	2.89	2.41	2.36	8.56	2,789
1969	84.40	33.89	19.90	14.23	9.96	7.26	6.73	6.15	5.09	3.97	2.97	2.23	2.08	2.05	10.97	2,886
1970	78.50	19.27	14.22	11.92	9.76	8.42	7.88	7.05	5.78	4.46	3.49	2.45	2.10	2.01	9.16	2,794
1971	50.49	28.90	19.07	15.21	12.53	9.83	8.60	7.74	6.56	5.56	4.45	3.43	3.14	3.08	11.45	2,907
1972	89.45	20.86	13.74	7.68	5.59	4.84	4.46	3.95	2.80	1.81	0.84	0.14	0.00	0.00	6.76	1,738
1973	66.12	15.05	10.35	7.76	6.01	5.01	4.46	3.98	2.96	2.53	1.84	1.26	1.14	1.13	6.10	2,360
1974	52.74	22.16	15.51	11.39	8.93	6.43	5.52	5.15	4.38	3.58	2.89	2.32	1.96	1.87	8.53	2,567
1975	46.42	18.38	13.48	10.82	8.94	7.54	6.73	6.04	5.04	4.38	3.52	2.61	2.41	2.35	8.18	2,507
1976	92.01	29.07	16.07	10.72	6.55	5.62	5.02	4.51	3.42	2.26	1.35	0.66	0.49	0.49	8.62	2,172
1977	46.98	18.69	11.53	7.43	5.65	4.02	3.68	3.42	2.38	1.40	0.41	0.00	0.00	0.00	5.82	1,973
1978	47.91	21.14	12.64	8.09	5.38	4.30	4.03	3.73	3.40	2.85	2.18	1.79	1.72	1.70	6.94	2,317
1979	62.37	23.04	15.90	12.19	9.20	7.63	5.68	5.15	4.22	3.31	2.45	1.96	1.83	1.79	8.81	2,536
1980	169.50	20.03	13.90	11.05	8.74	7.08	5.91	5.28	4.34	3.42	2.54	1.36	1.01	0.98	8.59	2,667
1981	29.07	14.27	9.92	7.36	5.20	3.85	3.45	3.20	2.66	1.65	0.54	0.00	0.00	0.00	4.94	1,504
1982	68.58	19.02	10.76	6.90	4.10	3.27	2.76	2.28	1.42	0.47	0.00	0.00	0.00	0.00	5.18	1,694
1983	39.96	15.23	9.06	6.58	4.93	3.65	2.95	2.61	2.04	1.14	0.47	0.00	0.00	0.00	4.68	1,808
1984	25.52	14.91	9.78	6.65	4.42	3.09	2.74	2.54	2.11	1.70	1.28	1.01	0.74	0.65	4.87	2,077
1985	40.64	11.02	5.45	3.80	2.83	2.36	2.23	2.08	1.64	1.12	0.71	0.09	0.00	0.00	3.25	1,474
1986	64.33	19.12	11.24	8.23	5.68	4.17	3.84	3.55	3.01	2.35	1.95	1.43	1.26	1.21	6.37	2,136
1987	77.52	25.91	15.33	10.52	5.90	4.25	3.92	3.57	2.78	1.66	0.49	0.00	0.00	0.00	7.78	2,386
1988	64.33	29.53	17.72	13.64	10.12	7.37	5.55	5.05	4.20	3.32	2.44	1.60	1.37	1.34	9.68	2,881
1989	103.96	32.66	17.87	14.02	11.80	9.96	9.44	8.54	6.55	5.38	4.14	3.20	3.08	3.05	12.34	3,181
1990	83.92	18.89	12.85	9.78	7.67	6.25	5.59	5.15	4.24	3.33	2.40	1.43	1.25	1.14	7.94	2,235
Average	69.63	21.02	13.21	9.61	7.06	5.53	4.88	4.39	3.49	2.62	1.79	1.18	1.02	0.98	7.39	2,282

Table 4.9 (3/3) FLOW REGIME CALCULATED BY TANK MODEL SIMULATION BLORONG RIVER : PUCUNG (C.A=157.0km2)

