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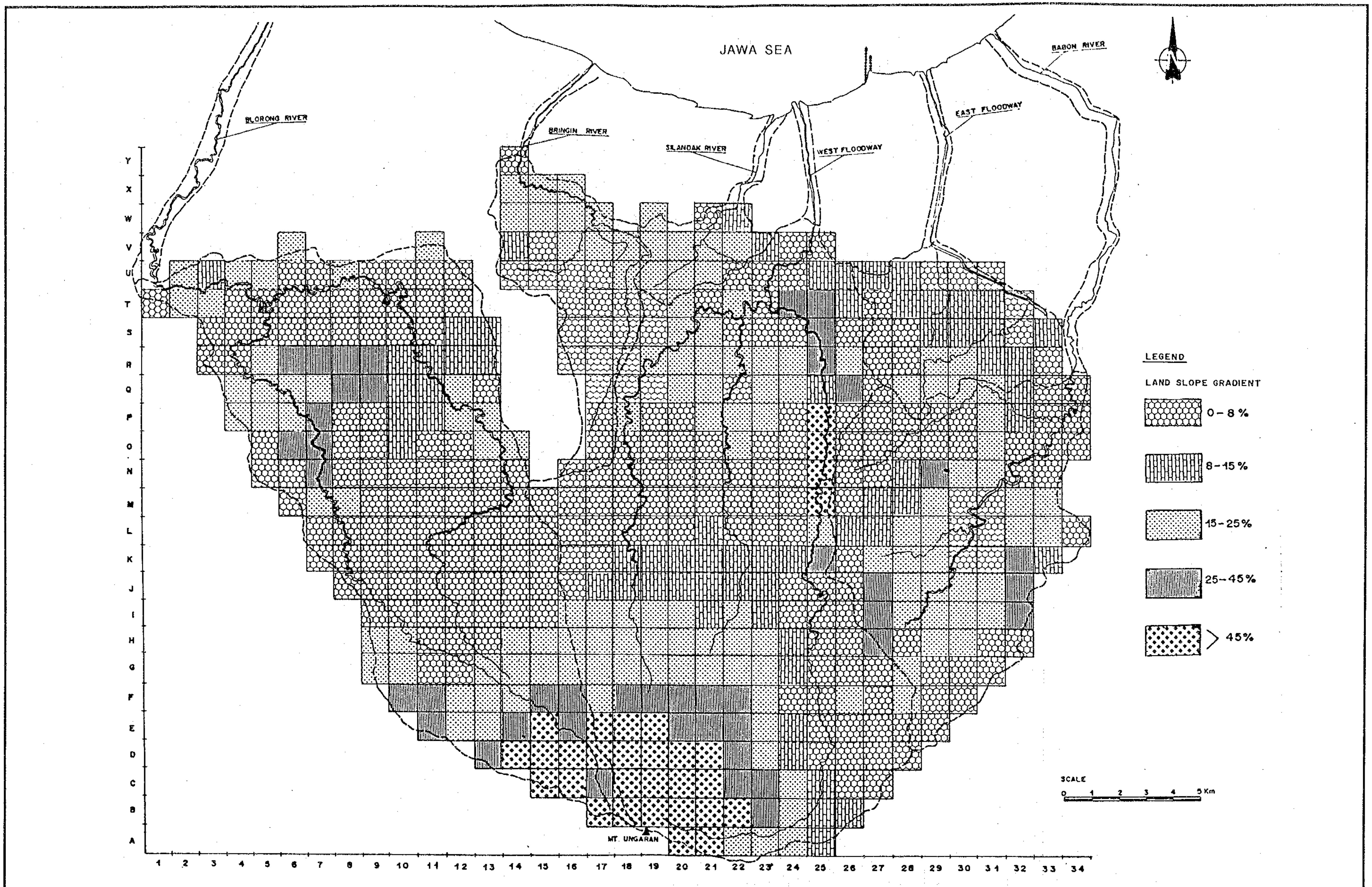

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VIII.3.3 LAND SLOPE GRADIENT MAP

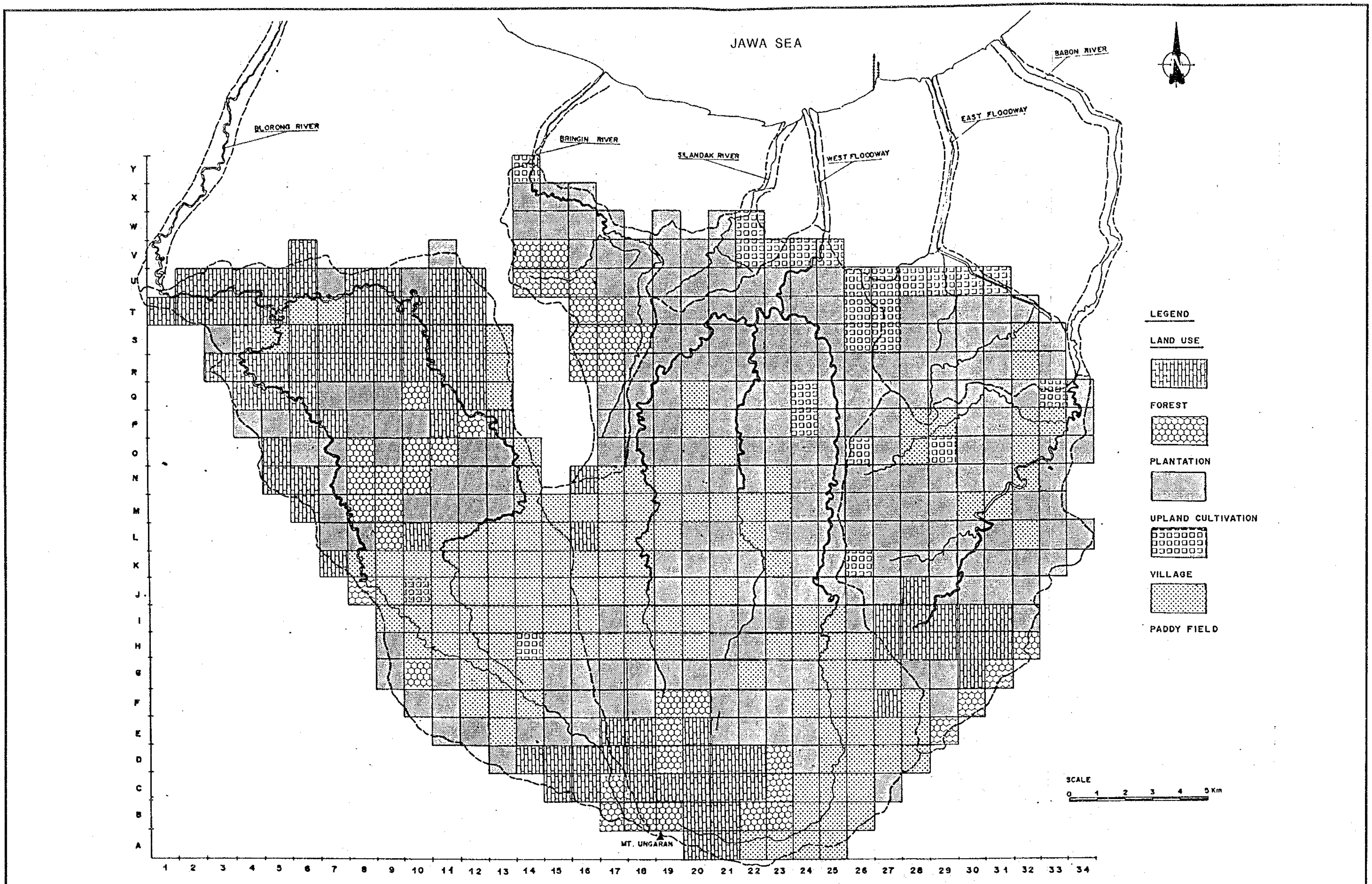

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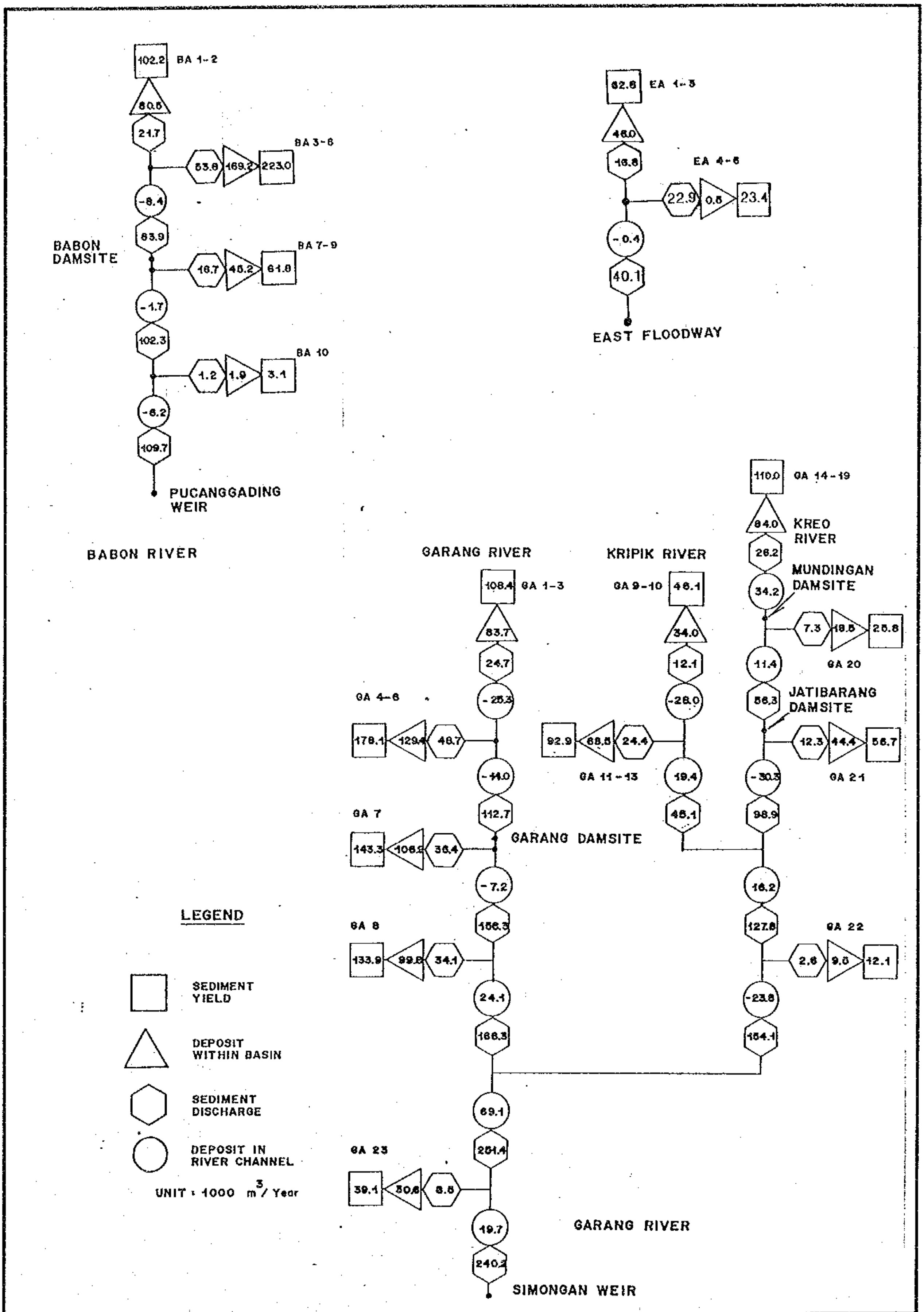
Fig. VIII.3.4
LAND USE MAP



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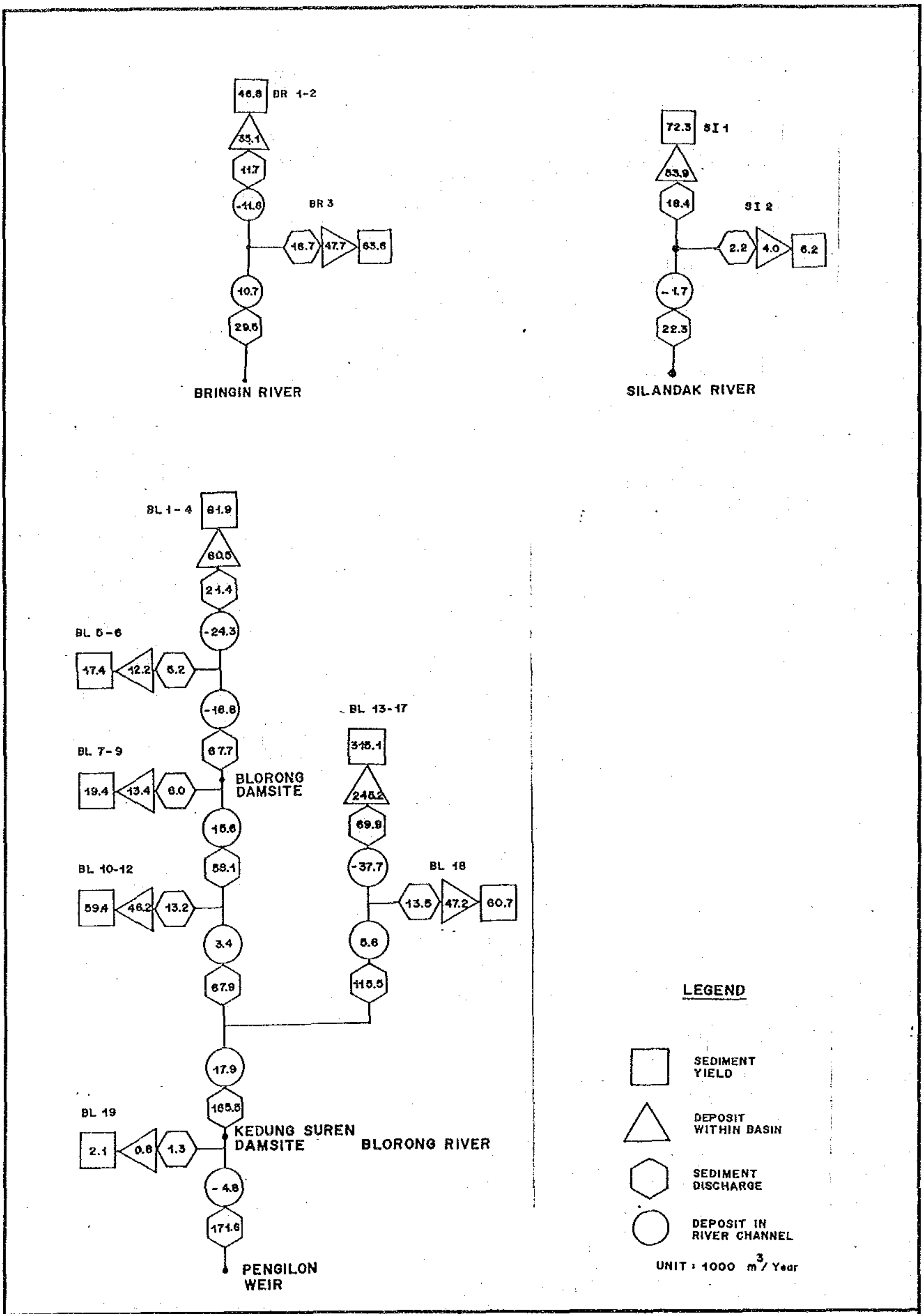

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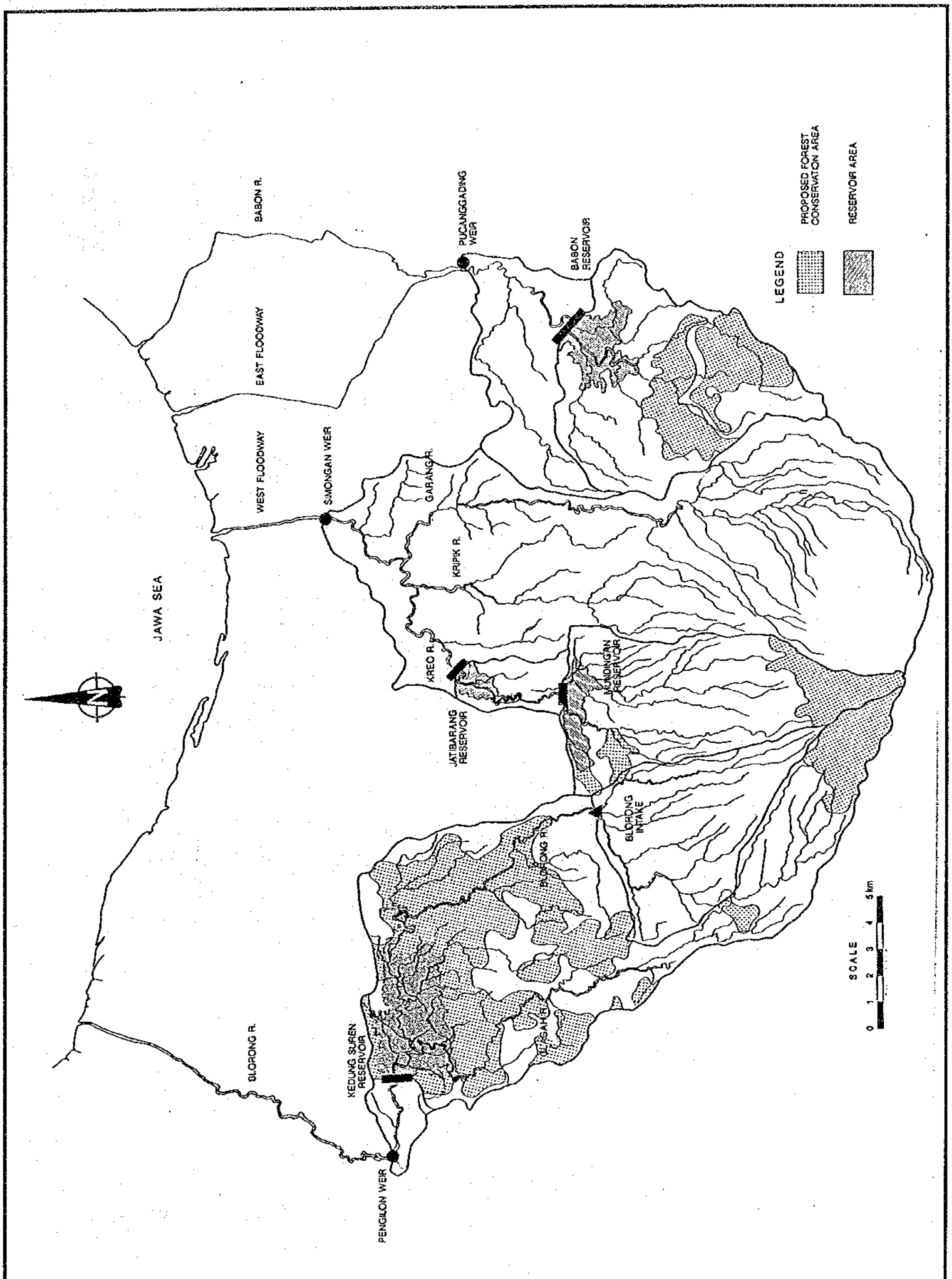

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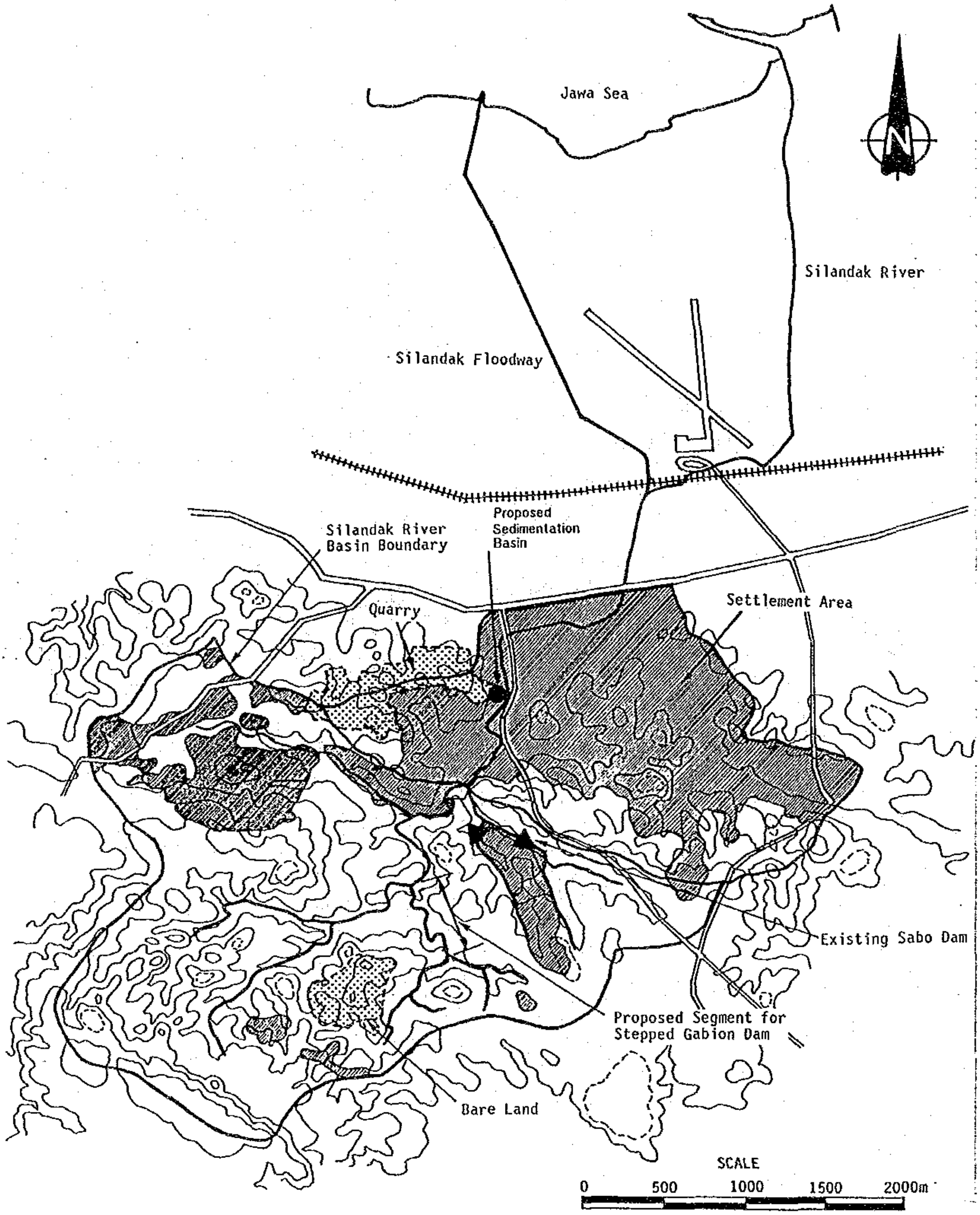

