CHAPTER 4

FORMULATION OF DEFINITIVE PLAN

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4.1 General

4.1.1 Confirmation of Scope of Project

In reference to the Scope of Work for the Study signed on November 29, 1996 between DGWRD, Ministry of Public Works and JICA Preparatory Study Team, the study on urban drainage system improvement in Semarang City consists of; (i) the review of the previous JICA Feasibility Study (F/S) including several basic field surveys, (ii) the preparation of definitive plan and detailed design for the urban drainage facilities proposed in the F/S.

Regarding the drainage system in the Bandarharjo East area, demarcation of the area and works between the Study and Semarang Surakarta Urban Development Program (SSUDP) which is financed by IBRD (World Bank) was made through discussions with agencies concerned to avoid duplication by both projects. Through the discussions in several times among JICA Study Team, Semarang City, Directorate General of Human Settlements (DGHS) and the World Bank mission, it has been cleared as follows:

(1) The JICA Project covers the improvement of main drainage facilities.

(2) SSUDP Project covers the improvement of secondary and tertiary drainage channels.

4.1.2 Planning Criteria

(1) Target Year

In the previous Feasibility Study (F/S), the target completion year of the proposed project was set at 2005. The pumping stations with retarding ponds are, however, to be planned and designed to meet the same target year (2015) in terms of the land use, population, development stage and etc. as the Master Plan, considering the followings;

(a) The service area is within almost fully and highly urbanized area in the central area of Semarang City.

(b) Though the full scale pump drainage will be executed at a time, it is evaluated in the previous F/S that the project economic efficiency is high.

(c) The difficulty of land acquisition for future expansion of the facilities.

(2) Scale of Design Flood

It is proposed to apply the same scale of design flood as the related projects, Urban V (Semarang River Drainage Improvement Project) and SSUDP assisted by IBRD, which meet the guideline on the level of services for urban drainage proposed in Integrated Urban Infrastructure Development Program (IUIDP) as shown in the table below:

Catchment Area (km^2)	Scale of Design Flood (year return period)
less than 0.1	1
0.1 - 1.0	2
1.0 - 5.0	5
more than 5.0	10

The improvement of Semarang River with a catchment area of 12.835 km^2 has, however, been executed for the design flood of 5-year return period in Urban V since 1985. The land acquisition has also been completed based on Local Government Regulation No. 2 in 1985. As this project is an urgent project selected from the Master Plan, it is proposed to apply the design flood of a 5-year return period for the river improvement.

(3) Design rainfall

The following two (2) design rainfalls proposed in the previous F/S are reviewed and revised by additional rainfall records from 1992 to 1996, of which details refer to the Probable Rainfall in Chapter 2.

(a) For Channel Improvement Plan

The rainfall intensity-duration with 2-year and 5-year return period are employed for the hydraulic design of channel improvement.

<u>2-year Return Period</u>

$I = 1{,}567/(T + 11.79)^{0.74}$: $T < 2$ hr

$I = 2{,}417/(T + 10.80)^{0.84}$: $2 \text{ hr} < T < 12$ hr

<u>5-year Return Period</u>

$I = 1{,}271/(T + 6.95)^{0.64}$: $T < 2$ hr

$I = 3{,}245/(T + 14.75)^{0.83}$: $2 \text{ hr} < T < 12$ hr

where, I : average rainfall intensity during time of concentration (mm/hr)

T : time of concentration (min)

(b) For Pump Drainage Plan

Consecutive 12 hours rainfall with a 5-year return period proposed in the previous F/S is applied as the design rainfall for the pump drainage plan. The rainfall depth and its hourly distribution are shown in Fig. 4.1.1.

(4) Design Tidal Level

Design tidal level is show below. Details are described in Chapter 2.

Water Level	BPP M2 System	TTG System
Highest High Water Level (HHWL)	+ 2.048	+ 0.45
Mean High Water Level (MHWL)	+ 1.848	+ 0.25
Mean Sea Level (MSL)	+ 1.368	- 0.23
Mean Low Water Level (MLWL)	+ 0.898	- 0.70
Lowest Low Water Level (LLWL)	+ 0.698	- 0.90

(4) Roughness Coefficient and Freeboard

For the design of river channel, non-uniform flow analysis is made by applying the value of Manning's coefficient of roughness (n).