Year	Flow Regime (m3/s)															Annual Rainfall (mm)
	Maximum	5%	15%	25%	35%	45%	50%	55%	65%	75%	85%	95%	99%	Minimum	Mean	
1961	74.06	19.32	12.48	9.41	6.79	5.10	4.69	4.35	3.55	2.83	2.23	1.71	1.64	1.63	7.27	2,138
1962	72.54	20.39	14.42	12.38	9.89	7.93	7.21	6.65	5.03	4.17	3.50	2.95	2.87	2.81	9.12	3,233
1963	143.19	16.91	11.74	9.25	7.25	5.42	4.63	4.30	3.58	2.78	2.08	1.78	1.73	1.68	7.05	2,050
1964	56.60	15.84	10.15	7.29	5.63	4.49	4.08	3.75	2.93	2.67	2.24	1.87	1.70	1.61	5.97	2,441
1965	48.59	17.51	9.80	6.46	4.66	3.48	3.17	2.94	2.40	1.69	0.96	0.36	0.15	0.09	5.31	1,698
1966	33.85	15.12	10.20	7.92	5.90	4.39	3.47	2.95	2.45	1.86	1.31	0.78	0.69	0.69	5.38	2,301
1967	48.98	17.19	12.06	9.07	6.89	4.71	3.70	3.38	2.75	1.96	1.35	0.75	0.60	0.60	6.39	2,439
1968	60.64	24.01	16.67	12.99	10.87	9.06	8.13	7.48	6.19	5.00	4.27	3.47	3.12	3.03	10.25	3,519
1969	61.53	20.05	14.71	11.10	8.24	5.80	5.41	5.05	4.46	3.92	3.10	2.55	2.25	2.20	8.18	2,376
1970	58.74	24.09	16.45	13.23	9.19	6.90	6.02	5.17	4.62	3.78	2.99	2.36	2.25	2.24	9.11	3,040
1971	44.79	18.72	14.35	11.80	10.14	8.70	7.97	7.47	6.29	4.81	4.08	3.23	2.86	2.78	9.20	2,971
1972	35.95	19.42	13.14	9.13	6.58	5.06	4.69	4.30	3.56	2.90	2.07	1.50	1.40	1.39	6.88	1,925
1973	50.54	17.42	11.70	9.39	7.74	6.51	5.98	5.45	4.61	3.62	2.97	2.45	2.33	2.28	7.30	2,786
1974	53.58	16.63	12.13	9.87	8.51	7.26	6.72	6.18	5.12	4.30	3.89	3.56	3.41	2.93	8.01	2,930
1975	37.89	15.82	11.79	9.70	8.27	7.12	6.76	6.44	5.66	4.53	4.02	3.41	3.21	3.18	7.81	2,529
1976	30.75	12.53	8.84	7.66	6.56	5.41	4.43	4.09	3.33	2.47	1.86	1.44	1.39	1.38	5.49	1,736
1977	23.62	10.44	7.14	5.75	4.65	2.94	2.77	2.65	2.37	1.67	0.96	0.43	0.30	0.25	3.98	1,577
1978	31.72	12.57	8.39	6.45	5.23	4.55	4.16	3.86	3.31	2.87	2.39	2.23	2.18	2.14	5.32	2,517
1979	47.45	16.95	12.71	10.16	8.24	6.81	6.17	5.51	4.30	3.81	3.21	2.71	2.51	2.43	7.82	2,732
1980	56.61	17.51	12.31	10.22	8.66	7.23	6.29	5.70	4.30	3.80	3.17	2.45	2.32	2.24	7.79	2,648
1981	61.62	18.28	14.06	12.21	10.47	8.68	7.87	7.25	5.67	4.76	4.25	3.70	3.55	3.50	9.29	3,071
1982	58.99	18.96	13.86	10.78	8.04	5.49	5.14	4.79	3.99	3.19	2.39	1.68	1.60	1.59	7.69	2,125
1983	47.60	20.23	13.79	10.95	9.19	7.46	6.51	5.61	4.03	3.26	2.59	1.84	1.61	1.57	8.11	2,802
1984	35.72	18.75	14.69	10.53	8.24	6.95	6.22	5.45	4.17	3.63	3.20	2.97	2.89	2.85	8.06	2,877
1985	49.63	19.15	14.63	12.16	10.21	8.76	8.05	7.11	5.38	4.88	4.26	3.45	3.16	3.07	9.21	2,904
1986	49.61	19.82	15.71	12.29	9.89	8.05	7.16	6.60	5.66	5.04	4.28	3.77	3.60	3.51	9.35	3,021
1987	69.31	19.16	14.41	11.02	8.80	6.73	5.75	4.93	4.22	3.35	2.54	1.97	1.86	1.84	7.95	2,338
1988	42.90	14.35	10.51	8.01	5.78	4.30	4.00	3.79	3.35	2.81	2.17	1.44	1.15	1.07	6.00	2,043
1989	72.48	16.78	11.80	9.25	7.43	6.30	5.62	5.10	3.92	3.52	2.97	2.42	2.28	2.27	7.30	2,705
1990	88.15	24.09	12.09	8.95	6.43	4.47	4.16	3.90	3.19	2.48	1.95	1.36	1.30	1.30	7.72	2,433
Average	54.92	17.93	12.56	9.85	7.81	6.20	5.56	5.07	4.15	3.41	2.78	2.22	2.06	2.00	7.48	2,530