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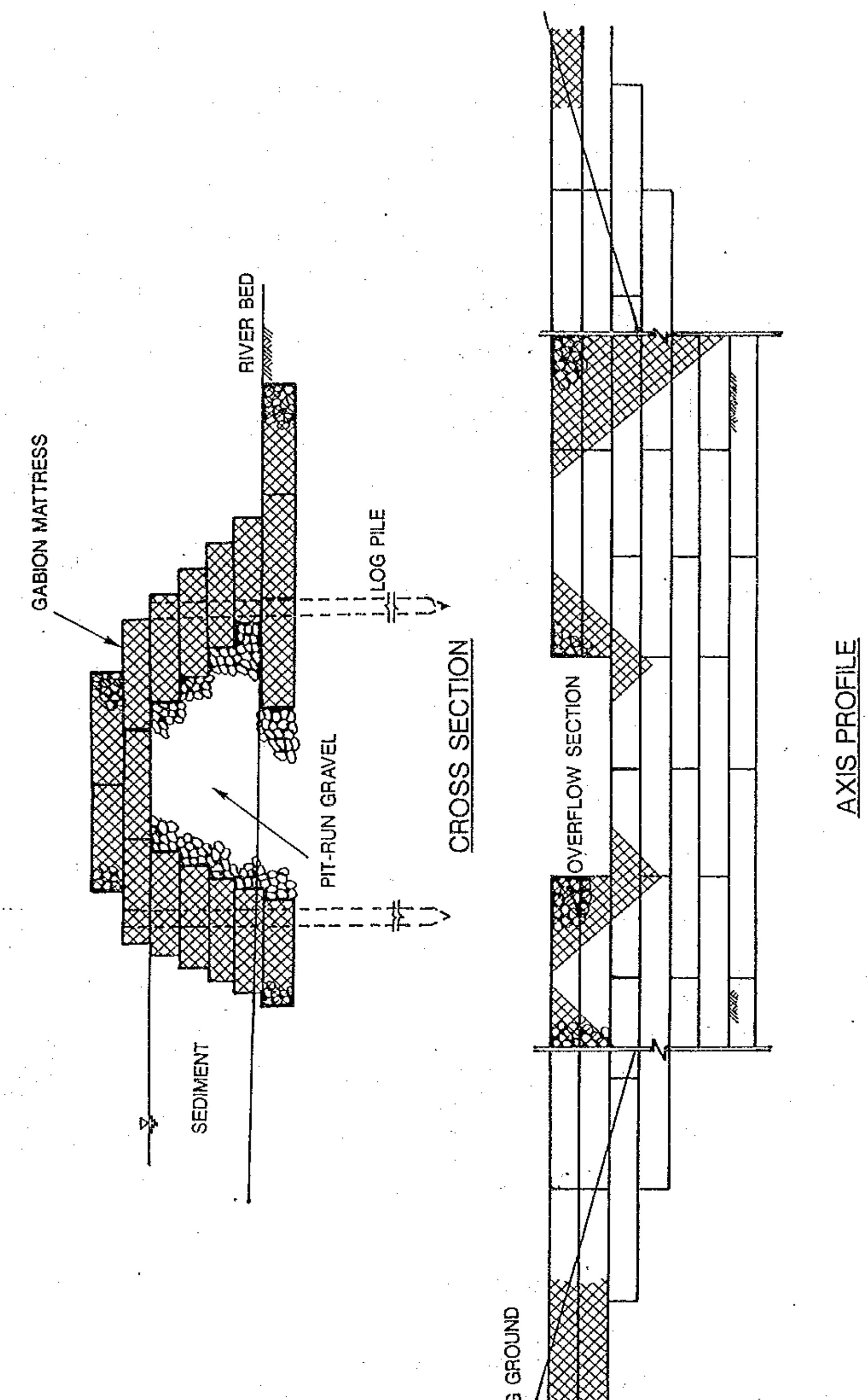

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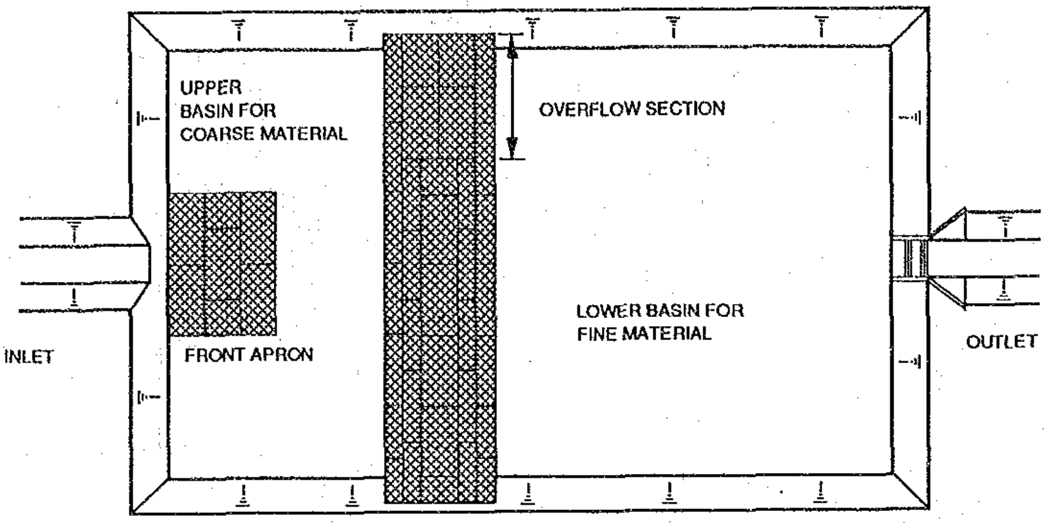
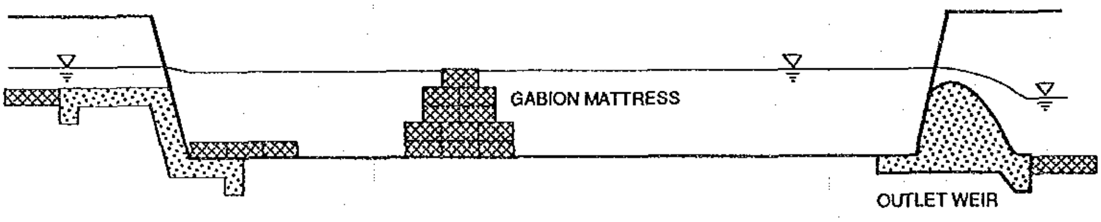
Fig. VIII.4.3
STANDARD FEATURES OF GABION DAM



PLAN



CROSS SECTION

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

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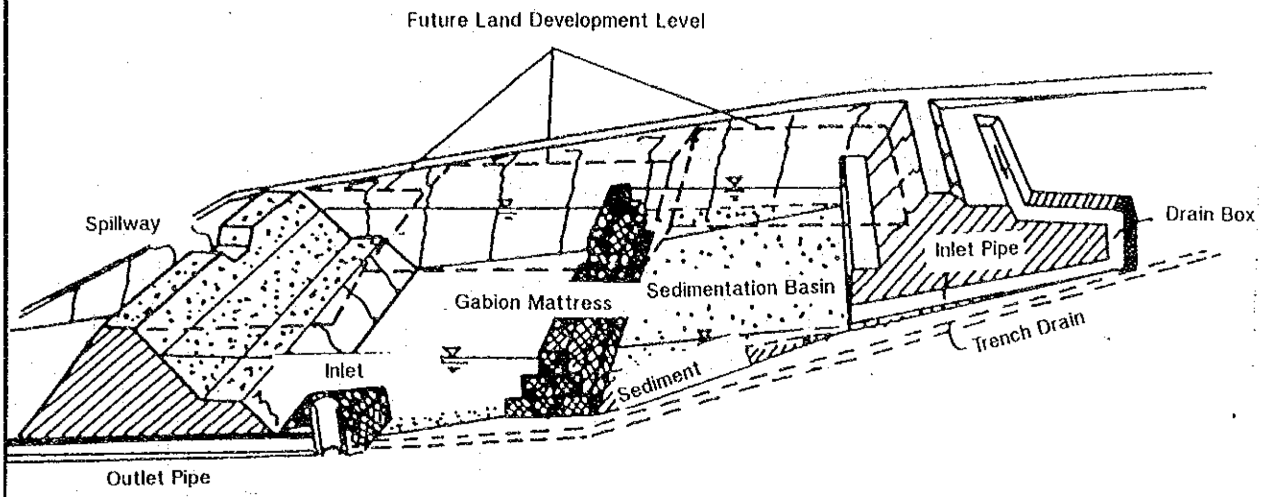
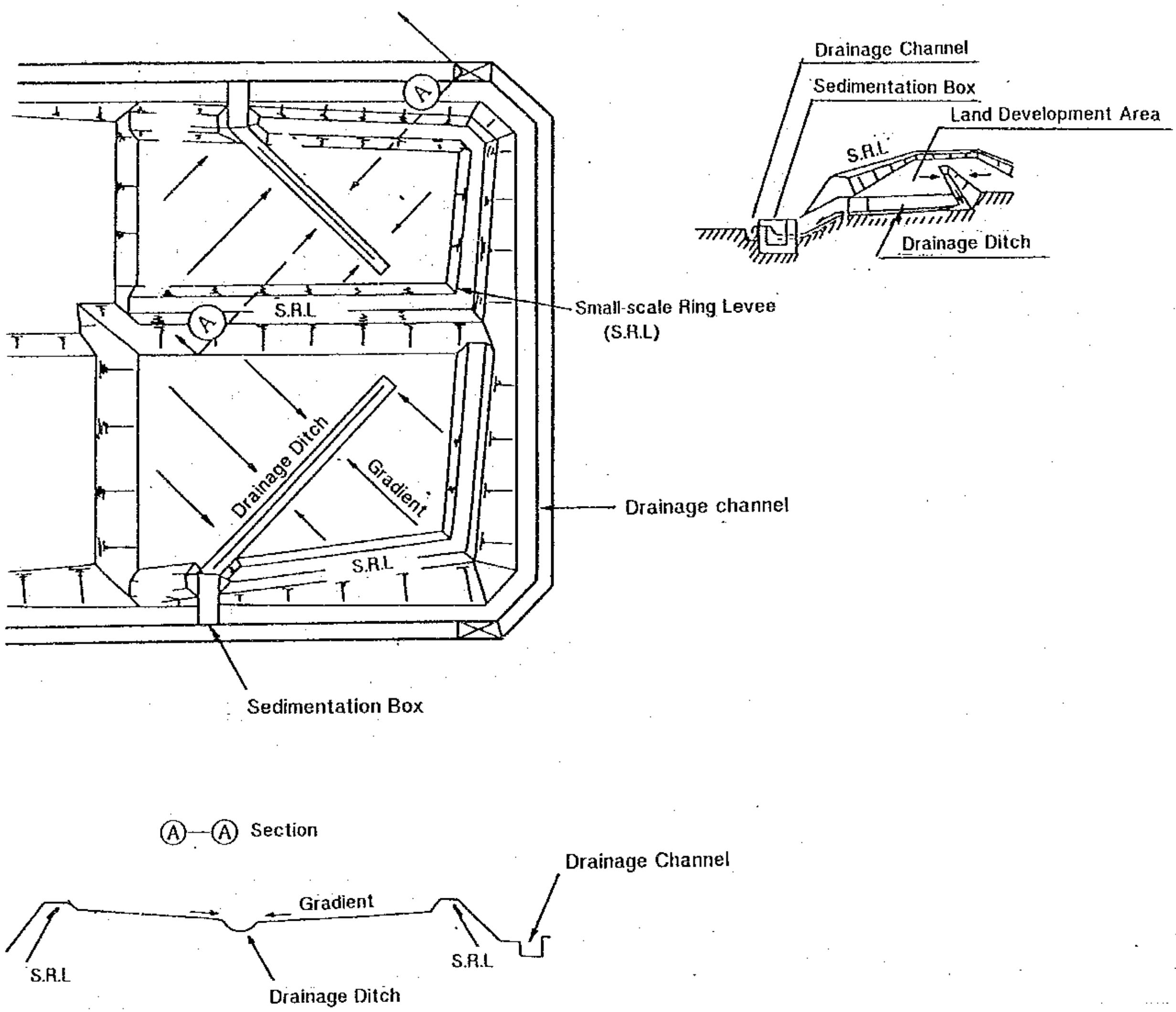
Fig. VIII.4.4
STANDARD FEATURES OF
SEDIMENTATION BASIN



TYPICAL DISASTER PREVENTION POND DURING CONSTRUCTION PERIOD



SMALL-SCALE RING LEVEE IN THE LAND DEVELOPMENT AREA

- to prevent soil erosion
- to regulate storm water

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VIII.4.5(1/2) EXAMPLES OF SEDIMENT CONTROL FACILITIES IN THE LAND DEVELOPMENT AREAS IN JAPAN
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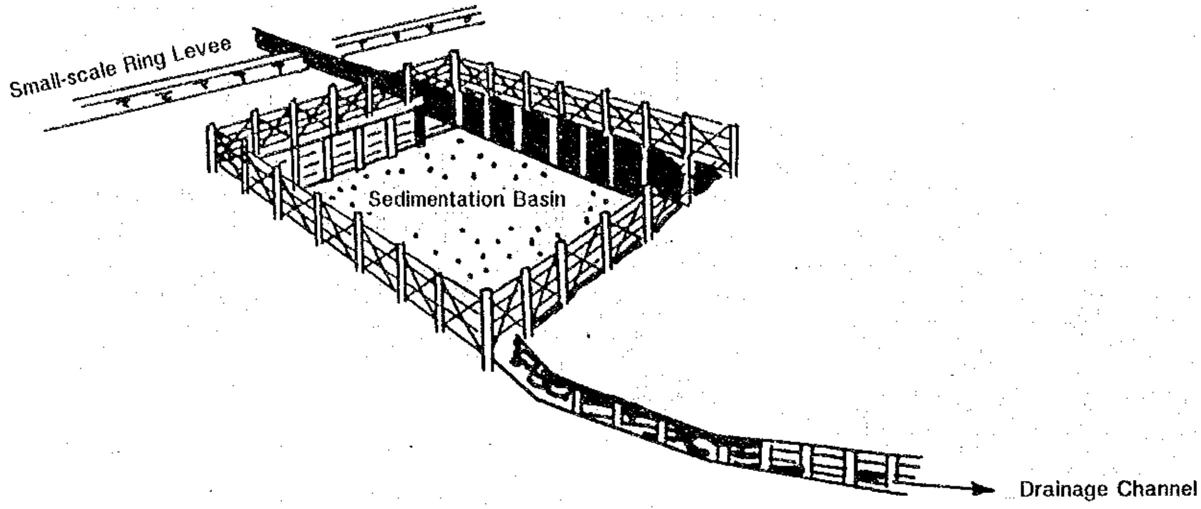
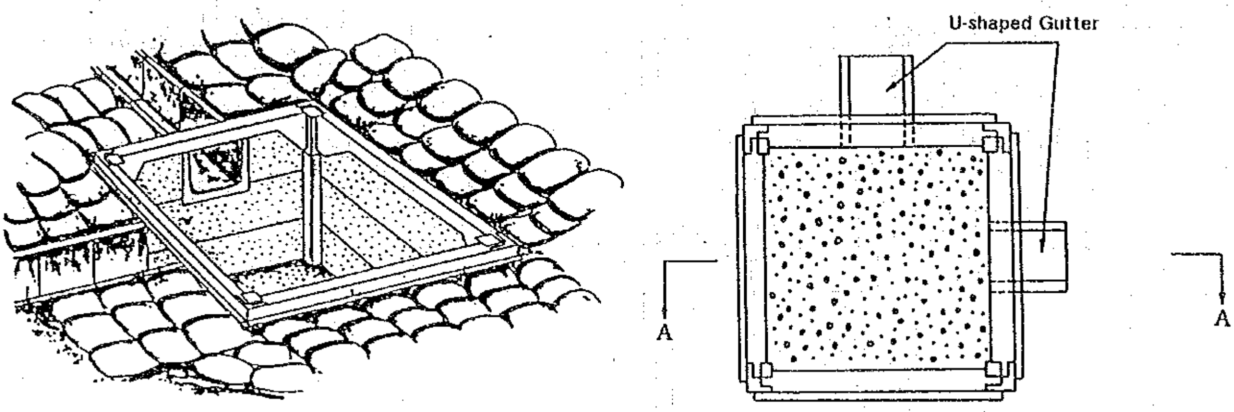
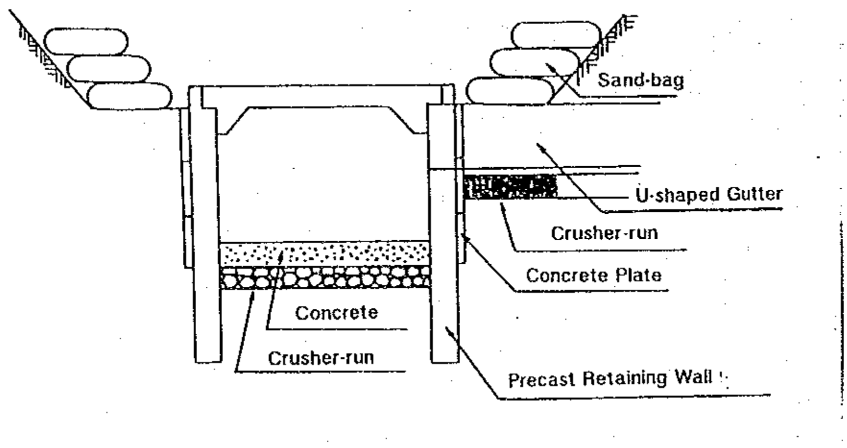


SIMPLE-TYPE SEDIMENTATION BASIN





A-A SECTION

SEDIMENTATION BOX

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig. VIII.4.5(2/2) EXAMPLES OF SEDIMENT CONTROL FACILITIES IN THE LAND DEVELOPMENT AREAS IN JAPAN
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IX DAM ENGINEERING

IX DAM ENGINEERING

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CHAPTER 1 GENERAL

This sector of the supporting report presents the results of the study on the identification of dam sites, the selection of proposed dams in the master plan, and the preliminary design for Jatibarang Multipurpose Dam.

In the master plan study, based on the topographic map with the scale of 1:50,000, seven (7) dam sites were identified as potential dam sites, and four (4) sites were selected from the viewpoint of dam development possibility in the preliminary screening. The Jatibarang dam site on Kreo River is selected to be more advantageous as the priority project due to the possiblity of multiple use for flood control and water supply.

In the feasibility study, based on the topographic map with the scale of 1:2,500 newly developed by the JICA Study Team and the results of boring tests at the dam site, the optimum crest level of Jatibarang Dam was studied from the economical point of view. Correspondingly, preliminary design was conducted by applying a concrete gravity dam, 81.0 m in height.

CHAPTER 2 MASTER PLAN STUDY

2.1 Preliminary Screening of Possible Dam Sites

Through field reconnaissance and scrutiny of 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. IX.2.1, 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 geological point of view, the dam sites except Kripic Dam have good geological conditions. Rock soundness is sufficient in proportion to the dam scale and permeability is not high in general.

The soundness of foundation rock at the Kripic dam site is low, and many rockfalls and faults have developed. The geological conditions of dam sites are presented in SECTOR II, GEOLOGY AND SOIL MECHANICS.

On the other hand, with reference to the results mentioned in CHAPTER 3 of SECTOR VIII, SEDIMENT

CONTROL PLAN, Blorong and Garang reservoirs have less development potential because of small storage capacity in comparison with the amount of sediment inflow. In addition, since a great deal of sediment inflow consists of wash load, structural sediment measures such as sabo dams are inadequate to reduce completely the sediment inflow into reservoirs from the engineering and economic points of view.