The value of Manning's coefficient of roughness (n) for drainage channel varies on the surface condition of bank and bed of the channel. Manning's n values for the channel improvement plan are applied as follows:

Channel Description	Manning's n value
Unnormalized earth channel	0.35
Normalized earth channel	
- with sodding protection for both bank	0.31
- with stone masonry protection for both bank	0.24
- with stone masonry protection for both bank/bed	0.15

As proposed in the previous F/S, freeboard of the river and drainage channel is applied as follows:

Channel Description	Freeboard (m)
Semarang River	
- from river mouth to railway crossing (3.2 km)	0.60
- upstream stretch from railway crossing	0.40
Baru River	0.60
Asin River	0.40
Other Secondary Drainage Channel	0.30

(5) Pump Drainage Criteria

In pump drainage design, the following criteria were applied;

(a) The pump drainage area is defined as the area where the existing ground elevation is lower than the design high water level of Semarang River and the gravity drainage into Semarang River is difficult.

(b) The pump drainage system is designed combining a pumping station and a retarding pond considering the rainfall pattern, which gives a large hourly rainfall and a comparatively small daily rainfall.

(c) As there is a limitation of available retarding pond area, a part of the drainage area (20% of the total drainage area) is to be subject to an allowable temporary inundation (20 cm in depth).

(d) The specified pump capacity per unit drainage area is designed taking into account the relationship between the pump capacity and the duration of pump operation.

4.2 Channel Improvement Plan

4.2.1 Semarang River System

The F/S was carried out in 1993 two years after completion of Urban V project including the full scale channel improvements of Semarang River. So, the Semarang river system proposed in Urban V is basically applied. The review of design discharge was conducted in the F/S, considering three pump drainage of Asin, Bandarharjo East and West. As shown in Fig. 4.2.1, the Semarang river system consists of two tributaries, Asin River and Simpang Lima Channel, and one diversion channel, Baru River. During floods, flood water of 6.0 m^3/s out of a total design discharge of 42 m^3/s are planned in the Feasibility Stucy to be diverted to Baru River. So, it was proposed that Baru River was divided into two parts, left bank side for the diversion channel with a flow capacity of 6.0 m^3/s (5.0 m in width, 2.0 m in depth) and right bank side for the retarding pond of Bandarharjo East area (20.0 m in width, 3.0 m in depth). A reinforced concrete wall with a height of 5.0 m and a length of more than 500 m was proposed to be constructed in Baru River as a partition wall of the above two parts.

Through the series of discussions with Semarang City municipal office, it has been found that this diversion method has the following disadvantages and problems:

(a) Baru River and its operation/maintenance are basically under Semarang Port Authority (SPA). Floods often cause navigation problems in Baru River downstream of North Ring Road. In fact, diversion of flood water of 6.0 m^3/s to Baru River has not been approved by SPA yet.

(b) It is anticipated much sedimentation consisting of suspended load, waste disposal, sludge and organic matter come into Semarang Harbor.

(c) Construction cost of the reinforced concrete partition wall are very costly because the additional foundation piles should be driven due to soft sub-soil condition.

So, in order to avoid these disadvantages, the following alternative has been studied.

<u>Alternative:</u> Baru River is to be separated from Semarang River by closing the diversion point. Semarang River downstream of the diversion point should be burden with flood discharge of 6.0 m^3/s because of no diversion to Baru River.

The evaluation of the alternative is as follows:

(a) Baru River can be used as only a retarding pond due to elimination of the function as a diversion channel. Since the storage capacity of retarding pond can be increased more than 7,000 m^3 at least, which is equivalent to about 25 % of original one, it will be possible to combine the Bandarharjo East and West areas as one drainage basin and to make simple drainage system. Details will be mentioned later.

(b) According to the hydraulic study results, if an additional channel improvement for Semarang River downstream of the diversion point will not be executed, the design high water level at the diversion point will be about 11 cm higher than original one due to the additional flood discharge of 6.0 m^3/s.

(c) If the deepening of 0.3 m in depth for the Semarang river bed between its river mouth and the diversion point is carried out, the flow capacity in this section can be increased by about 6.0 m^3/s under the same condition as original hydraulic gradient. Dredging volume and its cost are estimated to be about 17,000 m^3 and Rp. 160 x 10^6 respectively. Dredging cost is lower than the construction cost of reinforced concrete partition wall.