Table 4.10 MONTHLY AND ANNUAL TIDAL LEVEL OBSERVED AT SEMARANG HARBOR

(Unit: EL.m)

	Year: 1989			Year: 1990			Year: 1991			Year: 1992		
	HWL	LWL	MSL	HWL	LWL	MSL	HWL	LWL	MSL	HWL	LWL	MSL
Jan.	0.56	-0.47	0.00	0.54	-0.50	0.04	0.59	-0.39	0.03	0.50	-0.30	0.06
Feb.	0.49	-0.40	-0.04	0.52	-0.30	0.07	0.56	-0.27	0.07	0.52	-0.34	0.04
Mar.	0.56	-0.42	0.00	0.50	-0.36	-0.01	0.68	-0.30	0.14	0.60	-0.31	0.09
Apr.	0.54	-0.58	0.00	0.69	-0.40	0.09	0.67	-0.39	0.11	0.65	-0.36	0.12
May	0.68	-0.48	0.10	0.68	-0.38	0.10	0.71	-0.42	0.19			
Jun.	0.62	-0.35	0.14	0.63	-0.40	0.14	0.65	-0.36	0.13			
Jul.	0.60	-0.44	0.11	0.56	-0.37	0.09	0.62	-0.44	0.08			
Aug.	0.55	-0.37	0.08	0.56	-0.37	0.10	0.52	-0.33	0.04			
Sep.	0.56	-0.38	0.06	0.56	-0.31	0.09	0.48	-0.34	0.03			
Oct.	0.62	-0.46	0.05	0.58	-0.39	0.07	0.59	-0.38	0.08			
Nov.	0.69	-0.46	0.08	0.60	-0.46	0.07	0.62	-0.44	0.08			
Dec.	0.61	-0.43	0.06	0.59	-0.42	0.03	0.65	-0.42	0.10			
Ave.	0.59	-0.44	0.05	0.58	-0.39	0.07	0.61	-0.37	0.09	0.57	-0.33	0.08
Annual Max. & Min.	0.69	-0.58		0.69	-0.50		0.71	-0.44		0.65	-0.36	0.08

Note: (1) HWL: Monthly and annual highest tidal level.
(2) LWL: Monthly and annual lowest tidal level.
(3) MSL: Monthly and annual average tidal level.
(4) All tidal levels are presented as the elevation above MSL observed at Jakarta Harbour (Tanjung Priok) in 1925.