In conclusion, newly developed dams shall focus on four (4) dam sites, namely, Babon, Mundingan, Jatibarang and Kedung Suren.

2.2 Dam Development Plan

To determine the optimum yield of the dam development plan, the prioritization employed for multiple purpose projects is adopted. In the master plan study, the required purposes for dams are divided broadly into two categories, namely, flood control and water supply.

Each project is elaborated to the optimum level in other sectors of the supporting report. The aim of this SECTOR is to integrate each project into the dam development plan for designing the appropriate dam structures.

The flood control and water supply master plans are formulated at the target year 2015. There are two reservoirs to be utilized by both plans, i.e., Jatibarang and Kedung Suren reservoirs, which are planned as multipurpose reservoirs. The other two dams, Mundingan and Babon, are for water supply purpose only.

The principal reservoir features for dam design are given in the following table (refer to Fig. IX.2.2).

Principal Reservoir Features for Dam Design

Reservoir	Babon	Jatibarang	Mundingan	Kedung Suren
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

2.3 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.

Mundingan 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.

2.4 Structural Design

Dam

Principal features of the four dams are given in Table IX.2.1 and the general drawings are shown on Fig. IX.2.3. Design conditions and features are summarized below.

(1) Dam Type

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

(2) Dam Height

The dam height is taken as the difference between the elevation of the dam crest with freeboard considered and the elevation of the foundation. The dam heights are determined as follows:

Dam Height

Name of Dam	Dam Crest (m)	Foundation (m)	Height (m)
Babon	EL. 75.0	EL. 30.0	45.0
Jatibarang	EL. 162.0	EL. 85.0	77.0
Mundingan	EL. 230.0	EL. 180.0	50.0
Kedung Suren	EL. 76.0	EL. 30.0	46.0

(3) Configuration of Dam Body

The dam body is configured considering its characteristics and the foundation rock, and to ensure ample safety against anticipated load combinations. The principal features of each dam are given as follows:

Configuration of Dam Body

Name of Dam	Dam Type	Upstream Slope	Downstream Slope	Crest Length (m)	Dam Volume (m^3)
Babon	Rockfill	1 : 2.8	1 : 2.3	1,550	5,890,000
Jatibarang	Concrete Gravity	1 : 0.8	1 : 0.8	180	170,000
Mundingan	Concrete Gravity	1 : 0.8	1 : 0.8	480	188,000
Kedung Suren	Rockfill	1 : 2.8	1 : 2.3	1,000	4,120,000

(4) Spillway

The spillway is designed to be a non-gated spillway to avoid human error in operation, namely a man-made flood, taking into account the arrival time of flood run-off. The design discharges are summarized as follows:

(a) Design Discharge for Flood Regulation

Jatibarang Dam

Maximum Inflow	:	340 m^3/s (100-year return period)
Maximum Outflow	:	100 m^3/s

Kedung Suren Dam

Maximum Inflow	:	580 m^3/s (20-year return period)
Maximum Outflow	:	85 m^3/s

Mundingan Dam and Babon Dam are for water supply and they are not designed to control flood.

(b) Design Discharge for Emergency Spillway

- Babon Dam	:	800 m^3/s (200-year with 20% allowance)
- Jatibarang Dam	:	690 m^3/s (200-year)

- Mundingan Dam : 600 m^3/s (200-year)

- Kedung Suren Dam : 1,250 m^3/s (200-year with 20% allowance)

The principal features of each spillway are given as follows:

Principal Features of Spillway
for Flood Regulation

Name of Dam	Type	Overflow Section Width (m)	NWL (EL. m)	SWL (EL. m)
Babon	-	-	69.4	-
Jatibarang	Frontal Overflow	8.2	153.0	157.0
Mundingan	-	-	224.6	-
Kedung Suren	Frontal Overflow	45.0	69.7	71.0

Principal Features of Emergency Spillway

Name of Dam	Type	Overflow Section Width (m)	Overflow Depth (m)	DFWL (EL. m)
Babon	Side Overflow	96.0	2.6	72.0
Jatibarang	Frontal Overflow	38.0	3.0	160.0
Mundingan	Frontal Overflow	48.0	3.4	228.0
Kedung Suren	Side Overflow	126.0	2.0	73.0

(6) Land Acquisition and House Evacuation

Area of land to be acquired and number of houses to be evacuated are given below.

Land Acquisition and House Evacuation

Name of Dam	Land Acquisition (ha)	House Evacuation (No.)
Babon	485	1,330
Jatibarang	136	0
Mundingan	315	470
Kedung Suren	1,160	1,470

Related Structures

(1) Interbasin Transfer

Interbasin transfer conveying the surplus water of the Bringin river basin to Mundingan Reservoir consists of an intake weir on Blorong River and conveyance facilities.

The intake weir is located downstream of the confluence of Blorong River and Tambangan River. The foundation rock consisting of alternating beds of volcanic breccia and tuffaceous sandstone is fresh and hard, and is sufficient to construct the intake weir.

As conveyance facilities, tunnel type is adopted because of the more than 20 m excavation depth for the open channel type. Geological condition is almost the same as that of the intake weir.

Design conditions and principal features are given below, and the general drawings are shown on Fig. IX.2.4.

(a) Design Discharge to Mundingan Reservoir : Max. 3.0 m^3/s

When the discharge of Blorong River is bigger than 0.6 m^3/s, water will be diverted by interbasin transfer.

(b) Intake Weir on Blorong River

- Overflow Crest Elevation : EL. 233.5 m

- Foundation Elevation : EL. 230.5 m

- Overflow Crest Length : 20.0 m

(c) Tunnel

- Width : 2.0 m
- Height : 2.0 m
- Length : 1,600 m
- Gradient : 1/1,000

(2) Conveyance Channel

Water to be stored in the Kedung Suren reservoir shall be conveyed to Western Semarang. The conveyance channel is planned along the existing irrigation channel from Kedung Suren Dam to Kaliwungu, and along the existing road or railway from Kaliwungu to Western Semarang (refer to Fig. VII.3.5)

(a)	Design Discharge	:	1.7 m^3/s
(b)	Channel Type	:	Open channel
(c)	Width	:	1.6 m
(d)	Water Depth	:	0.8 m
(e)	Length	:	19 km
(f)	Gradient	:	1:1,000

CHAPTER 3 FEASIBILITY STUDY ON JATIBARANG DAM

3.1 General

Objective Dam Site

In the master plan study, Jatibarang Dam on Kreo River is selected as a priority project for the flood control, water resources development and hydropower generation plans.

Current Conditions

In the master plan study, information on topographical condition of the reservoir area was assumed using the topographic map of 1:50,000 edited in 1942. In the feasibility study, in contrast, information around the reservoir area was obtained from the map of 1:2,500 newly developed during the study period from the aerophotographs taken in 1991. The reservoir storage curve based on this map is presented in Fig. IX.3.1.

For geological investigation in this study, drillings at three (3) points along the proposed dam axis (left bank, riverbed and right bank) were conducted together with in situ permeability tests and laboratory tests.

Preliminary design of Jatibarang Dam is carried out based on the newly obtained data.

Design Criteria

Dam and reservoir design basically followed the Japanese criteria, namely:

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

3.2 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.

Spring occurred at two depths at Drillhole B-2 of the riverbed. The amount of spring was 64 l/min at the maximum pressure of 2.0 kg/cm^2 at the depth of 42 m, and 66 l/min at 1.8 kg/cm^2 at the depth of 62 m.

Detailed geological conditions of Jatibarang Dam are presented in SECTOR II, GEOLOGY AND SOIL MECHANICS.

3.3 Alternative and Optimum Dam Crest Level

Alternative Plan

In the master plan, the dam crest level is preliminarily set at EL. 162.0 m based on the study through the field reconnaissance and the topographic map on the scale of 1:50,000. In this stage, since the topographical and geological conditions have become clearer using the boring test results and the map of 1:2,500 newly developed, the alternative study for the dam crest level is executed to find out the optimum dam development plan.

The following four (4) alternatives are considered for comparative study (refer to Fig. IX.3.2). The details of the relationship between the alternative surcharge water level and its corresponding dam crest level are described in SECTOR V, FLOOD CONTROL PLAN.

Alter-natives	Crest Level (EL.m)	Design Flood Water Level (EL.m)	Surcharge Water Level (EL.m)	Gross Storage Capacity (MCM)	Effective Storage Capacity (MCM)
Alt. 1	160.5	158.5	155.5	23.7	16.9
Alt. 2	164.0	162.0	158.8	27.8	21.0
Alt. 3	167.0	165.0	161.9	32.0	25.2
Alt. 4	170.0	168.0	164.9	36.2	29.4

The following conditions are considered to estimate the construction base cost:

(1) Treatment of Left Side Ridge at Dam Axis

Judging from the geological condition of the ridge, permeability of the ridge below EL. 160.0 m can be improved by ordinary cement grouting.

(2) Treatment of Saddle Portion on the Right Bank

Auxiliary spillway is planned on this saddle portion. The foundation of the invert concrete can be set below EL. 160.0 m.

(3) Conservation of Goa Cave at EL. 162.4 m

In case the design flood water level is set above EL. 162.4 m, protection works for Goa Cave are necessary.

Comparative study is carried out on the premise of the concrete gravity type of dam. The final decision on dam type is done in the following section.

Optimum Dam Crest Level

Principal features and the general drawing are presented in Table IX.3.1 and Fig. IX.3.2, respectively. They are summarized below.

Alter- natives	Dam Crest Level (EL.m)	(1) Effective Storage Capacity (MCM)	(2) Construction Base Cost Plus Compensation Cost (Mill. Rp.)	(2)/(1) ($Rp./m^3$)
Alt. 1	160.5	16.9	48,092	2,846
Alt. 2	164.0	21.0	55,518	2,644
Alt. 3	167.0	25.2	69,685	2,765
Alt. 4	170.0	29.4	84,776	2,884

When the dam crest level is set higher than EL. 164.0 m, the construction base cost will drastically increase, because treatment of the left side ridge and protection works for Goa Cave are required. Accordingly, the dam crest EL. 164.0 of Alternative 2, which has the lowest cost per unit effective storage capacity, is selected as the optimum dam development plan (refer to Fig. IX.3.3).

3.4 Selection of Dam Type

Alternative Plan

Judging from the topographic and geological conditions at the Jatibarang dam site, concrete gravity and rockfill types are applicable. The basic conditions for the alternatives are given below.

Item	Concrete Gravity Type	Rockfill Type
Height	81.0 m	81.0 m
Crest Length	240.0 m	240.0 m
Dam Body		
- Upstream Slope	1:1.0	1:2.8
- Downstream Slope	1:0.8	1:2.3
Design Discharge (PMF)	1,800 m^3/s	1,800 m^3/s
Design Discharge for Diversion Tunnel	200 m^3/s (1-yr return period)	500 m^3/s (20-yr return period)

Construction Material

(1) Concrete Gravity Type

Quarry site for concrete aggregates do not exist near the dam site, because riverbed and flood plain deposits are composed mainly of soft rocks and flat gravel, which are not widely distributed in Kreo River. The intrusive rocks of andesite at Mt. Mergi should be utilized as construction material and these have to be transported from the foot of Mt. Mergi located about 16 km from the dam site.

(2) Rockfill Type

Soil material taken from the weathered portions of rock and topsoil distributed near the site are mostly usable as core material. It is difficult to find sufficient volume of appropriate rock materials such as andesite lava, therefore, these have to be transported from the foot of Mt. Mergi.

Proposed Dam Type

The general drawing and the construction base cost for the comparative study on dam type are presented in Fig. IX.3.4 and Table IX.3.2.

The rockfill type takes a higher construction base cost compared with the concrete gravity type, as estimated below:

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

The reasons why the rockfill type has a higher construction base cost are as follows:

(1) Due to the larger volume for the rockfill type, sufficient rock materials could not be obtained in the vicinity of the dam site.

(2) The rockfill type is less advantageous in such that a spillway has to be built separately from the dam body.

(3) The flow capacity of the diversion tunnel of the rockfill type must be larger than the one of the concrete gravity type to deal with the predicted flooding during the construction

period, because the resistance of the rockfill type to overflow is lower than the concrete gravity type.

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

3.5 Reservoir Capacity Allocation

Reservoir storage capacity is allocated to sediment capacity, water supply capacity and flood control capacity (refer to Fig. IX.3.5).

Sediment Capacity

Specific sediment inflow in the catchment area of Jatibarang Dam is estimated at 1,062 m^3/km^2/year (refer to SECTOR VIII, SEDIMENT CONTROL PLAN). Specific sediment inflow is converted to specific sediment yield considering trap efficiency of 96% and porosity of 60%. Sediment capacity is derived from the specific sediment yield for 50 years of project life multiplied by the catchment area of 53 km^2, as follows:

Specific Sediment Yield

$$= \frac{\text{Specific Sediment Inflow x Trap Efficiency}}{(1 - \text{Porosity})}$$

$$= \frac{1{,}062 \times 0.96}{(1 - 0.6)}$$

$$= 2{,}550$$

$$Vs = \text{Specific Sediment Yield x 50 years x catchment area}$$

$$= 2{,}550 \times 50 \times 53$$

$$= 6{,}800{,}000 \ m^3$$

Low Water Level = EL. 136.6 m

Water Supply Capacity

The required reservoir capacity at the dam site is estimated at 16,700,000 m^3, applying the intake rate of 2.54 m^3/s (refer to SECTOR VII, WATER RESOURCES DEVELOPMENT PLAN).

Intake Rate	:	$Q = 2.54\ m^3/s$
Water Supply Capacity	:	$Vm = 16,700,000\ m^3$
Normal Water Level	:	EL. 155.3 m

Flood Control Capacity

Flood control capacity is determined by flood regulation method in compliance with the flood control plan (refer to SECTOR V, FLOOD CONTROL PLAN).

Max. Inflow Discharge	:	280 m^3/s (100-yr standard flood)
Max. Outflow Discharge	:	100 m^3/s
Flood Control Capacity (incl. 20% allowance)	:	4,300,000 m^3
Surcharge Water Level	:	EL. 158.8 m

3.6 Preliminary Design

Dam

The drawings of Jatibarang Dam are shown in Fig. IX.3.6 to Fig. IX.3.9.

Dam Height

Freeboard 2.0 m in height provided above the design flood water level (refer to the following Subsection) includes the following:

Clearance	:	1.5 m
Height of Girder	:	0.5 m
Total	:	2.0 m

Consequently, the crest level is determined at EL. 164.0 m and the dam height comes to 81.0 m, assuming that the dam foundation level is EL. 83.0 m.

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:

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

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

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

As a result, the slope is determined as 1:1.0 for the upstream face and 1:0.8 for the downstream face. The results of stability analysis and applied design conditions are shown in Table IX.3.3.

Foundation Treatment

Consolidation grouting is made for the purpose of suppressing any seepage in the foundation near the contact plane of the dam, and for the improvement of any deformability.

As to the permeability, most of the dam foundation rock show impervious characteristics except the weathered rock above the water table, especially at the left side narrow ridge. Consequently, curtain grouting is to be made to improve the permeability, as shown in Fig. IX.3.10.

Flood Control Outlet and Spillways

(1) Type

A non-gated type for the flood control outlet and the spillways will be adopted under the following considerations:

(a) A non-gated type has no probability of flooding caused by human error, while a gated type generally has possibility to bring mis-operation under the circumstances that arrival time of flood run-off at the dam site is quite short due to the small catchment area and its topographic condition.

(b) By applying a non-gated type, easier and more economical maintenance works can be expected.

(2) Flood Control Outlet

The flood control outlet will regulate floods of less than 100-year return period (refer to SECTOR V, FLOOD CONTROL PLAN). This outlet will be installed in the dam body, and the crest level will be set at the normal water level EL. 155.3 m. The principal features of the outlet are as follows:

Type	:	Non-gated Frontal Overflow
Crest Level	:	Normal Water Level, EL. 155.3 m
Crest Length	:	10.0 m

(3) Spillway

The spillway and the flood control outlet in combined operation will pass the probable maximum flood (PMF). The peak discharge of PMF is 1,800 m^3/s at the Jatibarang dam site (refer to SECTOR I, METEOROLOGY AND HYDROLOGY).

The spillways are designed as follows:

(a) From the structural and economical points of view, two kinds of spillways are provided, namely, a service spillway and an auxiliary spillway. The service spillway will be equipped in the dam body, and the auxiliary spillway will be constructed at the saddle portion on the right bank of the reservoir immediately upstream of the dam site (refer to Fig. IX.3.6).

(b) During flood with a return period of less than 10,000-year return period, all flow is discharged through the service spillway and the flood control outlet in the dam body. All flow will be rapidly dissipated by an energy dissipator.

(c) When an extreme flood larger than 10,000-year return period occurs, the auxiliary spillway will pass the flood to protect Jatibarang Dam from being overtopped. Extensive erosion downstream could be expected, but it will not endanger any major structure.

The crest lengths of the spillways are determined from topographic and structural conditions. The principal features are as follows:

(a) Service Spillway (refer to Fig. IX.3.9)

Type	:	Non-gated Frontal Overflow
Crest Level	:	Surcharge Water Level, EL. 158.8 m
Crest Length	:	60.0 m

(b) Auxiliary Spillway (refer to Figs. IX.3.6 and IX.3.11)

Type	:	Non-gated Frontal Overflow
Crest Level	:	EL. 160.2 m

Crest Length	:	150.0 m

(4) Design Flood Water Level

The total peak discharge from the spillway operations is limited to 1,600 m^3/s against a PMF peak inflow of 1,800 m^3/s. At that time, the design flood water level will become EL. 162.0 m (refer to Fig. IX.3.12).

Diversion Works

Temporary diversion works during dam construction is planned applying a diversion tunnel underneath the left abutment of the dam body. The design discharge of the tunnel is 200 m^3/s, which corresponds to a flood of 1.01-year return period. The principal features are as follows (refer to Fig. IX.3.6):

Design Discharge	:	200 m^3/s
Type	:	Horseshoe-shaped Section
Inner Diameter	:	5.6 m
Length	:	350.0 m

Intake Facilities

Intake facilities are designed in such that the intake volume of 2.54 m^3/s is possible at the low water level of the reservoir. Intake tower will be located at the upstream face of the dam, and the intake water that will flow through the penstock will be used for the hydropower generation.

Land Acquisition and House Evacuation

About 128.2 hectares of land consisting of 24.8 hectares of paddy fields and 103.4 hectares of upland cultivation are to be acquired. No houses are to be evacuated in the reservoir area, but some electric transmission towers presently existing in the reservoir area are required to be relocated.