Accordingly, it is recommended not to divert flood discharge from Semarang to Baru rivers but to use Baru River as only a retarding pond for both drainage areas, Bandarharjo East and West.

4.2.2 Reclamation Effect on Semarang River

The seashore between West Floodway and Semarang Harbor is being undertaken to reclaim since 1980's for the development of industrial estates by the private sectors, in which PT. Tanah Mas Baruna and PT. Cipta Guna Buana were permitted by Semarang Port Authority (SPA) for the reclamation of the left and right banks of Semarang River downstream from North Ring Road respectively.

According to their development plans, the seashore being reclaimed about 800 m further offshore. Therefore, for hydraulic calculation of Semarang River, +10 cm is added to the M.H.W.L. considering the reclamation effect. While revision of the reclamation plan which will minimize the effect on river discharge capacity was proposed by JICA Study Team to Semarang City as shown in Fig. 4.2.2.

4.2.3 Design Discharge

Three options were compared as mentioned in Chapter 3. In this consideration, the number of pumping stations in the Bandarharjo area was proposed to be one as described in Sub-section 4.3.3. Therefore, finally Option C was selected as the proposed configuration of the Semarang river system. The final design discharge is shown in Fig. 4.2.3.

4.2.4 Definitive Plan of Semarang River Drainage System Improvement

The definitive plan of Semarang River Improvement is composed of following works, and the location of each work is shown in Fig. 4.2.4.

(1) Channel Improvement Plan

(a) Channel Alignment

The alignment of Semarang River is proposed to follow the existing channels except the relocation of 0. 3 km in the lower reaches, in order to create a space for a retarding pond for the Asin Pumping Station.

(b) Longitudinal Profile

Longitudinal profile of Semarang River is designed to coincide with the designed in the Urban V Project to accommodate the design discharge mentioned above.

(c) Cross Sections

Cross sections of Semarang River are designed according to the design longitudinal profile.

Inspection road is newly constructed or reconstructed along the river channels for maintenance and inspection purpose. The total width of the inspection road is 7 m, and the width of pavement is 5 m by the standard of Semarang City. However, the design dimension of inspection road will be modified for each section during the implementation stage according to the housing conditions of the area.

(d) Dredging of Semarang River

Semarang River is dredged according to the design channel sections with the total length of dredging of 7.24 km and the volume of 95,000 m^3.

Since the sediment in the channel contains heavy metals such as Cu, Zn and Pb with the amount exceeding Japanese Environmental Standard by 2 to 3 times, excavated material shall be treated so that such harmful substance will not contaminate groundwater at spoil banks. After conducting leaching test of heavy metals to compare alternative treatment method, it is proposed to mix cement by the amount of 7% of the dry weight of soil.

(e) Closure of diversion gate to Baru River

The existing diversion gate is proposed to be closed by placing concrete wall on the position.

(f) Relocation of the channel at the confluence of Asin River

The length of new channel is 0.3 km. Wet masonry inclined wall, is applied in the part of the relocated channel of Semarang River concrete sheet pile type revetment is applied at the beginning and the end of the relocated channel.

(g) Raising of existing dike

The total length of the existing dike is 3.1 km along the river. Wet masonry shall be added on top of and land side of the existing dike. The elevation of the top of the dike is determined by adding free board to the design high water level at each section. The crown width of the dike is proposed to be 0.4 m taking into account further raising of the structure in the future.

(h) Closure of all drainage outlets into Semarang River.

There are 56 existing drainage outlets to be closed in the project in order to prevent backflow of the water into the pump drainage area.

4.2.5 Definitive Plan of Asin River Improvement

(1) Design Discharge

The design discharge of Asin River is 35 m^3/s as shown in Fig.4.2.3. The design high water level in Asin River (EL-1.0m) is lower than the Lowest Low Water Level of the Semarang Harbor (El-0.90 m), therefore, gravity drainage of the design flood through Asin River can expected in only limited occasions.

(2) Channel Improvement Plan

(a) Channel Alignment

The alignments of Asin River will follow the existing channel. The upper reaches of Asin River were designed as a box culvert revised from an open channel in the Feasibility Study, in order to avoid a large number of house evacuation.