TABLE 5.1 OPTIMUM PLAN FOR EACH OBJECTIVE RIVER

Description		Blorong River	Bringin River	Silandak River	West Floodway/ Garang River	East Floodway	Babon River
1. Entire Project							
(1) Design Scale	(year of R.P.)	20	50	100	100	100	50
(2) Project Cost	(Mill. Rp.)	94,047	25,988	6,983	85,053	30,642	98,876
(3) Operation/Maintenance Cost	(Mill. Rp./yr.)	185	214	50	303	180	469
(4) Land Acquisition Area	(ha)	82.3	33.3	10.0	20.4	1.1	66.0
(5) Number of House Evacuated	(pc)	32	57	0	0	40	289
2. River Improvement Portion							
(1) Standard flood Discharge	(m3/s)	630	320	120	980	350	630
(2) Design Flood Discharge	(m3/s)	100	320	120	770	350	420
(3) Improvement Length	(km)	6.5	5.0	5.3	9.5	12.0	17.4
(4) Improvement Cost	(Mill. Rp.)	7,742	25,988	6,983	61,640	30,642	52,854
(5) Operation/Maintenance Cost	(Mill. Rp./yr.)	58	214	133	253	180	244
(6) Land Acquisition Area	(ha)	0.0	33.2	10.0	0.0	1.1	66.0
(7) Number of House Evacuated	(pc)	0	57	0	0	40	289
3. Flood Control Dam Portion							
(1) Name of Dam		Kedung Suren	-	-	Jatibarang	-	-
(2) Flood Storage Capacity	(MCM)	10.73	-	-	4.33	-	-
(3) Normal Water Level (NWL)	(El. m)	69.7	-	-	153.0	-	-
(4) Surcharge Water Level (SWL)	(El. m)	71.0	-	-	157.0	-	-
(5) Allocated Cost	(Mill. Rp.)	86,305	-	-	23,413	-	-
(6) Operation/Maintenance Cost	(Mill. Rp./yr.)	127	-	-	50	-	-
(7) Land Acquisition Area	(ha)	82.3	-	-	20.4	-	-
(8) Number of House Evacuated	(pc)	32	-	-	0	-	-
4. Floodway Portion							
(1) Design Flood Discharge	(m3/s)	-	-	-	-	-	210
(2) Construction Length	(km)	-	-	-	-	-	18.3
(3) Project Cost	(Mill. Rp.)	-	-	-	-	-	46,022
(4) Operation/Maintenance Cost	(Mill. Rp./yr.)	-	-	-	-	-	225
(5) Land Acquisition Area	(ha)	-	-	-	-	-	277
(6) Number of House Evacuated	(pc)	-	-	-	-	-	125

Table 5.2 ANNUAL DISBURSEMENT SCHEDULE OF FLOOD CONTROL PLAN FOR MASTER PLAN

(Financial Cost)

Unit: Million Rp.

Description	Total	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1. Babon River																						
Babon River Improvement	58,139	0	0	0	0	0	0	0	0	0	0	1,431	1,431	7,099	22,111	17,378	8,689	0	0	0	0	0
Babon Floodway	50,624	0	6,028	14,356	14,289	13,330	2,621	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. East Floodway																						
East Floodway Improvement	33,706	0	0	0	0	0	0	0	1,018	1,018	472	12,669	12,355	6,174	0	0	0	0	0	0	0	0
3. Garang River																						
Garang River Improvement	52,397	2,104	2,191	0	19,729	19,729	8,644	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West Floodway Improvement	15,407	458	476	0	5,936	5,936	2,601	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jatibarang Dam	25,754	0	2,594	6,736	7,189	7,189	2,046	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Silandak River																						
Silandak River Improvement	12,462	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	634	1,324	6,655	3,849	0	0
5. Bringin River																						
Bringin River Improvement	28,587	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,436	3,219	15,220	8,712
6. Blorong River																						
Blorong River Improvement	8,516	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	527	0	7,989	0	0
Kedungsuren Dam	94,936	0	0	0	0	2,382	2,382	9,336	10,384	11,331	22,325	16,709	16,709	3,378	0	0	0	0	0	0	0	0
Total	380,528	2,562	11,289	21,092	47,143	48,566	18,294	9,336	11,402	12,349	22,797	30,809	30,495	16,651	22,111	17,378	9,323	1,851	8,091	15,057	15,220	8,712

Note : Value added tax is included, but Price contingency is excluded.

(Economic Cost)

Unit: Million Rp.

Description	Total	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1. Babon River																						
Babon River Improvement	48,375	0	0	0	0	0	0	0	0	0	0	1,301	1,301	5,848	18,309	14,411	7,205	0	0	0	0	0
Babon Floodway	38,777	0	4,651	11,039	10,950	10,176	1,961	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. East Floodway																						
East Floodway Improvement	28,107	0	0	0	0	0	0	0	925	925	388	10,504	10,245	5,120	0	0	0	0	0	0	0	0
3. Garang River																						
Garang River Improvement	43,906	1,913	1,992	0	16,407	16,407	7,187	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West Floodway Improvement	12,851	416	433	0	4,923	4,923	2,156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jatibarang Dam	21,627	0	2,236	5,694	5,995	5,995	1,707	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Silandak River																						
Silandak River Improvement	10,372	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	576	1,091	5,514	3,191	0	0
5. Bringin River																						
Bringin River Improvement	23,791	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,305	2,651	12,608	7,227
6. Blorong River																						
Blorong River Improvement	7,104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	479	0	6,625	0	0
Kedungsuren Dam	79,039	0	0	0	0	2,165	2,165	7,690	8,578	9,375	18,514	13,872	13,872	2,808	0	0	0	0	0	0	0	0
Total	313,949	2,329	9,312	16,733	38,275	39,666	15,176	7,690	9,503	10,300	18,902	25,677	25,418	13,776	18,309	14,411	7,781	1,570	6,819	12,467	12,608	7,227

Table 5.3 (1/6) ANNUAL COST AND BENEFIT FLOW OF BLORONG RIVER PROJECT

Unit: Million Rp.