TABLES

Table IX.2.1 PRINCIPAL FEATURES OF PROPOSED DAM

Description	Babon Dam	Jatibarang Dam	Mundingan Dam	Kedung Suren dam
Purpose	Water Supply	Water Supply Flood Control	Water Supply	Water Supply Flood Control
Dam				
- Type of Dam	Rockfill with Center Core	Concrete Gravity	Concrete Gravity	Rockfill with Center Core
- Catchment Area	51.9 km2	53.0 km2	45.7 km2	146.5 km2
- Height	45.0 m	77.0 m	50.0 m	46.0 m
- Crest Length	1,550.0 m	180.0 m	480.0 m	1,000.0 m
- Crest Elevation	EL.75.0 m	EL.162.0 m	EL.230.0 m	EL.76.0 m
- Dam Foundation	EL.30.0 m	EL.85.0 m	EL.180.0 m	EL.30.0 m
- Dam Body Volume	5,890,000 m3	170,000 m3	188,000 m3	4,120,000 m3
Reservoir				
- Design Flood Water Level (DFWL)	EL.72.0 m	EL.160.0 m	EL.228.0 m	EL.73.0 m
- Surcharge Water Level (SWL)	-	EL.157.0 m	- 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
- Gross Storage Capacity	45,900,000 m3	23,700,000 m3	35,000,000 m3	82,800,000 m3
Flood Control Capacity	0 m3	4,300,000 m3	0 m3	10,700,000 m3
Water Supply Capacity	35,700,000 m3	12,600,000 m3	27,600,000 m3	52,400,000 m3
Sediment Capacity	10,200,000 m3	6,800,000 m3	7,400,000 m3	19,700,000 m3
Spillway				
- Type	Overflow	Overflow	Overflow	Overflow
- Dam Design Discharge	800 m3/s	690 m3/s	600 m3/s	1250 m3/s
- Flood Regulation	-	100-yr Return Period	-	20-yr Return Period
Maximum Inflow Discharge	-	340 m3/s	-	582 m3/s
Maximum Outflow Discharge	-	100 m3/s	-	95 m3/s
Compensation				
- Land Acquisition	485 ha	136 ha	315 ha	1,160 ha
- House Evacuation	1,330 houses	0 houses	470 houses	1,470 houses

Project Cost (Million Rp.)	Babon Flood Control	Babon Water Supply	Babon Total	Jatibarang Flood Control	Jatibarang Water Supply	Jatibarang Total	Mundingan Flood Control	Mundingan Water Supply	Mundingan Total	Kedung Suren Flood Control	Kedung Suren Water Supply	Kedung Suren Total
1. Construction Base Cost	0	185,090	185,090	14,025	24,000	38,025	0	54,240	54,240	47,921	97,380	145,301
2. Compensation Cost	0	35,249	35,249	2,228	3,812	6,040	0	29,996	29,996	18,136	36,854	54,990
3. Administration Cost	0	15,424	15,424	1,138	1,947	3,085	0	5,897	5,897	4,624	9,396	14,020
4. Engineering Cost	0	30,540	30,540	3,997	6,840	10,837	0	15,458	15,458	8,199	16,660	24,859
5. Physical Contingency	0	25,088	25,088	2,025	3,465	5,490	0	9,969	9,969	7,426	15,089	22,515
Total	0	291,391	291,391	23,413	40,064	63,477	0	115,560	115,560	86,306	175,379	261,685

Table IX.3.1 PRINCIPAL FEATURES FOR COMPARATIVE STUDY ON JATIBARANG DAM CREST LEVEL

Description	Alt.1 Dam Crest EL.160.5m	Alt.2 Dam Crest EL.164.0m	Alt.3 Dam Crest EL.167.0m	Alt.4 Dam Crest EL.170.0m
I. Dam				
- Dam Type	Concrete Gravity	Concrete Gravity	Combined Type	Combined Type
- Height	77.5 m	81.0 m	84.0 m	87.0 m
- Crest Length				
Concrete Portion	230.0 m	240.0 m	255.0 m	270.0 m
Fill Portion	-	-	270.0 m	330.0 m
- Crest Elevation	EL.160.5 m	EL.164.0 m	EL.167.0 m	EL.170.0 m
- Dam Foundation	EL. 83.0 m	EL. 83.0 m	EL. 83.0 m	EL. 83.0 m
- Dam Volume				
Concrete Portion	180,000 m3	219,000 m3	263,000 m3	311,000 m3
Fill Portion	-	-	27,000 m3	53,000 m3
II. Reservoir				
- Design Flood Water Level	EL.158.5 m	EL.162.0 m	EL.165.0 m	EL.168.0 m
- Surcharge Water Level	EL.155.5 m	EL.158.8 m	EL.161.9 m	EL.164.9 m
- Normal Water Level	EL.151.5 m	EL.155.3 m	EL.158.7 m	EL.161.8 m
- Low Water Level	EL.136.6 m	EL.136.6 m	EL.136.6 m	EL.136.6 m
- Gross Storage Capacity	23,700,000 m3	27,800,000 m3	32,000,000 m3	36,200,000 m3
Flood Control Capacity	4,300,000 m3	4,300,000 m3	4,300,000 m3	4,300,000 m3
Water Supply Capacity	12,600,000 m3	16,700,000 m3	20,900,000 m3	25,100,000 m3
Sediment Capacity	6,800,000 m3	6,800,000 m3	6,800,000 m3	6,800,000 m3
III. Compensation				
- Land Acquisition	117.8 ha	128.2 ha	137.2 ha	146.1 ha
- House Evacuation	0.0 houses	0.0 houses	0.0 houses	0.0 houses
IV. Cost				
- Construction Base Cost	42,878 Million Rp.	49,936 Million Rp.	63,784 Million Rp.	78,559 Million Rp.
- Compensation Cost	5,214 Million Rp.	5,582 Million Rp.	5,901 Million Rp.	6,217 Million Rp.
Cost divided by Effective Storage Capacity	2,846 Rp./m3	2,644 Rp./m3	2,765 Rp./m3	2,884 Rp./m3

Table IX.3.2 PRINCIPAL FEATURES FOR COMPARATIVE STUDY ON TYPE OF JATIBARANG DAM

Item	Alt.1 Concrete Gravity Type	Alt.2 Rock Fill Type
Principal Features		
- Height	81.0 m	81.0 m
- Crest Length	240.0 m	240.0 m
- Crest Elevation	EL.164.0 m	EL.164.0 m
- Dam Foundation	EL.83.0 m	EL.83.0 m
- Excavation Volume for Dam Body	115,000 m3	244,000 m3
- Concrete Volume		
Dam Concrete	206,000 m3	-
Spillway Concrete	13,000 m3	33,000 m3
- Embankment Volume		
Core	-	139,000 m3
Filter	-	50,000 m3
Rock	-	747,000 m3
- Diversion Tunnel		
Diameter (2r Horseshue Type)	5.6 m	7.8 m
Length	350.0 m	510.0 m

Construction Base Cost	Unit	Alt.1 Q'ty	Alt.1 (Mill.Rp.)	Alt.2 Q'ty	Alt.2 (Mill.Rp.)
1. Preparatory Works	L.S.	1	4,540	1	5,463
2. Main dam					
- Stripping & Excavation	m3	115,000	1,496	244,000	1,732
- Dam Concrete	m3	206,000	24,720	-	-
- Dam Embankment					
Core	m3	-	-	139,000	3,058
Filter	m3	-	-	50,000	700
Rock	m3	-	-	747,000	19,422
- Spillway Concrete (Reinforced)	m3	13,000	3,640	33,000	9,240
- Foundation Treatment (Grouting)	m	15,000	3,150	14,200	2,982
- Intake Facility	L.S.	1	1,190	1	1,730
- Maintenance Bridge	m2	350	182	150	78
3. Left Side Ridge Treatment	L.S.	1	1,345	1	1,345
4. Auxiliary Spillway	L.S.	1	1,151	1	1,151
5. Diversion Tunnel	m	350	2,800	510	6,630
6. Relocation Road	L.S.	1	875	1	875
7. Relocation of Electrical Tower	L.S.	1	720	1	720
8. Miscellaneous Works	L.S.	1	4,127	1	4,966
Total			49,936		60,092

Table IX.3.3 (1/3) STABILITY ANALYSIS FOR JATIBARANG DAM (NORMAL WATER LEVEL)

1. Conditions

Dam Height	H	81.0 m
Fillet Height	Hf	41.0 m
Slope of Downstream Face	n	0.8
Slope of Upstream Face	m	1.0
Length of Bottom Plane	L	105.8 m
Depth of Reservoir	hu	72.3 m
Depth of Mud	hm	53.6 m
Water Depth of Downstream	hd	2.0 m
Unit weight of Concrete	Wc	2.30 t/m3
Unit Weight of Mud	Wm	1.00 t/m3
Seismic Intensity	k	0.12
Mud Pressure Coefficient	Ce	0.40
Uplifting Pressure Coefficient	Up	0.20
Location of Drain		(29.0)m
Crest Width		(5.0)m
Total Height of Waves	hw+he	1.160 m
Waves Generated by Wind	hw	0.677 m
Waves Induced by seismic Tremor	he	0.483 m
Rock Foundation		
Shear Strength	TO	90.0 t/m2
Internal-Friction	f	0.9

2. Calculation Results

1) External Loads & Moment

Load	Vertical Load V (t)	Horizontal Load H (t)	Moment M (t-m)
Hydrostatic Pressure	0.0	2,698.2	66,069.6
Water Weight	2,171.4	0.0	(50,256.3)
Hydrodynamic Pressure	0.0	365.2	10,535.8
Dam's Self Weight	8,007.2	0.0	104,079.9
Inertia Force	0.0	960.9	23,078.0
Horizontal Mud Pressure	0.0	574.6	10,266.0
Vertical Mud Pressure	1,357.1	0.0	(33,564.0)
Uplifting Pressure	(1,377.2)	0.0	14,377.8
Total	10,158.5	4,598.8	144,586.9

2) Condition for Safety against Shear

Safety Factor n = (TO·L + f·V)/H = 4.06 > 4 ----- O.K.

3) Condition for Making Upstream Face of Dam Free From Tensile Stresses

Stress at Upstream Toe 83.3 t/m2 > 0 ----- O.K.
Stress at Downstream Toe 108.7 t/m2 > 0 ----- O.K.

Table IX.3.3 (2/3) STABILITY ANALYSIS FOR JATIBARANG DAM (SURCHARGE WATER LEVEL)

1. Conditions

Dam Height	H	81.0 m
Fillet Height	Hf	41.0 m
Slope of Downstream Face	n	0.8
Slope of Upstream Face	m	1.0
Length of Bottom Plane	L	105.8 m
Depth of Reservoir	hu	75.8 m
Depth of Mud	hm	53.6 m
Water Depth of Downstream	hd	2.0 m
Unit weight of Concrete	Wc	2.30 t/m3
Unit Weight of Mud	Wm	1.00 t/m3
Seismic Intensity	k	0.06
Mud Pressure Coefficient	Ce	0.40
Uplifting Pressure Coefficient	Up	0.20
Location of Drain		(29.0)m
Crest Width		(5.0)m
Total Height of Waves	hw+he	0.919 m
Waves Generated by Wind	hw	0.677 m
Waves Induced by seismic Tremor	he	0.242 m
Rock Foundation		
Shear Strength	T0	90.0 t/m2
Internal-Friction	f	0.9

2. Calculation Results

1) External Loads & Moment

Load	Vertical Load V (t)	Horizontal Load H (t)	Moment M (t-m)
Hydrostatic Pressure	0.0	2,942.9	75,258.8
Water Weight	2,305.0	0.0	(52,995.5)
Hydrodynamic Pressure	0.0	201.0	6,094.1
Dam's Self Weight	8,007.2	0.0	104,079.9
Inertia Force	0.0	480.4	11,539.0
Horizontal Mud Pressure	0.0	574.6	10,266.0
Vertical Mud Pressure	1,357.1	0.0	(33,564.0)
Uplifting Pressure	(1,435.2)	0.0	15,219.0
Total	10,234.1	4,199.0	135,897.5

2) Condition for Safety against Shear

Safety Factor n = (T0·L + f·V)/H = 4.46 > 4 ----- O.K.

3) Condition for Making Upstream Face of Dam Free From Tensile Stresses

Stress at Upstream Toe 89.2 t/m2 > 0 ----- O.K.
Stress at Downstream Toe 104.3 t/m2 > 0 ----- O.K.

Table IX.3.3 (3/3) STABILITY ANALYSIS FOR JATIBARANG DAM (DESIGN FLOOD WATER LEVEL)

1. Conditions

Dam Height	H	81.0 m
Fillet Height	Hf	41.0 m
Slope of Downstream Face	n	0.8
Slope of Upstream Face	m	1.0
Length of Bottom Plane	L	105.8 m
Depth of Reservoir	hu	79.0 m
Depth of Mud	hm	53.6 m
Water Depth of Downstream	hd	2.0 m
Unit weight of Concrete	Wc	2.30 t/m3
Unit Weight of Mud	Wm	1.00 t/m3
Seismic Intensity	k	0.00
Mud Pressure Coefficient	Ce	0.40
Uplifting Pressure Coefficient	Up	0.20
Location of Drain		(29.0)m
Crest Width		(5.0)m
Total Height of Waves	hw+he	0.677 m
Waves Generated by Wind	hw	0.677 m
Waves Induced by seismic Tremor	he	0.000 m
Rock Foundation		
Shear Strength	TO	90.0 t/m2
Internal-Friction	f	0.9

2. Calculation Results

1) External Loads & Moment

Load	Vertical Load V (t)	Horizontal Load H (t)	Moment M (t-m)
Hydrostatic Pressure	0.0	3,174.2	84,303.9
Water Weight	2,426.3	0.0	(55,481.7)
Hydrodynamic Pressure	0.0	0.0	0.0
Dam's Self Weight	8,007.2	0.0	104,079.9
Inertia Force	0.0	0.0	0.0
Horizontal Mud Pressure	0.0	574.6	10,266.0
Vertical Mud Pressure	1,357.1	0.0	(33,564.0)
Uplifting Pressure	(1,488.3)	0.0	15,988.0
Total	10,302.3	3,748.8	125,592.3

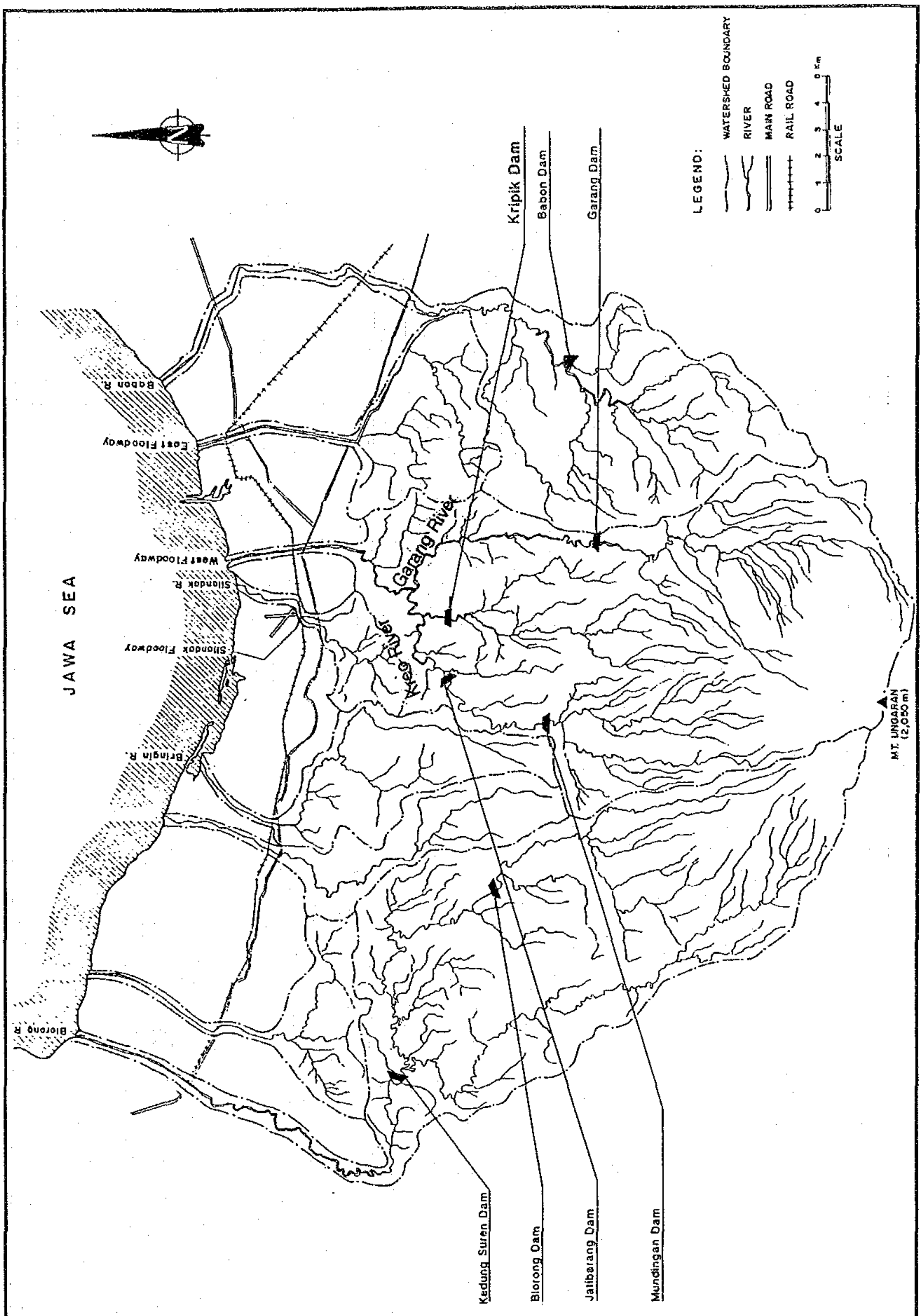
2) Condition for Safety against Shear

Safety Factor n = (TO·L + f·V)/H = 5.01 > 4 ----- O.K.

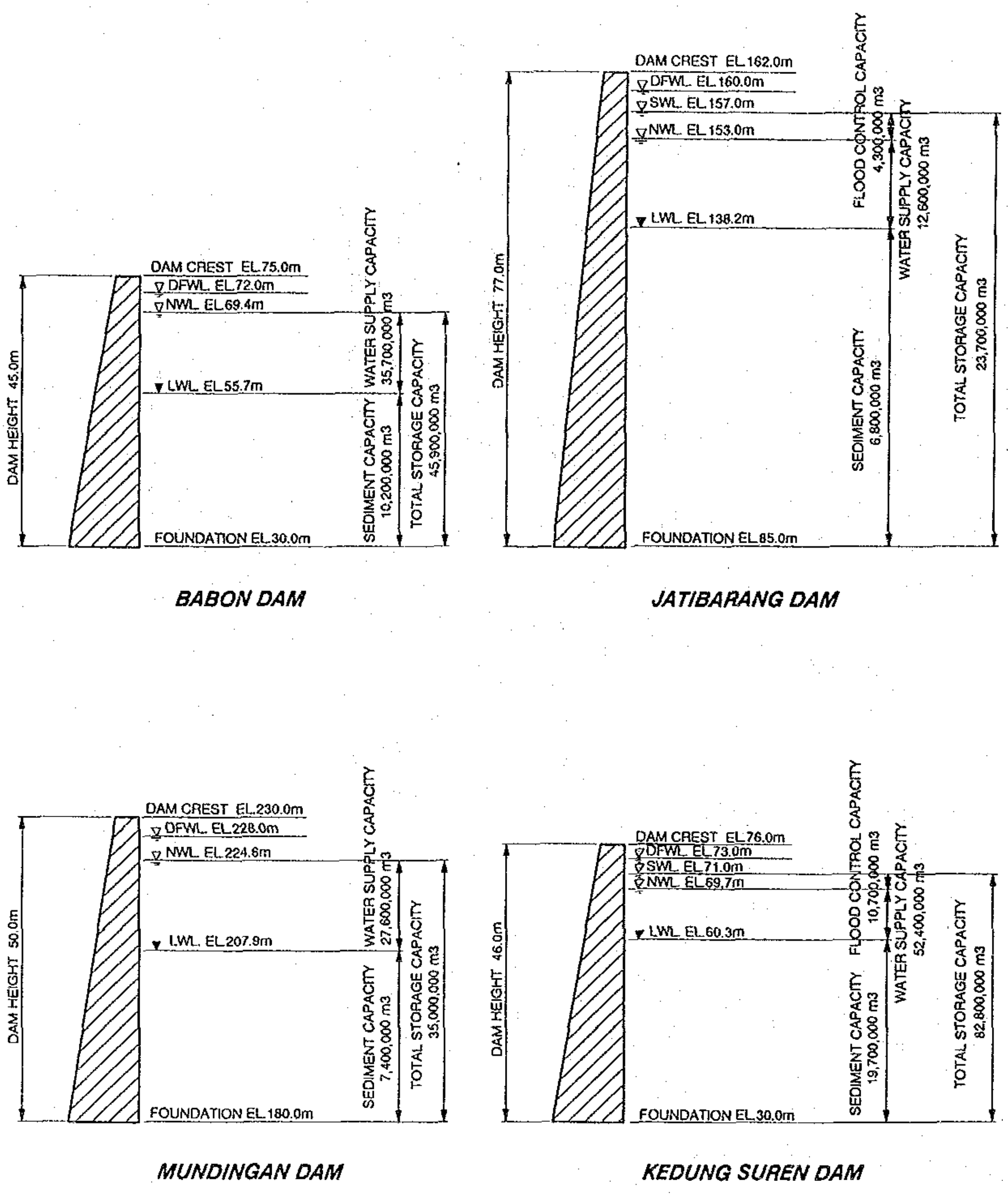
3) Condition for Making Upstream Face of Dam Free From Tensile Stresses

Stress at Upstream Toe 95.8 t/m2 > 0 ----- O.K.
Stress at Downstream Toe 99.0 t/m2 > 0 ----- O.K.