	Year	Economic Cost Const.	Comp.	Admin.	E/S	Phy. Conti.	OMR	Total	Benefit	Balance
	1994							0	0	0
	1995							0	0	0
	1996							0	0	0
	1997							0	0	0
-9	1998				1,968	197		2,165	0	-2,165
-8	1999				1,968	197		2,165	0	-2,165
-7	2000		6,529	508	0	653		7,690	0	-7,690
-6	2001	2,156	4,897	549	246	730		8,578	0	-8,578
-5	2002	4,313	3,264	589	410	799		9,375	0	-9,375
-4	2003	12,939	1,632	1,133	1,230	1,580		18,514	0	-18,514
-3	2004	10,782		839	1,066	1,185		13,872	0	-13,872
-2	2005	10,782		839	1,066	1,185		13,872	0	-13,872
-1	2006	2,156		167	245	240		2,808	0	-2,808
1	2007						115	115	8,864	8,749
2	2008						115	115	9,396	9,281
3	2009						115	115	9,960	9,845
4	2010						115	115	10,557	10,442
5	2011						115	115	11,191	11,076
6	2012				435	44	115	594	11,852	11,258
7	2013	/			0	0	115	115	12,574	12,459
8	2014	5,219		406	435	565	115	6,740	13,328	6,588
9	2015						168	168	14,312	14,144
10	2016						168	168	14,312	14,144
11	2017						168	168	14,312	14,144
12	2018						168	168	14,312	14,144
13	2019						168	168	14,312	14,144
14	2020						168	168	14,312	14,144
15	2021						168	168	14,312	14,144
16	2022						168	168	14,312	14,144
17	2023						168	168	14,312	14,144
18	2024						168	168	14,312	14,144
19	2025						168	168	14,312	14,144
20	2026						168	168	14,312	14,144
21	2027						168	168	14,312	14,144
22	2028						168	168	14,312	14,144
23	2029						168	168	14,312	14,144
24	2030						168	168	14,312	14,144
25	2031						168	168	14,312	14,144
26	2032						168	168	14,312	14,144
27	2033						168	168	14,312	14,144
28	2034						168	168	14,312	14,144
29	2035						168	168	14,312	14,144
30	2036						168	168	14,312	14,144
31	2037						168	168	14,312	14,144
32	2038						168	168	14,312	14,144
33	2039						168	168	14,312	14,144
34	2040						168	168	14,312	14,144
35	2041						168	168	14,312	14,144
36	2042						168	168	14,312	14,144
37	2043						168	168	14,312	14,144
38	2044						168	168	14,312	14,144
39	2045						168	168	14,312	14,144
40	2046						168	168	14,312	14,144
41	2047						168	168	14,312	14,144
42	2048						168	168	14,312	14,144
43	2049						168	168	14,312	14,144
44	2050						168	168	14,312	14,144
45	2051						168	168	14,312	14,144
46	2052						168	168	14,312	14,144
47	2053						168	168	14,312	14,144
48	2054						168	168	14,312	14,144
49	2055						168	168	14,312	14,144
50	2056						168	168	14,312	14,144
	2057							0	0	0
	2058							0	0	0
	2059							0	0	0
	2060							0	0	0
	2061							0	0	0
	2062							0	0	0
	2063							0	0	0
	2064							0	0	0
	TOTAL	48,347	16,322	5,030	9,069	7,375	7,976		EIRR =	10.5%

(Discount Rate 10%)
B/C = 1.07
NPV = 2,351

Table 5.3 (2/6) ANNUAL COST AND BENEFIT FLOW OF BRINGIN RIVER PROJECT

Unit: Million Rp.