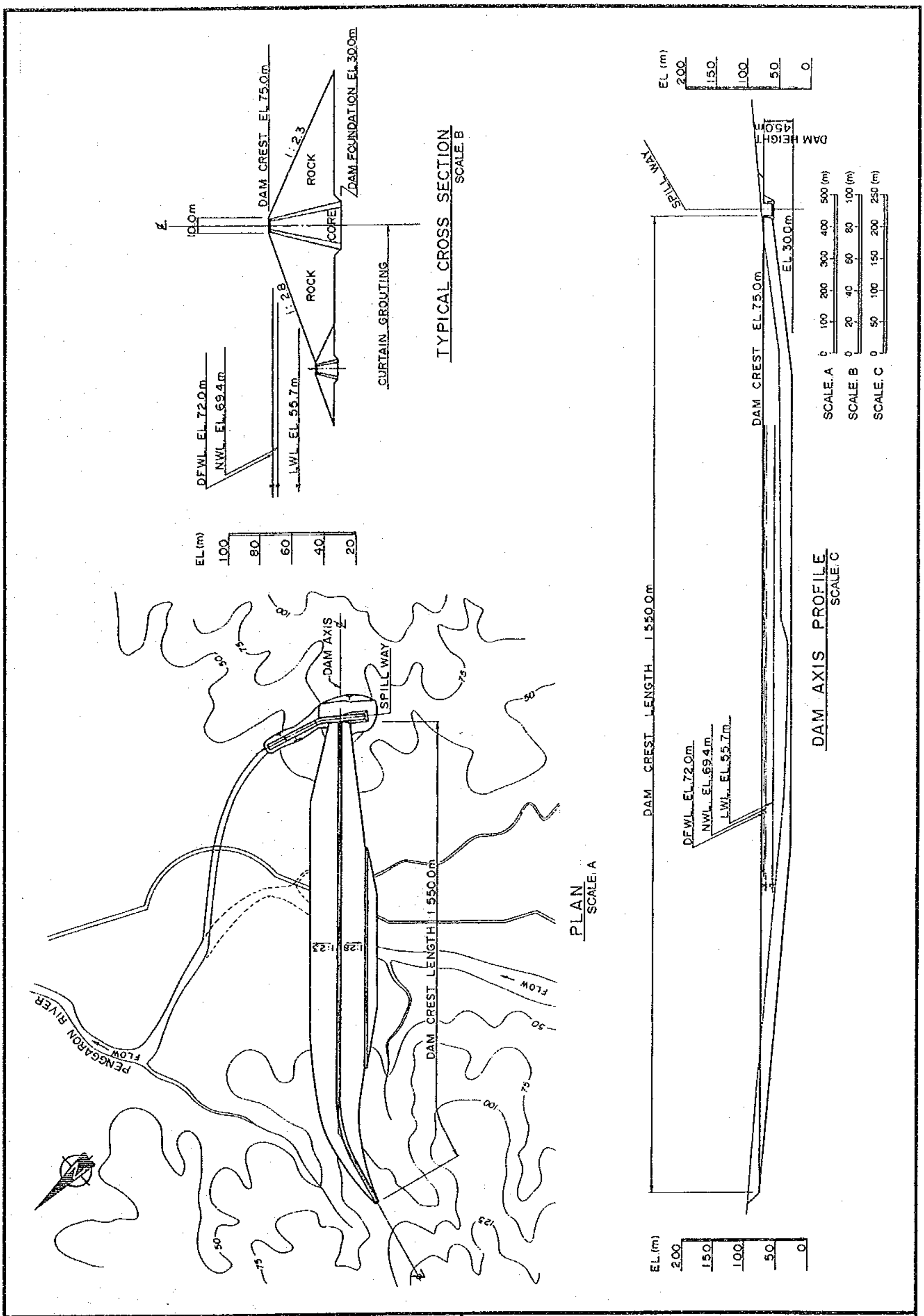
FIGURES



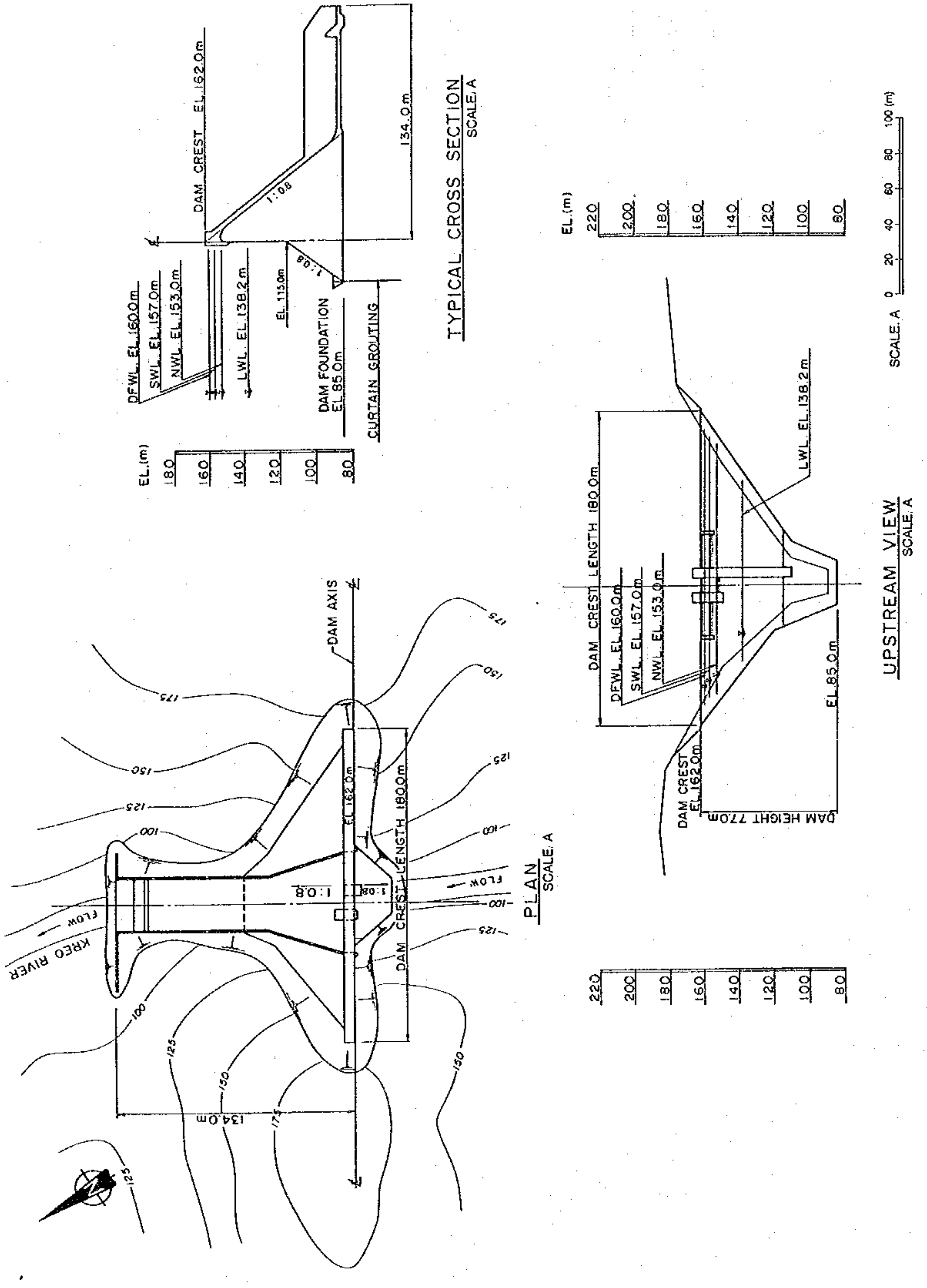
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.2.1 LOCATION MAP OF PROPOSED DAM SITES
JAPAN INTERNATIONAL COOPERATION AGENCY	



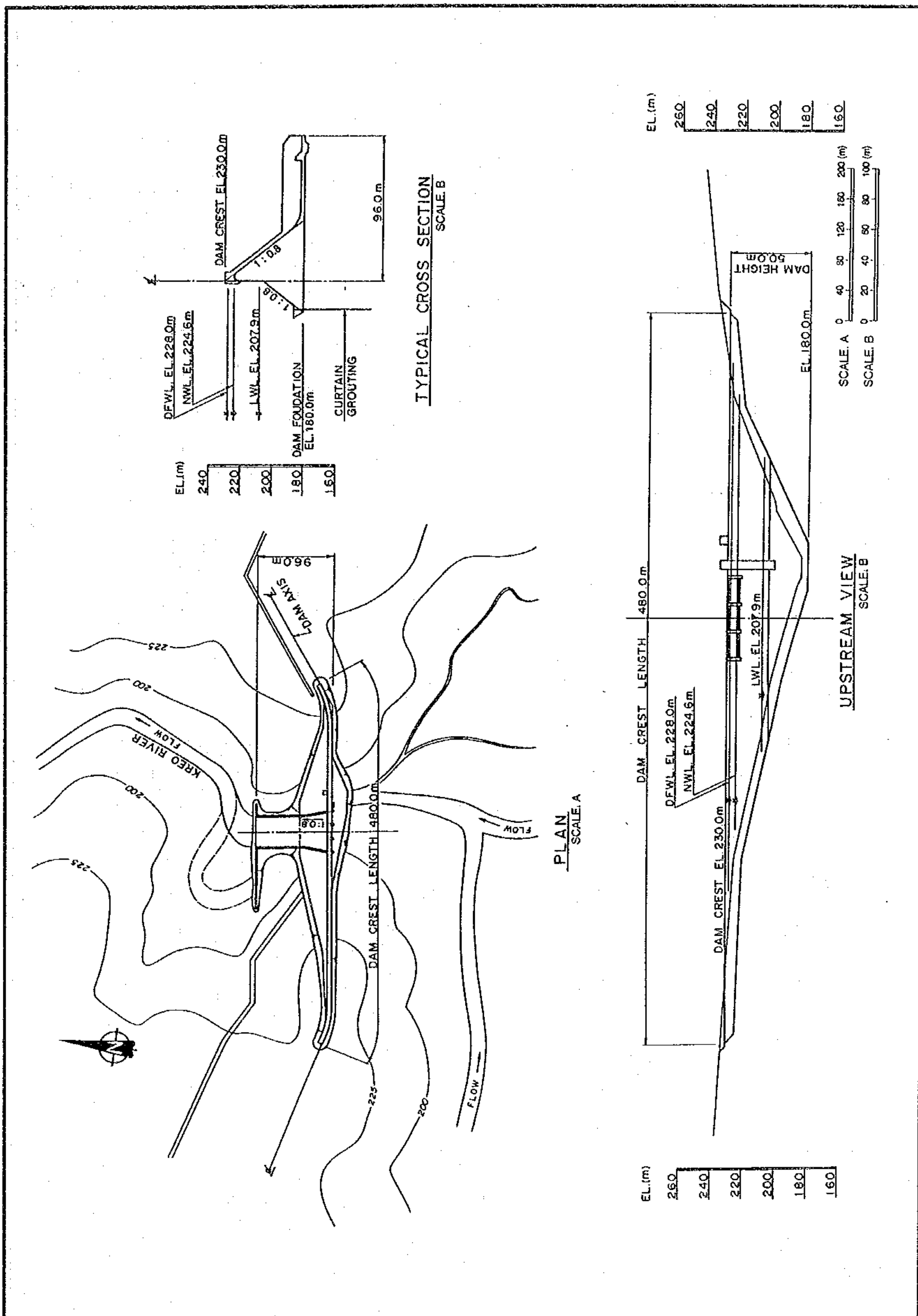
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.2.2 RESERVOIR CAPACITY ALLOCATION OF PROPOSED DAM
JAPAN INTERNATIONAL COOPERATION AGENCY	



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.2.3 (1/4)
JAPAN INTERNATIONAL COOPERATION AGENCY	GENERAL DRAWING OF BABON DAM



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.2.3 (2/4) GENERAL DRAWING OF JATIBARANG DAM
JAPAN INTERNATIONAL COOPERATION AGENCY	

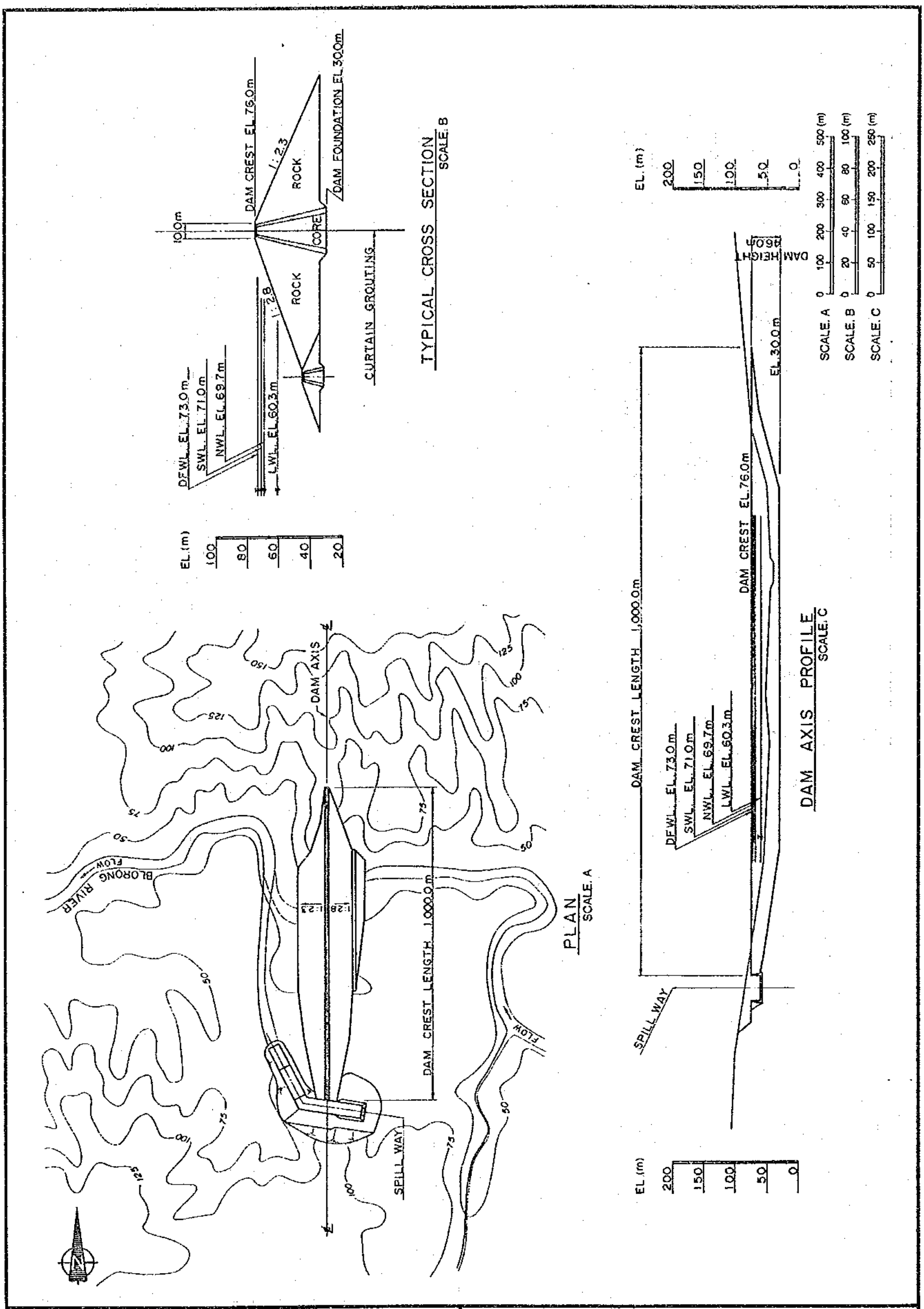


MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

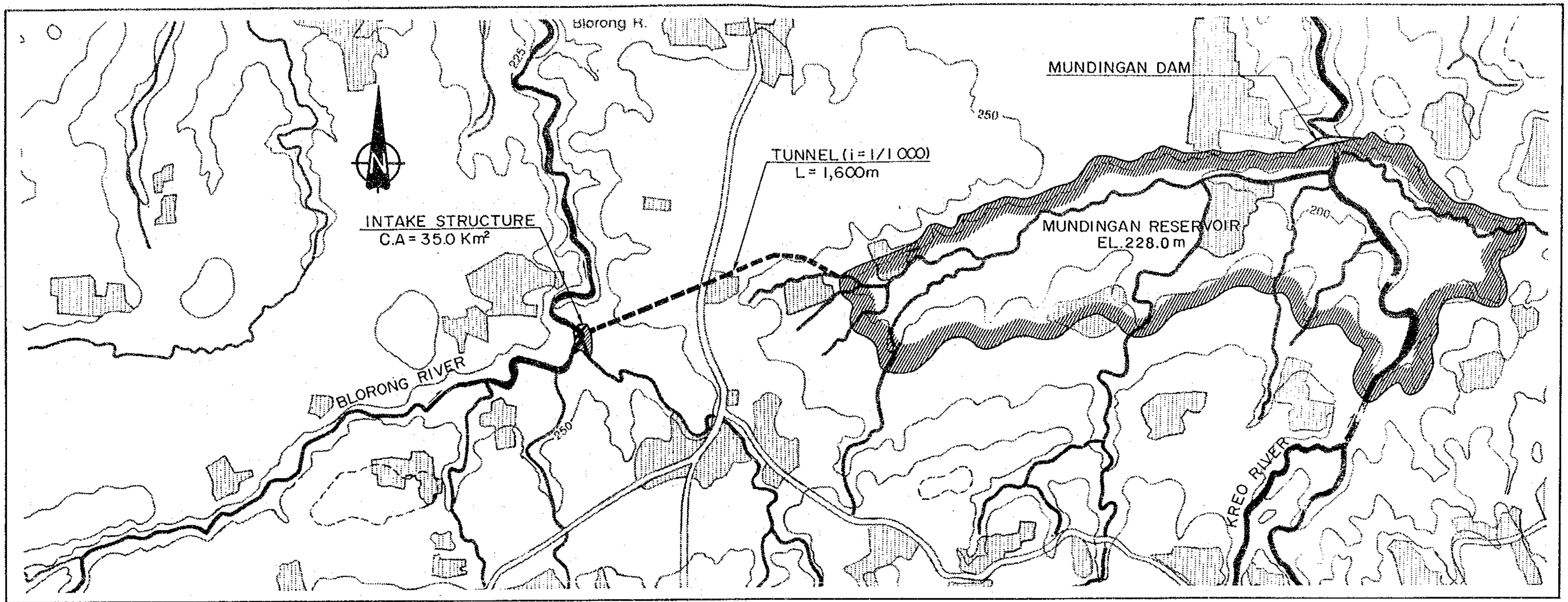
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig.IX.2.3 (3/4)

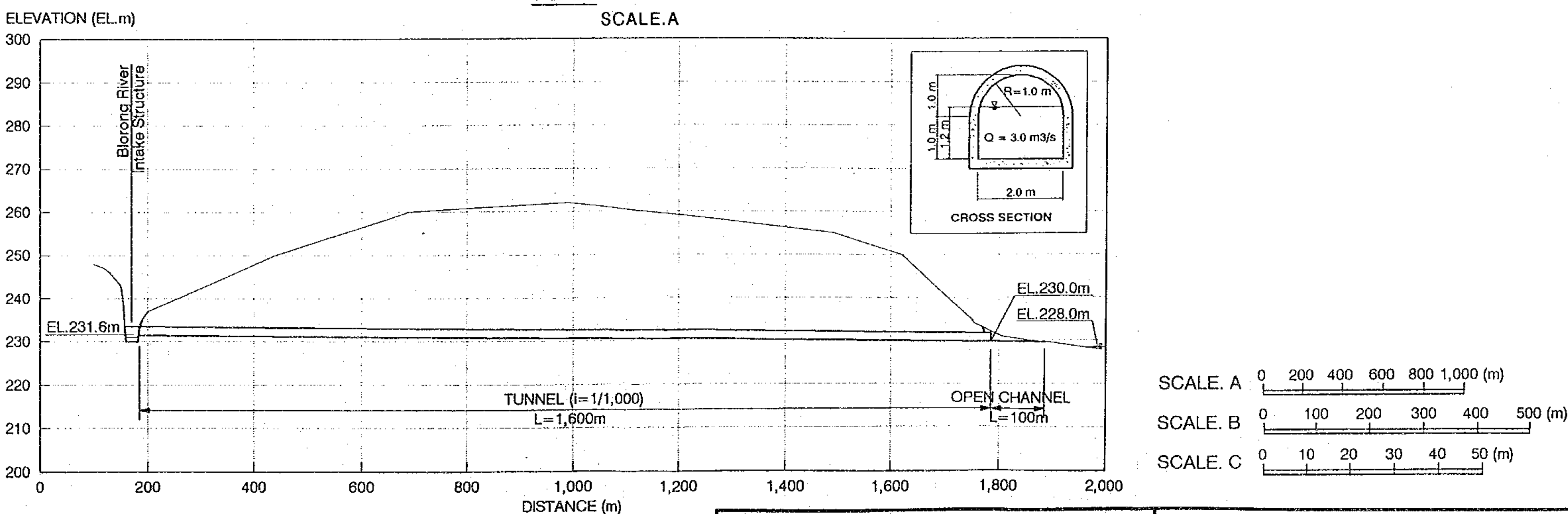
GENERAL DRAWING OF MUNDINGAN DAM



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.2.3 (4/4)
JAPAN INTERNATIONAL COOPERATION AGENCY	GENERAL DRAWING OF KEDUNG SUREN DAM



PLAN
SCALE.A

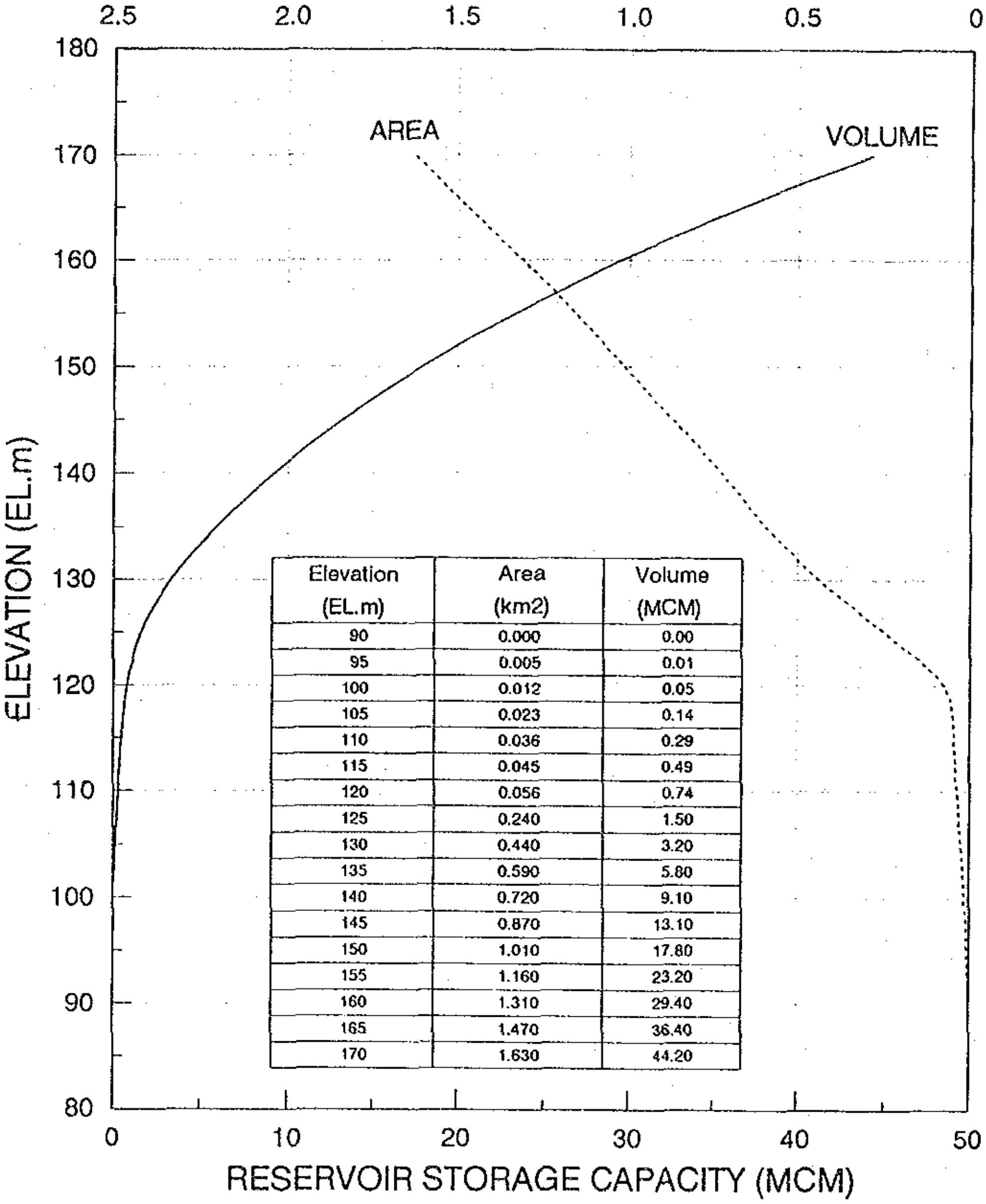


LONGITUDINAL PROFILE
H : SCALE B, V : SCALE C

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

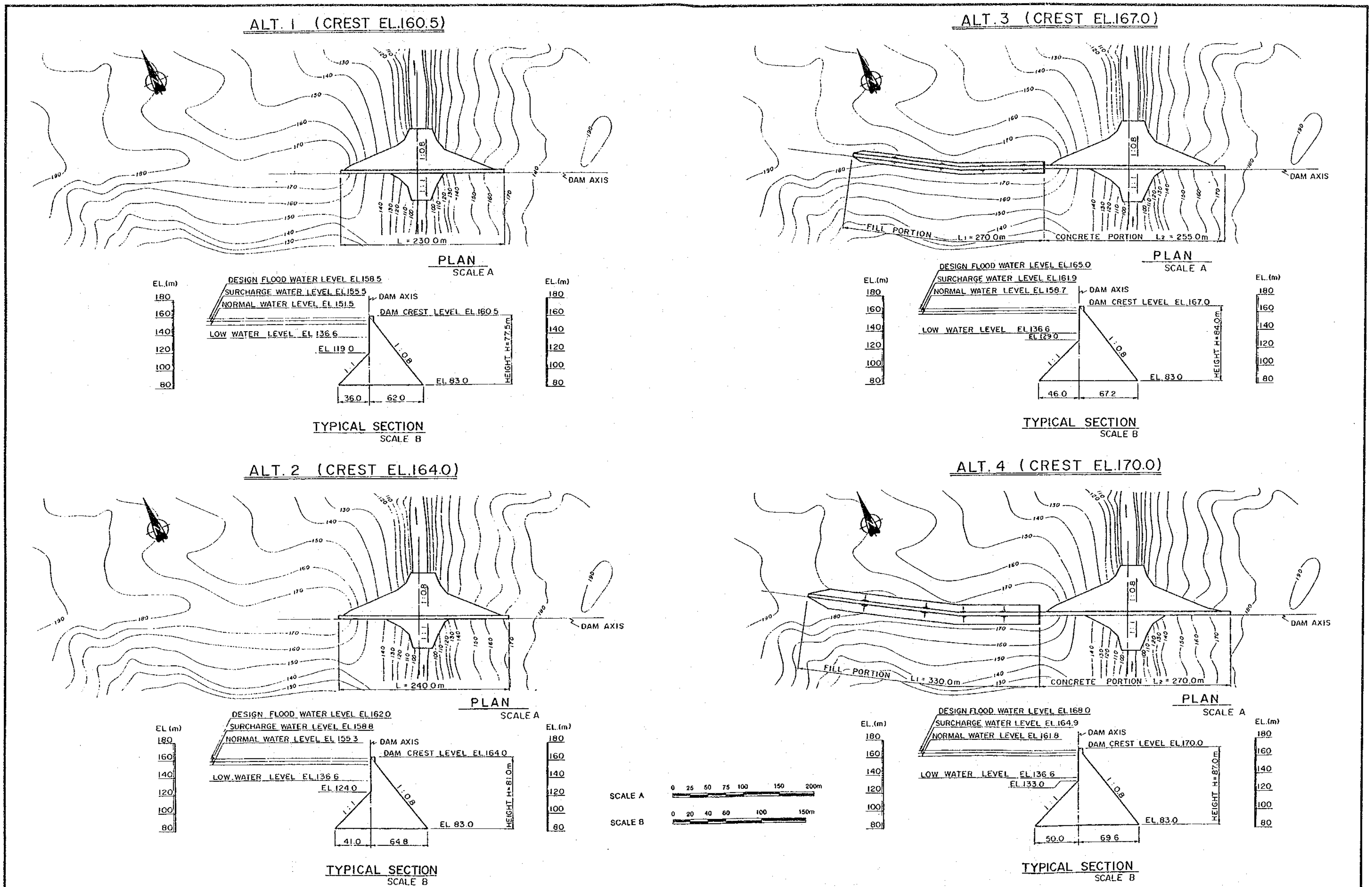
Fig.IX.2.4
GENERAL DRAWING OF INTERBASIN TRANSFER

JATIBARANG DAM

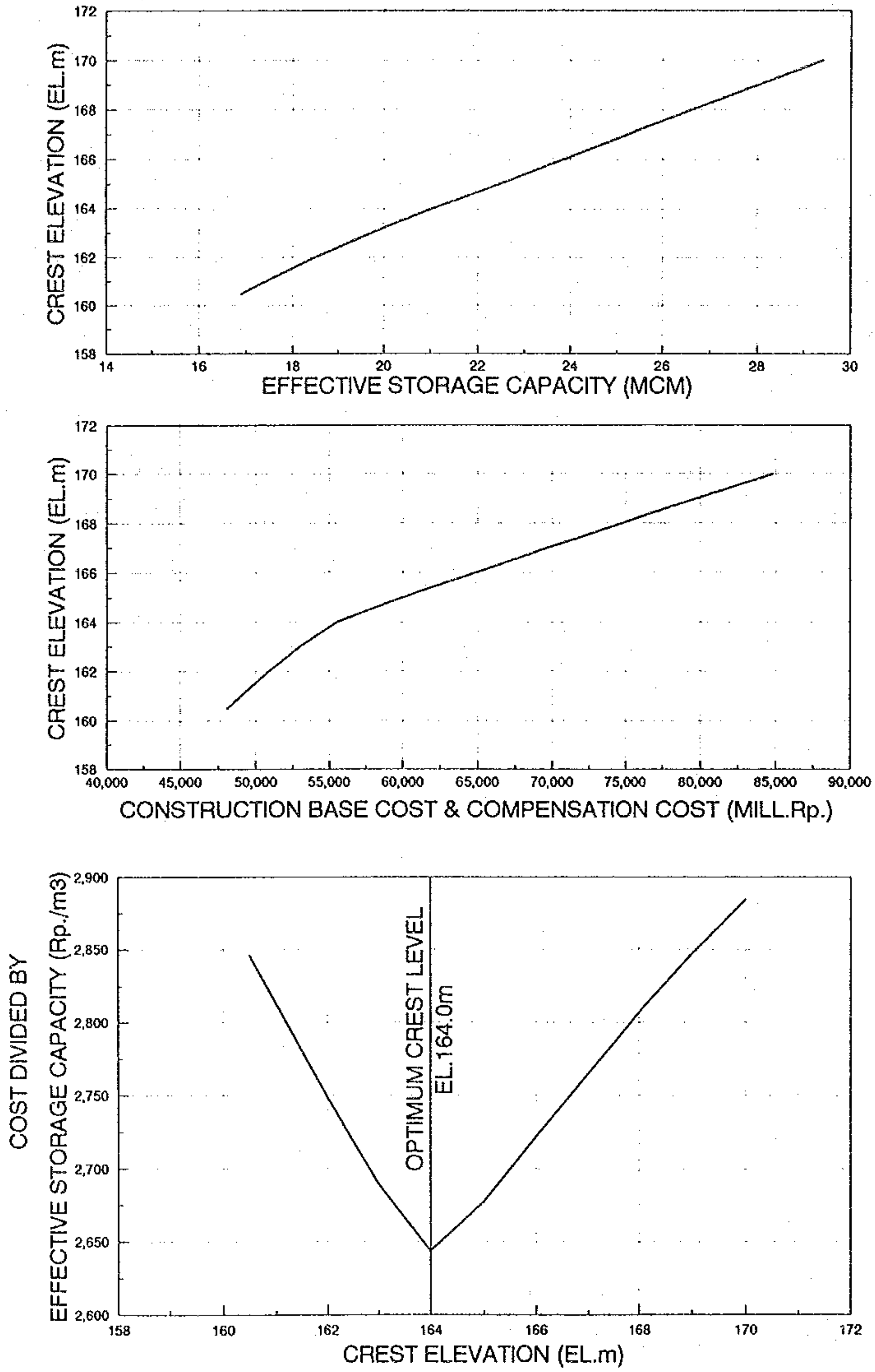


Elevation (EL.m)	Area (km2)	Volume (MCM)
90	0.000	0.00
95	0.005	0.01
100	0.012	0.05
105	0.023	0.14
110	0.036	0.29
115	0.045	0.49
120	0.056	0.74
125	0.240	1.50
130	0.440	3.20
135	0.590	5.80
140	0.720	9.10
145	0.870	13.10
150	1.010	17.80
155	1.160	23.20
160	1.310	29.40
165	1.470	36.40
170	1.630	44.20

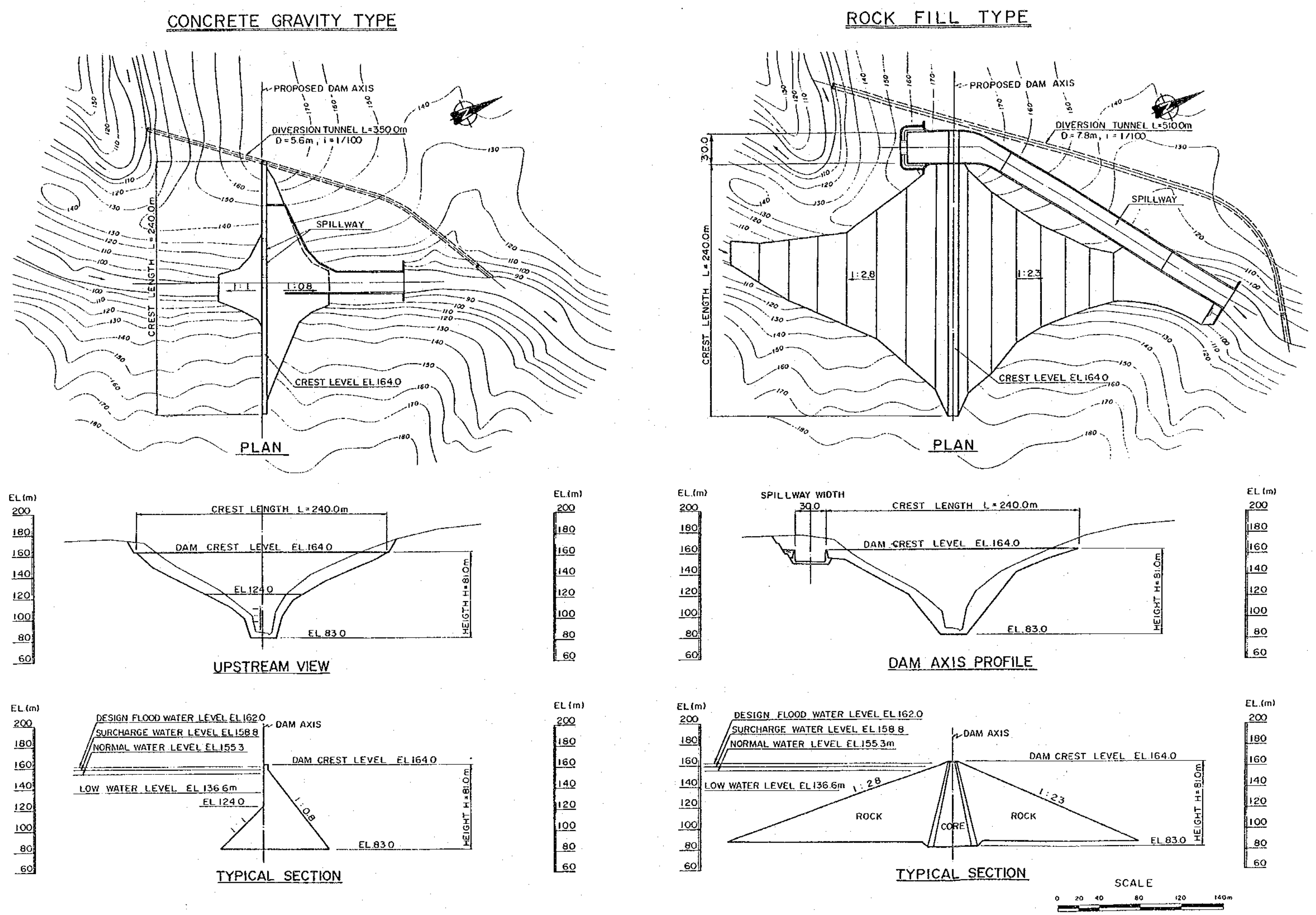
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.3.1 RESERVOIR STORAGE CURVE OF JATIBARANG DAM
JAPAN INTERNATIONAL COOPERATION AGENCY	



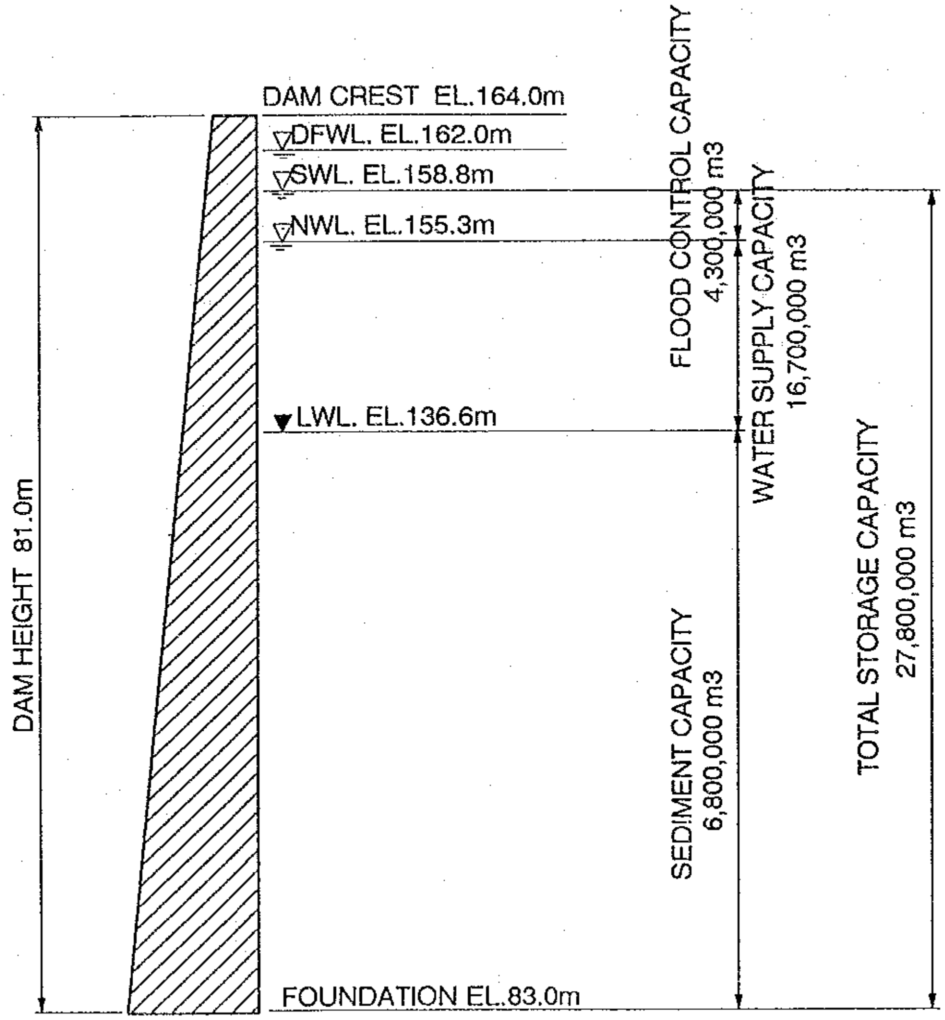
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.3.2 GENERAL DRAWING FOR COMPARATIVE STUDY ON DAM CREST LEVEL
JAPAN INTERNATIONAL COOPERATION AGENCY	



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.3.3 RELATIONSHIP BETWEEN DAM CREST LEVEL AND COST PER CUBIC METER
JAPAN INTERNATIONAL COOPERATION AGENCY	



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.IX.3.4 GENERAL DRAWING FOR COMPARATIVE STUDY ON DAM TYPE



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.3.5 RESERVOIR CAPACITY ALLOCATION OF JATIBARANG DAM
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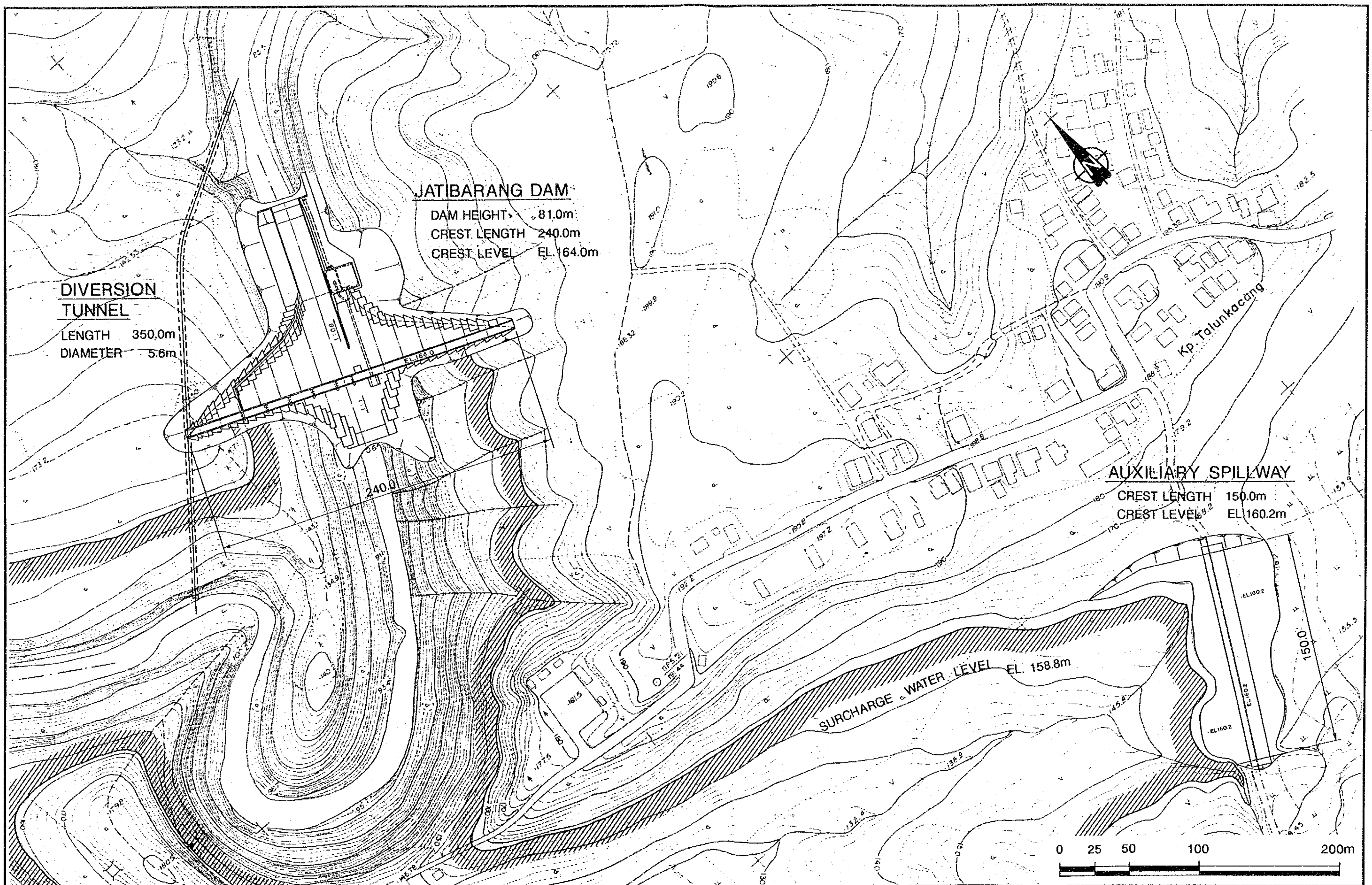