	Year	Economic Cost							Benefit	Balance
		Const.	Comp.	Admin.	E/S	Phy. Conti.	OMR	Total		
	1994							0	0	0
	1995							0	0	0
	1996							0	0	0
	1997							0	0	0
	1998							0	0	0
	1999							0	0	0
	2000							0	0	0
	2001							0	0	0
	2002							0	0	0
	2003							0	0	0
	2004							0	0	0
	2005							0	0	0
	2006							0	0	0
	2007							0	0	0
	2008							0	0	0
	2009							0	0	0
	2010							0	0	0
-4	2011				1,186	119		1,305	0	-1,305
-3	2012		2,251	175		225		2,651	0	-2,651
-2	2013	8,539	1,501	781	712	1,075		12,608	0	-12,608
-1	2014	5,693		443	474	617		7,227	177	-7,050
1	2015						157	157	1,768	1,611
2	2016						157	157	1,768	1,611
3	2017						157	157	1,768	1,611
4	2018						157	157	1,768	1,611
5	2019						157	157	1,768	1,611
6	2020						157	157	1,768	1,611
7	2021						157	157	1,768	1,611
8	2022						157	157	1,768	1,611
9	2023						157	157	1,768	1,611
10	2024						157	157	1,768	1,611
11	2025						157	157	1,768	1,611
12	2026						157	157	1,768	1,611
13	2027						157	157	1,768	1,611
14	2028						157	157	1,768	1,611
15	2029						157	157	1,768	1,611
16	2030						157	157	1,768	1,611
17	2031						157	157	1,768	1,611
18	2032						157	157	1,768	1,611
19	2033						157	157	1,768	1,611
20	2034						157	157	1,768	1,611
21	2035						157	157	1,768	1,611
22	2036						157	157	1,768	1,611
23	2037						157	157	1,768	1,611
24	2038						157	157	1,768	1,611
25	2039						157	157	1,768	1,611
26	2040						157	157	1,768	1,611
27	2041						157	157	1,768	1,611
28	2042						157	157	1,768	1,611
29	2043						157	157	1,768	1,611
30	2044						157	157	1,768	1,611
31	2045						157	157	1,768	1,611
32	2046						157	157	1,768	1,611
33	2047						157	157	1,768	1,611
34	2048						157	157	1,768	1,611
35	2049						157	157	1,768	1,611
36	2050						157	157	1,768	1,611
37	2051						157	157	1,768	1,611
38	2052						157	157	1,768	1,611
39	2053						157	157	1,768	1,611
40	2054						157	157	1,768	1,611
41	2055						157	157	1,768	1,611
42	2056						157	157	1,768	1,611
43	2057						157	157	1,768	1,611
44	2058						157	157	1,768	1,611
45	2059						157	157	1,768	1,611
46	2060						157	157	1,768	1,611
47	2061						157	157	1,768	1,611
48	2062						157	157	1,768	1,611
49	2063						157	157	1,768	1,611
50	2064						157	157	1,768	1,611
	TOTAL	14,232	3,752	1,399	2,372	2,036	7,850		EIRR =	6.1%

(Discount Rate 10%)

B/C = 0.64

NPV = -1,337

Table 5.3 (3/6) ANNUAL COST AND BENEFIT FLOW OF SILANDAK RIVER PROJECT

Unit: Million Rp.

	Year	Economic Cost Const.	Comp.	Admin.	E/S	Phy. Conti	OMR	Total	Benefit	Balance
	1994							0	0	0
	1995							0	0	0
	1996							0	0	0
	1997							0	0	0
	1998							0	0	0
	1999							0	0	0
	2000							0	0	0
	2001							0	0	0
	2002							0	0	0
	2003							0	0	0
	2004							0	0	0
	2005							0	0	0
	2006							0	0	0
	2007							0	0	0
	2008							0	0	0
	2009							0	0	0
	2010							0	0	0
-4	2011		926		524	52		1,502	0	-1,502
-3	2012		618	72		93		783	0	-783
-2	2013	3,771		341	314	470		4,896	0	-4,896
-1	2014	2,514		196	209	272		3,191	163	-3,028
1	2015						120	120	1,628	1,508
2	2016						120	120	1,628	1,508
3	2017						120	120	1,628	1,508
4	2018						120	120	1,628	1,508
5	2019						120	120	1,628	1,508
6	2020						120	120	1,628	1,508
7	2021						120	120	1,628	1,508
8	2022						120	120	1,628	1,508
9	2023						120	120	1,628	1,508
10	2024						120	120	1,628	1,508
11	2025						120	120	1,628	1,508
12	2026						120	120	1,628	1,508
13	2027						120	120	1,628	1,508
14	2028						120	120	1,628	1,508
15	2029						120	120	1,628	1,508
16	2030						120	120	1,628	1,508
17	2031						120	120	1,628	1,508
18	2032						120	120	1,628	1,508
19	2033						120	120	1,628	1,508
20	2034						120	120	1,628	1,508
21	2035						120	120	1,628	1,508
22	2036						120	120	1,628	1,508
23	2037						120	120	1,628	1,508
24	2038						120	120	1,628	1,508
25	2039						120	120	1,628	1,508
26	2040						120	120	1,628	1,508
27	2041						120	120	1,628	1,508
28	2042						120	120	1,628	1,508
29	2043						120	120	1,628	1,508
30	2044						120	120	1,628	1,508
31	2045						120	120	1,628	1,508
32	2046						120	120	1,628	1,508
33	2047						120	120	1,628	1,508
34	2048						120	120	1,628	1,508
35	2049						120	120	1,628	1,508
36	2050						120	120	1,628	1,508
37	2051						120	120	1,628	1,508
38	2052						120	120	1,628	1,508
39	2053						120	120	1,628	1,508
40	2054						120	120	1,628	1,508
41	2055						120	120	1,628	1,508
42	2056						120	120	1,628	1,508
43	2057						120	120	1,628	1,508
44	2058						120	120	1,628	1,508
45	2059						120	120	1,628	1,508
46	2060						120	120	1,628	1,508
47	2061						120	120	1,628	1,508
48	2062						120	120	1,628	1,508
49	2063						120	120	1,628	1,508
50	2064						120	120	1,628	1,508
	TOTAL	6,285	1,544	609	1,047	887	6,000		EIRR =	12.8%

(Discount Rate 10%)
B/C = 1.28
NPV = 485

Table 5.3 (4/6) ANNUAL COST AND BENEFIT FLOW OF GARANG RIVER/WEST FLOODWAY PROJECT

Unit: Million Rp.

	Year	Economic Cost							Benefit	Balance
		Const.	Comp.	Admin.	E/S	Phy. Conti.	OMR	Total		
-6	1994	0			2,117	212	0	2,329	0	-2,329
-5	1995	0	1,003	78	3,164	416	0	4,661	0	-4,661
-4	1996	2,525	1,003	274	1,399	493	0	5,694	0	-5,594
-3	1997	20,799		1,618	2,571	2,337	0	27,325	0	-27,325
-2	1998	20,799		1,618	2,571	2,337	0	27,325	2,540	-24,785
-1	1999	8,454		657	994	945	0	11,050	5,385	-5,665
1	2000						271	271	11,376	11,105
2	2001						271	271	12,059	11,788
3	2002						271	271	12,782	12,511
4	2003						271	271	13,549	13,278
5	2004						271	271	14,362	14,091
6	2005						271	271	15,224	14,953
7	2006						271	271	16,137	15,866
8	2007						271	271	17,105	16,834
9	2008						271	271	18,132	17,861
10	2009						271	271	19,220	18,949
11	2010						271	271	20,373	20,102
12	2011						271	271	21,595	21,324
13	2012						271	271	22,891	22,620
14	2013						271	271	24,264	23,993
15	2014						271	271	25,720	25,449
16	2015						271	271	27,264	26,993
17	2016						271	271	27,264	26,993
18	2017						271	271	27,264	26,993
19	2018						271	271	27,264	26,993
20	2019						271	271	27,264	26,993
21	2020						271	271	27,264	26,993
22	2021						271	271	27,264	26,993
23	2022						271	271	27,264	26,993
24	2023						271	271	27,264	26,993
25	2024						271	271	27,264	26,993
26	2025						271	271	27,264	26,993
27	2026						271	271	27,264	26,993
28	2027						271	271	27,264	26,993
29	2028						271	271	27,264	26,993
30	2029						271	271	27,264	26,993
31	2030						271	271	27,264	26,993
32	2031						271	271	27,264	26,993
33	2032						271	271	27,264	26,993
34	2033						271	271	27,264	26,993
35	2034						271	271	27,264	26,993
36	2035						271	271	27,264	26,993
37	2036						271	271	27,264	26,993
38	2037						271	271	27,264	26,993
39	2038						271	271	27,264	26,993
40	2039						271	271	27,264	26,993
41	2040						271	271	27,264	26,993
42	2041						271	271	27,264	26,993
43	2042						271	271	27,264	26,993
44	2043						271	271	27,264	26,993
45	2044						271	271	27,264	26,993
46	2045						271	271	27,264	26,993
47	2046						271	271	27,264	26,993
48	2047						271	271	27,264	26,993
49	2048						271	271	27,264	26,993
50	2049						271	271	27,264	26,993
	2050							0	0	0
	2051							0	0	0
	2052							0	0	0
	2053							0	0	0
	2054							0	0	0
	2055							0	0	0
	2056							0	0	0
	2057							0	0	0
	2058							0	0	0
	2059							0	0	0
	2060							0	0	0
	2061							0	0	0
	2062							0	0	0
	2063							0	0	0
	2064							0	0	0
	TOTAL	52,577	2,006	4,245	12,816	6,740	13,550		EIRR =	16.8%