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

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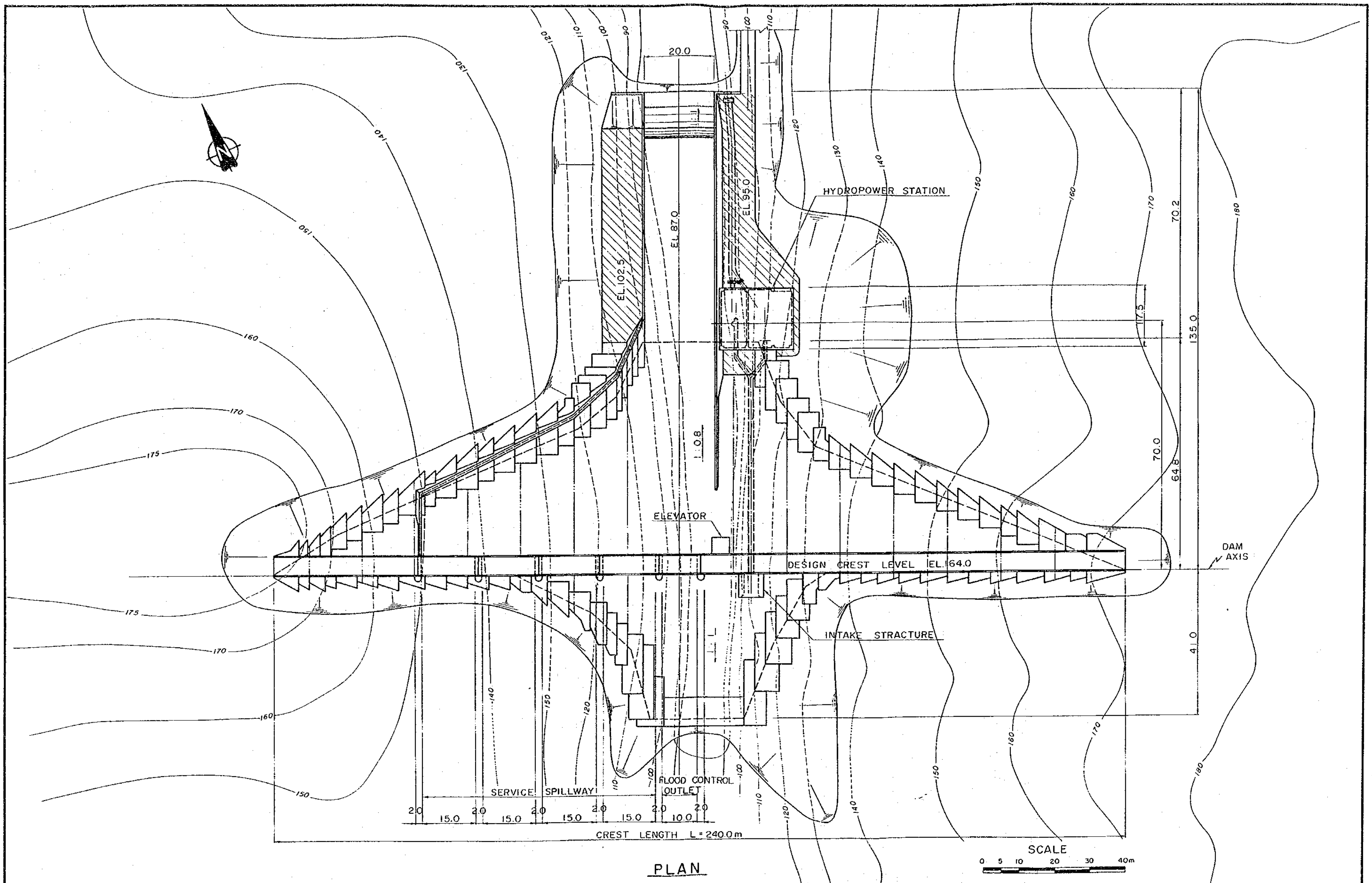
Fig.IX.3.6 GENERAL PLAN OF JATIBARANG DAM



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.3.7 PLAN OF JATIBARANG DAM
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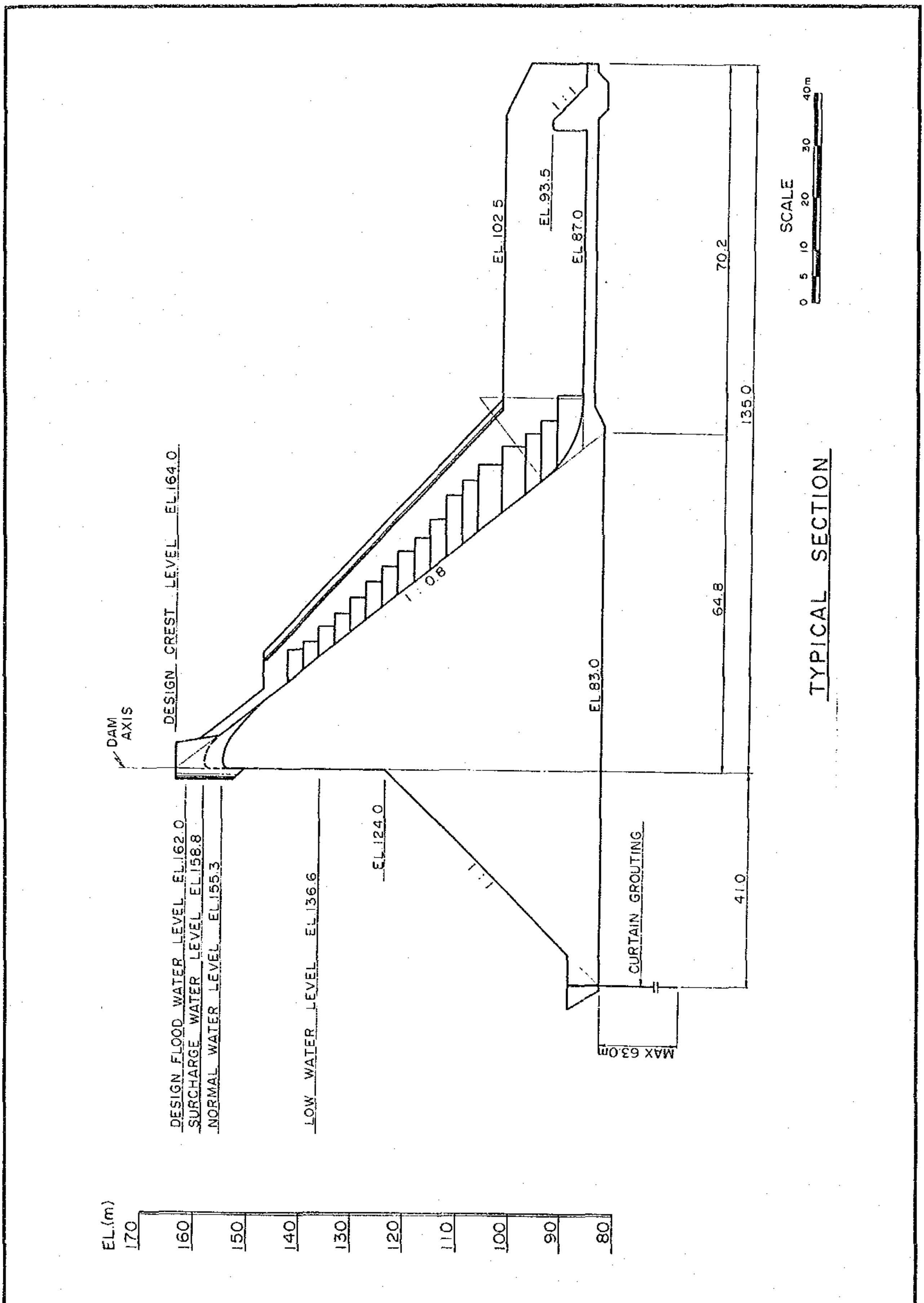

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.3.8 TYPICAL SECTION OF JATIBARANG DAM
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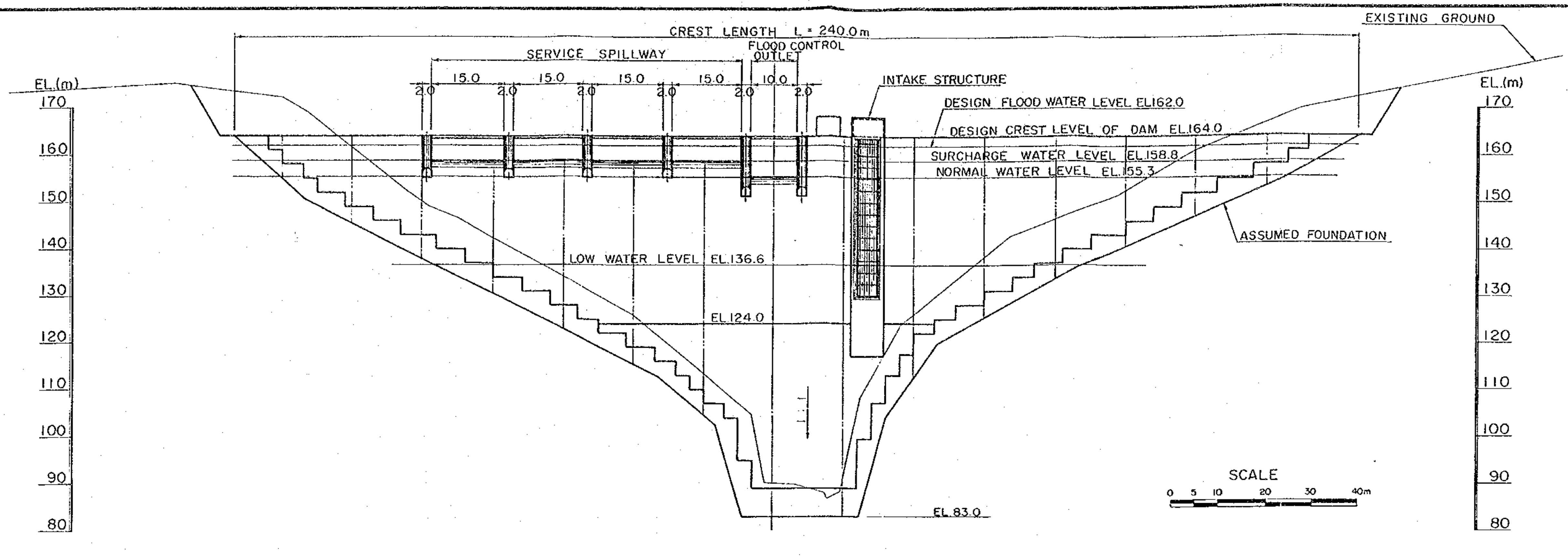
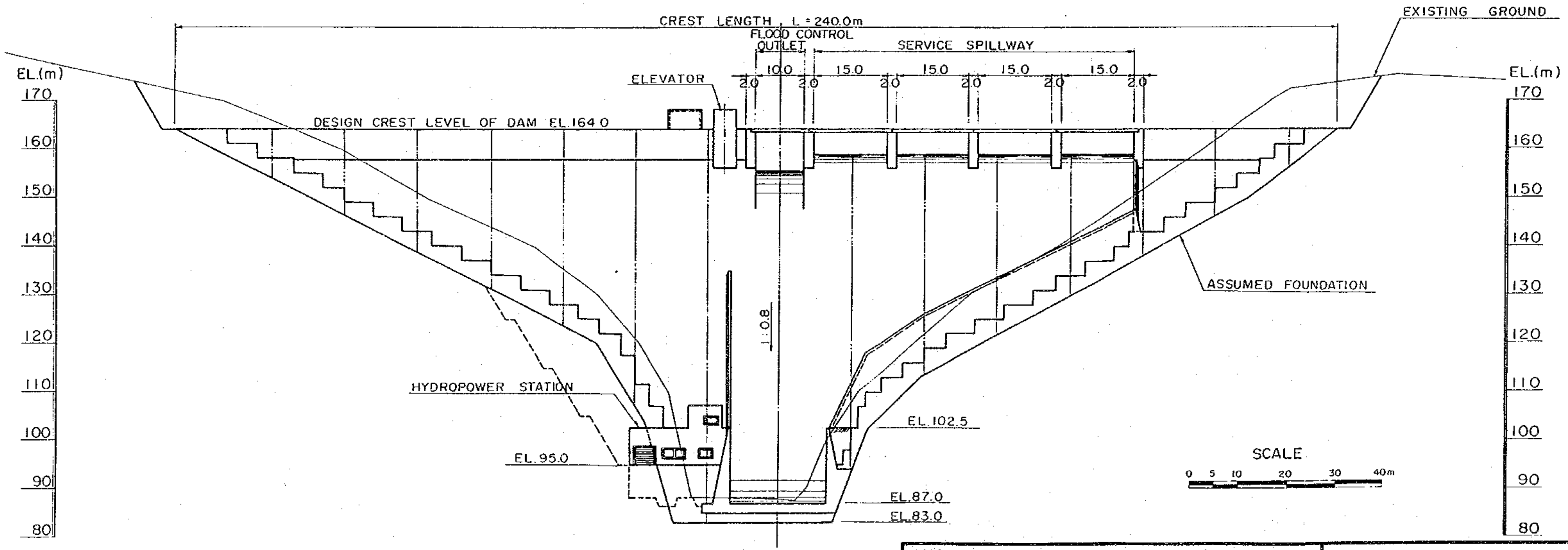


UPSTREAM VIEW



DOWNSTREAM VIEW

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

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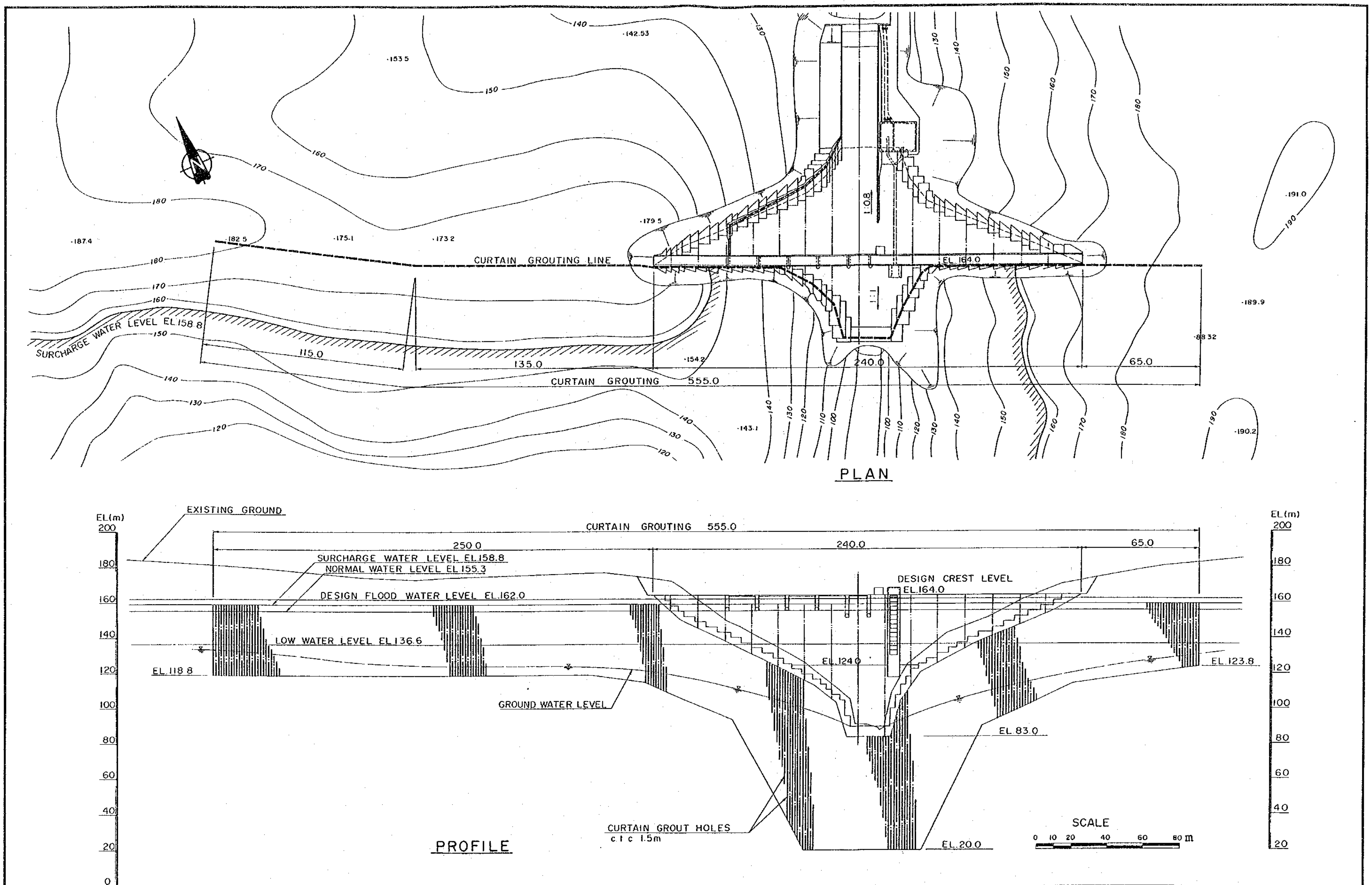
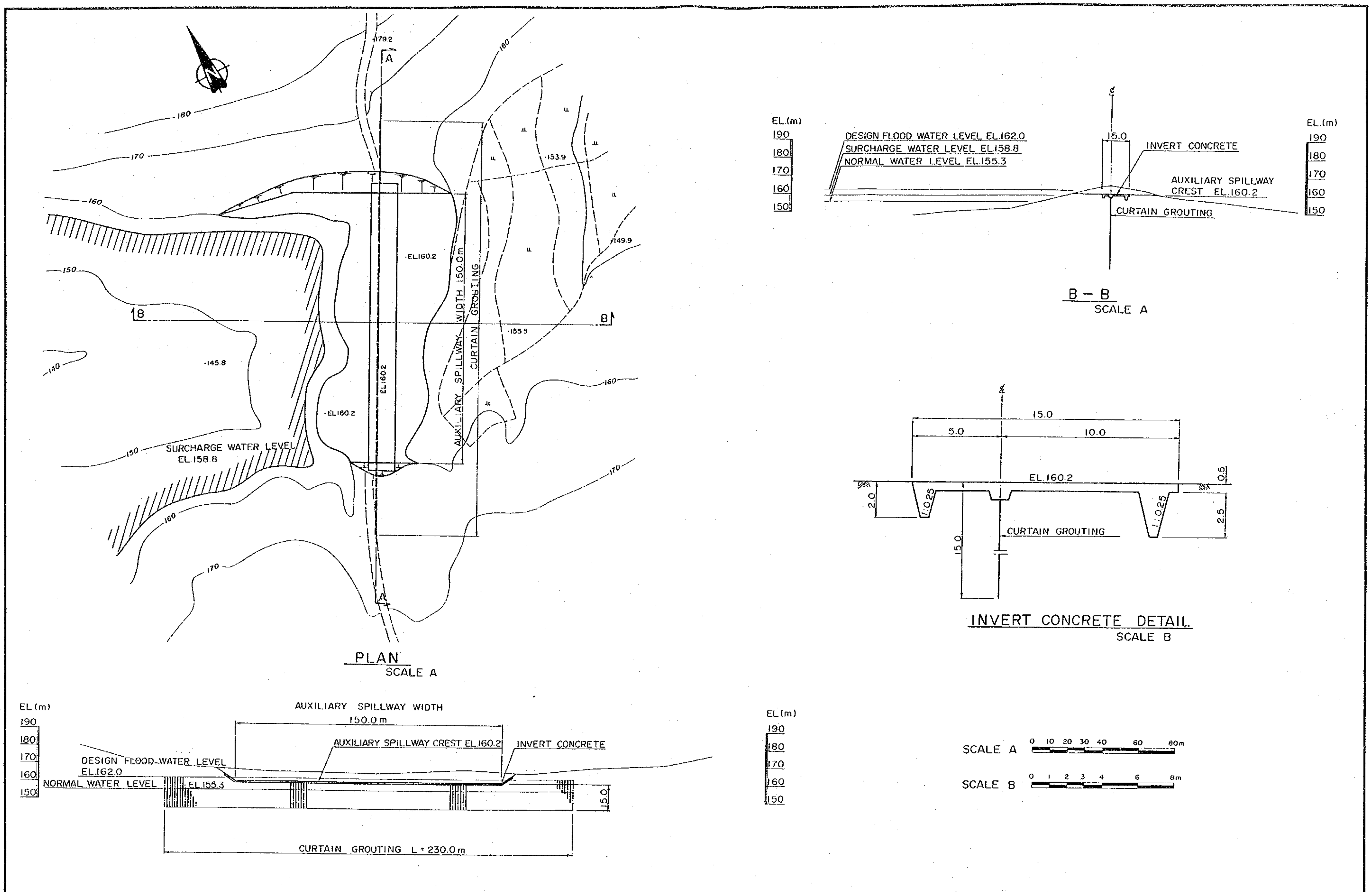
Fig.IX.3.9 UPSTREAM AND DOWNSTREAM VIEW OF JATIBARANG DAM



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.3.10
JAPAN INTERNATIONAL COOPERATION AGENCY	PLAN AND PROFILE OF CURTAIN GROUTING

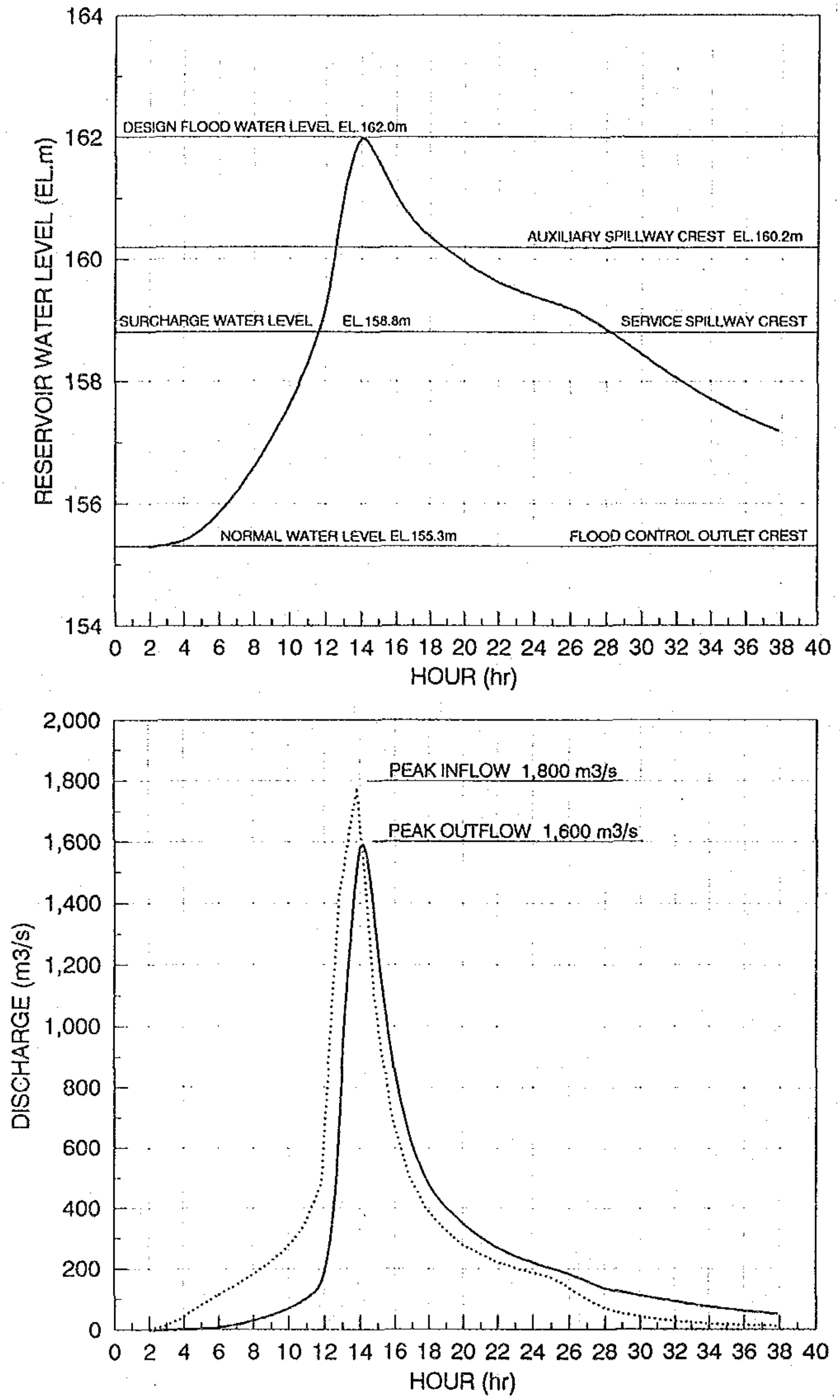


MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig.IX.3.11

GENERAL DRAWING OF AUXILIARY SPILLWAY



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS	Fig.IX.3.12	HYDROLOGY OF PROBABLE MAXIMUM FLOOD AT JATIBARANG DAM
JAPAN INTERNATIONAL COOPERATION AGENCY		

X RIPARIAN STRUCTURE DESIGN

X RIPARIAN STRUCTURE DESIGN

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CHAPTER 1 INTRODUCTION

Riparian structure design has been carried out to determine the best structural measures against floods and adopt the most suitable design on each structure. Structural design comprises three (3) phases, and the objectives of each phase are given as follows:

Phase I: Master Plan Study

(1) To investigate and evaluate the present conditions of existing structures; and

(2) To carry out the basic design on comprehensive flood control and urban drainage structures.

Phase II: Feasibility Study for Priority Project

(1) To conduct the preliminary design on all the structures identified as priority project.

Phase III: Urgent Project Study

(1) To investigate and evaluate the present conditions of existing structures along West Floodway/Garang River; and

(2) To conduct the preliminary design on objective structures identifed as urgent project.

Riparian structure works basically consist of flood control works and urban drainage works. Flood control works are composed mainly of dredging and construction of dike, weir, groundsill and other related structures. On the other hand, urban drainage works include dredging and construction of pumping station, gate structure, drainage channel and others.

CHAPTER 2 MASTER PLAN

2.1 General

The basic planning for flood control and urban drainage was proposed as mentioned in SECTOR V, FLOOD CONTROL PLAN and SECTOR VI, URBAN DRAINAGE PLAN. In line with the above planning, basic design on flood control and urban drainage structures was carried out considering the present conditions of existing structures. The following sections present the basic design concept and structural design on both flood control and urban drainage structures.

2.2 Flood Control Plan

2.2.1 Basic Design Concept

Scope of Structural Design

Structural design shall be carried out for all the structures proposed in the Flood Control Plan. The standard design which is stable under the general design conditions is applied to the design of related structures, however, the detailed computations for structural analysis are not made in this phase of the study.

Design Criteria

There are some design criteria for river and drainage channel structures in Indonesia. Deliberating over the collected criteria and standards, and through the discussions with related organizations, the following criteria were applied for structural designing:

(1) Design Criteria for Irrigation Structures prepared by the Directorate General of Water Resources Development, Ministry of Public Works, Government of Indonesia.

(2) The Technical Standard for River and Sabo Facilities prepared by the Ministry of Construction, Government of Japan.

In addition to the above criteria, the following basic design concepts were considered:

(1) In designing structures, locally based materials are to be used as much as possible in consideration of the economical aspect.

(2) Practical use of precast concrete manufactures (e.g., bridge girder, foundation pile, culvert and so on) is recommendable from the viewpoints of quality control and schedule control.

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

2.2.2 Structural Design for Flood Control Structures

Structural design was carried out for the following flood control structures for the Master Plan. Proposed layout of these structures are shown in Figs. X.2.1 to X.2.3.

(1) Earth Dike

Earth dike is applied for sections where enough right-of-way or easy land acquisition is expected. There are two (2) types of earth dike as shown in Fig. X.2.4; namely, single cross section (Type A) and compound cross section (Type B).

The crown width of the dike is designed to keep sufficient section for stability, seepage protection and inspection road. To assure the safety of the dike against overtopping of flood flow, the dike height is determined by adding a freeboard to the design high water level.

The side slope gradient on both landside and riverside of the dike is designed as 1:2 (1.0 vertical to 2.0 horizontal) for stability of the dike. To prevent scouring of dike slope, two (2) types of revetment as shown in Fig. X.2.5 are adopted on the riverside slope.

Revetment of the high-water channel, which is classified into Type A, should cover the slope of earth dike from foot up to high water level. The revetment consist of cobblestone pitching and backfill gravel, supported by base concrete. Base concrete should be embedded deep enough to cope with the scouring.

Revetment of the low-water channel, which is classified into Type B, is employed at zones where there is a great impact of running water. Structural composition of revetment is the same as Type A. To prevent scouring of riverbed and high-water channel, gabion mattress is provided at the foot and top of revetment.

(2) Retaining wall

Retaining Wall is applied for sections where right-of-way is limited and land acquisition or house evacuation is deemed to be difficult.

There are two (2) types of retaining wall, namely Type A and Type B.

Type A is a concrete gravity wall with log pile foundation. Footing concrete should be embedded deep enough to cope with scouring. Type B is of reinforced concrete and attached to the existing concrete gravity wall which have log pile foundation. The typical sections of retaining wall are shown in Fig. X.2.5.

(3) Weir

Reconstruction of Pucang Gading Weir is proposed in Jratunseluna Project. The typical design of the weir presented by Jratunseluna Project is illustrated in Fig. X.2.6.

The weir mainly consist of mass concrete main body, concrete apron, gabion protection and intake structure. The details for structural design are described in the aforesaid project report.

(4) Foreland Channel

This channel is proposed inside the river course to conduct river water into the agricultural lands without the use of intake weir. The typical section of the channel is presented in Fig. X.2.7. The channel body is designed as reinforced concrete structure, supported by log pile foundation. To prevent scouring of dike slope and berm, revetment which consist of cobblestone pitching, backfill gravel and base concrete, is provided from the foot up to the top of slope. Gabion mattress is also provided in front of the foreland channel for protection of the riverbed.

(5) Bridge

Reconstruction of existing bridges is planned at places where roads and railways cross rivers proposed to be improved. The number of bridges is summarized below.

River	Road Bridge	Railway Bridge	Total
Blorong	1	-	1
Bringin	3	1	4
Silandak	2	1	3
West Floodway	-	1	1
East Floodway	-	1	1
Babon	9	1	10
Total	15	5	20

The length and width of the bridges are decided in consideration of existing bridge dimensions and proposed river sections. From the structural consideration and economical aspect, prestressed concrete (PC) girder type and steel structural warren truss type are employed for road bridges and railway bridges, respectively. To ensure the stability of the bridge piers and abutments, prestressed concrete (PC) pile foundation is employed. The typical designs of road bridges and railway bridges are presented in Fig. X.2.8 and X.2.9, respectively.

2.3 Urban Drainage Plan

2.3.1 Basic Design Concept

The basic design concept for the structures proposed in the Urban Drainage Plan are the same as those of the Flood Control Plan as mentioned in the Subsection 2.2.1.

2.3.2 Structural Design for Urban Drainage Structures

Structural design was carried out for the following urban drainage structures to be provided for the Master Plan. The summary of proposed urban drainage structures and their proposed layouts are shown in Table X.2.1 and Figs. X.2.10 to X.2.13, respectively.

(1) Urban Drainage Channel

In deciding the type of urban drainage channel, comparative study is made not only from the structural and economical aspects but also from easiness of land acquisition and house evacuation. Inspection roads are provided on both sides of each channel to facilitate the operation and maintenance activities. Six (6) types of drainage channels shown in Figs. X.2.14 and X.2.15 are proposed, namely:

(a) Type A

This is applied for sections where enough right-of-way or easy land acquisition is expected. The crown width, freeboard and slope gradient are determined according to the same concept as mentioned in Subsection 2.2.2(1), Earth Dike. Sodding is provided on both landside slope and riverside slope to mitigate the erosion of the dike.

(b) Type B

Basic concepts for structural designing are the same as those of Type A as mentioned above. To keep the required hydraulic section, revetment (Type A), which consist of cobblestone pitching, backfill gravel and base concrete, is provided on riverside slope up to high water level. To cope with the erosion of the dike slope, sodding is proposed from high water level up to the top of slope on riverside, and whole slope on landside.

(c) Type C

This trapezoidal shape channel is applied for the sections where land acquisition and house evacuation are considered to be difficult. Retaining wall with inner slope of 1:0.33 (1.0 vertical to 0.33 horizontal) is provided at inner sides of channel. This wall is designed as gravity type stone masonry structure composed of rubble and lean-mix mortar, supported by log pile foundation. To cope with the scouring, footing of wall should be embedded deep enough.

(d) Type D

The rectangular shape channel is proposed to cope with the difficulty of land acquisition and house evacuation in highly urbanized areas. Retaining wall with vertical inner slope is provided at inner sides of channel. Structural composition of retaining wall is the same as Type C as mentioned above.

(e) Type E

This type is applied for the sections where the flow sectional area of existing channel (Type C) is not enough and excavation of channel bed is required. For foot protection, concrete sheet pile is provided in front of the existing retaining wall.

(f) Type F

This type is applied for the sections where the rectangular shape channel (Type D) is existing and excavation of channel bed is required to keep sufficient flow sectional area. The countermeasure adopted for foot protection is the same as Type E.

Proposed channel improvement works are summarized in Table X.2.2.

(2) Pumping Station

Construction of three (3) pumping stations is proposed at the low-lying area along Semarang River for the purpose of inner water drainage. The pumping station mainly consists of pump house, surge tank, sluice and retarding basin. The typical design is shown in Fig. X.2.16.

(a) Pump House

The pump house is basically divided into substructure and superstructure. Substructure, which consists mainly of pump pit, cooling water tank and fuel tank, is constructed with reinforced concrete and supported by PC pile foundation. Superstructure constructed of reinforced concrete is designed to have enough space and functions for pump/motor room, electrical/control room, work shop and so on.

The sand basin constructed of reinforced concrete is proposed in front of pump pit to promote the sedimentation of bed load and suspended load in the flowing water.

(b) Surge Tank

The surge tank is installed between the pump house and the sluice to transmit the pumped water smoothly to the sluice. The surge tank is designed as reinforced concrete structure with the top elevation proposed to be the same as that of the earth dike. To ensure stability, prestressed concrete pile foundation is employed.

(c) Sluice

The sluice with slide gates at the inlet are planned with reinforced concrete box culvert type through the earth dike. The box culvert is also supported by prestressed concrete pile foundation. To cope with the scouring of riverbed, gabion mattress is provided at the inlet side and the outlet side of the sluice.

(d) Retarding Basin

The retarding basin is provided beside the pump house to reduce the pump capacity. The inner slope gradient of the retarding basin is designed as 1:2 (1.0 vertical to 2.0 horizontal) for stability of the slope. Sodding is also applied on the slope to mitigate erosion. At the boundary of drainage channel and retarding basin, the overflow section of concrete structure is placed to control the inflow water from drainage channel.

(3) Gate Structure

Reconstruction of a gate structure is proposed from the evaluation of the existing structure. The type of the gate is to be determined based on not only the hydraulic dimensions but also the gate functions such as easy operation and prompt and precise water stop. Considering the above requirements, the slide gate is employed. The basic structure is composed of floor slab supported with log pile foundation, piers, operation stage and wing walls. The typical design of the gate structure is shown in Fig. X.2.17.

(4) Bridge and Culvert

Considering the existing condition and proposed channel improvement plan, reconstruction of bridges and culverts are proposed. Proposed dimensions of bridges and culverts are decided based on the existing dimensions and proposed channel sections.

From the structural consideration and economical aspect, prestressed concrete and reinforced concrete girder type are employed for road bridges and steel structural warren truss type is employed for railway bridges. To ensure the stability of bridge piers and abutments, prestressed concrete pile foundation is employed.

The culvert type is employed where the channel width is not so large and discharge volume is limited. The culvert is designed as a reinforced concrete structure supported with log pile foundation. The typical designs of road bridge, railway bridge and culvert are presented in Figs. X.2.18 to X.2.20, respectively.

CHAPTER 3 FEASIBILITY STUDY

3.1 General

The Feasibility Study was carried out on the objective area identified for the priority project. According to the basic planning criteria, preliminary design for structures was conducted and work quantities were obtained for the project cost and benefit analysis.

The following sections present the basic design concept, preliminary structural design and quantities of proposed works.

3.2 Flood Control Plan

West Floodway/Garang River is selected as the target area of the Feasibility Study. Structural details of river improvement for the flood control plan are presented in CHAPTER 4 as the Urgent Project.

3.3 Urban Drainage Plan

3.3.1 Basic Design Concept

Scope of Preliminary Design

The preliminary design is carried out for all the structures identified as priority project. The proposed works are as follows:

(1) Bandarharjo West Drainage Area

(a) Pumping Station with Gates ($Q=0.8$ m3/s)
(b) Retarding Pond ($V=16,700$ m^3)

(c) Drainage Channel (L=0.8km)

(2) Asin River Basin Area

(a) Pumping Station with Gates (Q=5.7 m^3/s)
(b) Retarding Pond (V=80,000 m^3)
(c) Channel Improvement (L=1.3 km)
(d) Road Bridge (1 place)

(3) Bandarharjo East Drainage Area

(a) Pumping Station with Gates (Q=2.0 m^3/s)
(b) Retarding Pond (V=28,000 m^3)
(c) Drainage Channel (L=0.7 km)

(4) Semarang River

(a) Channel Improvement (L=6.9 km)

(5) Baru River

(a) Channel Improvement (L=0.8 km)
(b) Gate Structure (2.2 m x 1.8 m x 2 sets)

The proposed works are summarized in Table X.3.1. The location of these works are presented in Fig. X.3.1.

Design Criteria

Design criteria for the structures projected in the Feasibility Study are the same as those of the Master Plan, as mentioned in the Subsection 2.2.1.

3.3.2 Preliminary Design for Urban Drainage Structures

The preliminary design was carried out for the following urban drainage structures to be provided for the priority project.

<u>Pumping Station</u>

Construction of three (3) pumping stations is proposed at the low-lying area along Semarang River; namely, Bandarharjo West Drainage Area (P1), Asin River Basin Area (P2), and Bandarharjo East Drainage Area (P3). Design conditions for each pumping station are summarized in Table X.3.2. The layout of proposed pumping stations are shown in Figs. X.3.2 to X.3.4.

(1) Mechanical and Electrical Works

<u>Selection of Pump Type</u>

(a) Classification of Pump

The pump types are generally classified as follows:

- Pump
  - Turbo Pump
    - Centrifugal Pump
    - Mixed Flow Pump
    - Axial Flow Pump
  - Others
    - Rotary Pump
    - Reciprocating Pump
    - Vacuum Pump
    - Jet Pump
    - Air Lift Pump

Since in drainage services the pump total head is generally low and the pump capacity is large, axial and mixed flow pumps are widely used in modern practice. Since centrifugal pump is mainly applied for high head purpose and others are not generally used for drainage system, mixed or axial flow pumps are applied for the Urban Drainage Plan.

(b) Comparison of Pump Type

General comparison between mixed and axial flow pumps is given in Table X.3.3. In addition, shaft direction is also compared as shown in Table X.3.4. Applicable ranges in pump total head for mixed and axial flow pumps are summarized below:

PUMP TYPE	SHAFT TYPE	
	VERTICAL	HORIZONTAL
MIXED FLOW PUMP	≤ 9 m	≤ 7 m
AXIAL FLOW PUMP	≤ 5 m	≤ 3 m

In this project, approximate pump total head is as follows:

PUMP STATION	P1	P2	P3
PUMP TOTAL HEAD	3.4 m	4.4 m	4.4 m

* Pump Total Head consist of Static Head and Head Loss
* Static Head is shown in Table X.3.2.

Considering all matters above, horizontal type mixed flow pump is recommended.

Number of Pump Units and Bore Size

The required pumping capacity is usually divided into several units to meet variable demands resulting from various extents of rainfall. The following table gives a general guide regarding the number of units for drainage project.

TOTAL DRAINAGE CAPACITY	NUMBER OF PUMP UNITS
LESS THAN 10 m^3/s	2 - 3 SETS
10 m^3/s - 30 m^3/s	2 - 4 SETS
30 m^3/s ABOVE	3 SETS

The total drainage capacity for each pumping station in this project is less than 10 m^3/s. Considering initial construction cost and maintenance, two (2) sets of pump units are recommended.

Besides, pump bore is calculated by the following formula.

$$D = 1{,}000 \times (0.1 \text{ to } 0.08) \times Q^{1/2}$$

where, D : pump bore (mm)
Q : capacity (m^3/min)

From the above consideration, the general specification for each pumping station is as follows:

PUMPING STATION	TOTAL CAPACITY (m^3/s)	PUMP UNIT CAPACITY (m^3/s)	NUMBER OF PUMP UNIT (set)	PUMP BORE (mm)	PUMP TYPE
P1	0.8	0.4	2	500	HORIZONTAL MIXED FLOW
P2	5.7	2.85	2	1200	HORIZONTAL MIXED FLOW
P3	2.0	1.0	2	700	HORIZONTAL MIXED FLOW

Selection of Prime Mover

When reliable commercial electric power is easily available and continuous operation