(Discount Rate 10%)

B/C = 2.02

NPV = 54,950

Table 5.3 (5/6) ANNUAL COST AND BENEFIT FLOW OF EAST FLOODWAY PROJECT

Unit: Million Rp.

	Year	Economic Cost							Benefit	Balance
		Const.	Comp.	Admin.	E/S	Phy. Conti.	OMR	Total		
	1994							0	0	0
	1995							0	0	0
	1996							0	0	0
	1997							0	0	0
	1998							0	0	0
	1999							0	0	0
	2000							0	0	0
	2001							0	0	0
	2002							0	0	0
	2003							0	0	0
	2004							0	0	0
	2005							0	0	0
	2006							0	0	0
	2007							0	0	0
	2008							0	0	0
-6	2009				841	84		925	0	-925
-5	2010				841	84		925	0	-925
-4	2011		329	26	0	33		388	0	-388
-3	2012	8,070	220	645	673	896		10,504	0	-10,504
-2	2013	8,070		628	673	874		10,245	262	-9,983
-1	2014	4,035		313	335	437		5,120	524	-4,596
1	2015						180	180	5,239	5,059
2	2016						180	180	5,239	5,059
3	2017						180	180	5,239	5,059
4	2018						180	180	5,239	5,059
5	2019						180	180	5,239	5,059
6	2020						180	180	5,239	5,059
7	2021						180	180	5,239	5,059
8	2022						180	180	5,239	5,059
9	2023						180	180	5,239	5,059
10	2024						180	180	5,239	5,059
11	2025						180	180	5,239	5,059
12	2026						180	180	5,239	5,059
13	2027						180	180	5,239	5,059
14	2028						180	180	5,239	5,059
15	2029						180	180	5,239	5,059
16	2030						180	180	5,239	5,059
17	2031						180	180	5,239	5,059
18	2032						180	180	5,239	5,059
19	2033						180	180	5,239	5,059
20	2034						180	180	5,239	5,059
21	2035						180	180	5,239	5,059
22	2036						180	180	5,239	5,059
23	2037						180	180	5,239	5,059
24	2038						180	180	5,239	5,059
25	2039						180	180	5,239	5,059
26	2040						180	180	5,239	5,059
27	2041						180	180	5,239	5,059
28	2042						180	180	5,239	5,059
29	2043						180	180	5,239	5,059
30	2044						180	180	5,239	5,059
31	2045						180	180	5,239	5,059
32	2046						180	180	5,239	5,059
33	2047						180	180	5,239	5,059
34	2048						180	180	5,239	5,059
35	2049						180	180	5,239	5,059
36	2050						180	180	5,239	5,059
37	2051						180	180	5,239	5,059
38	2052						180	180	5,239	5,059
39	2053						180	180	5,239	5,059
40	2054						180	180	5,239	5,059
41	2055						180	180	5,239	5,059
42	2056						180	180	5,239	5,059
43	2057						180	180	5,239	5,059
44	2058						180	180	5,239	5,059
45	2059						180	180	5,239	5,059
46	2060						180	180	5,239	5,059
47	2061						180	180	5,239	5,059
48	2062						180	180	5,239	5,059
49	2063						180	180	5,239	5,059
50	2064						180	180	5,239	5,059
	TOTAL	20,175	549	1,612	3,363	2,408	9,000		EIRR =	14.9%

(Discount Rate 10%)

B/C = 1.54

NPV= 2,501