(b) Longitudinal Profile

Since Asin River is used as a part of the retarding pond, longitudinal profiles of Asin River is designed so as to have a capacity of retarding pond of 36,000 m^3. In order to obtain the required storage volume of Asin River, the existing channel bed is excavated down to the design channel bed.

(c) Cross Sections

Required cross sections are designed so that the channel has a capacity of retarding pond of 36,000 m^3. The design criteria for the Inspection Road are the same as Semarang River.

Channel improvement criteria of Asin River are shown in the table below.

Width of channel (No.0 ~ SAO) L =1,165 m (open channel)	20 m
Width of channel (upstream from SAO) L =194 m, (box culvert *1)	3.5 m
Lowest ground elevation in the drainage are	EL-0.20 m
Anticipated future land subsidence *2	0.4 m
Allowance for secondary channel slope *3	0.4 m
Design high water level during flood	EL-1.00 m (= -0.2-0.4-0.4)
Design low water level during flood season	EL-2.50 m (=-1.0-1.5)
Available depth for retarding	1.5 m
Required water depth to carry maximum pump discharge (8.86m^3/s)	0.9 m
Design river bed elevation	EL-3.40 m (= -2.5-0.9)

*1 In the F/S stage, open channel with the width of 20 meters were planned at these sections. The design was revised in the definitive plan in order to avoid house evacuation.

*2 According to the various information combined, average annual land subsidence in the area is about four (4) centimeters. In drainage channel design, 40 cm of allowance has been taken into account while in pumping station design, 120 cm of allowance has been considered. Therefore, about 30 years of land subsidence is included in the design. The design life span of the facilities is 50 years but the land subsidence is expected to be stopped in 30 years, by transferring water source from groundwater to surface water by water resources development including Jatibarang Multipurpose Dam.

*3 The minimum slope for the secondary channel is 5/10,000. Based on the topographic data of the drainage area, the longest distance from the low points to Asin River or the Retarding Pond is 800 m. Therefore, 800 m × 5/10,000 = 0.4 m.

4.2.6 Definitive Plan of Baru River Improvement

(1) Design Discharge

The design discharge of Baru River from Semarang River is 0 m^3/s as shown in Fig. 4.2.3. Therefore, the design discharge for the channel and the gate for Baru River is equivalent to the maximum discharge of the Pump, that is 4.37 m^3/s.

(2) Channel Improvement Plan

(a) Channel Alignment

The alignment of Baru River will follow the existing channel.

(b) Longitudinal Profile

Longitudinal profile of Baru River was designed to have enough capacity as a retarding pond. In order to obtain the required storage volume, the existing channel bed is excavated.

(c) Cross Sections

Required cross sections are designed so that the channel has enough capacity as a retarding pond. The design criteria for the Inspection Road are the same as Semarang River.

Channel improvement criteria of Baru River are shown in the table below.

Width	30 m
Lowest ground elevation in the drainage area	EL-0.10 m
Anticipated future land subsidence	0.40 m
Allowance for secondary channel slope	0.40 m
Design high water level during flood	EL-0.90 m (=-0.1-0.4-0.4)
Design low water level during flood season	EL-2.40 m (=-0.9-1.5)
Available depth for retarding	1.50 m
Required water depth to carry maximum pump discharge (4.40m³/s)	0.60 m
Design river bed elevation	EL-3.00 m (=-2.4-0.6)

4.3 Pump Drainage Plan

4.3.1 Specific Pump Capacity

In the F/S, the smallest specific pump capacity of 1.34 $m^3/s/km^2$ was applied under the condition of 24 hours pump drainage considering the gravity discharge could be expected in the latter half of floods.

However, since the gravity discharge would not be fully expected in the near future due to progressing of land subsidence, an increase of the specific pump capacity should be considered to decrease a flood risk of each drainage area.

Fig. 4.3.1 shows the relationship between the specific pump capacity and discharge volume. The figure shows the duration of pump operation to cope with the design rainfall by each specific capacity of the pump.

Studying this figure, 2.0 m^3/s is selected as the optimum specific capacity, where further increase of specific capacity will not give significant improvement in shortening the duration.

4.3.2 Polder Dike

As mentioned before, three (3) drainage areas, Asin, West and East Bandarharjo, include the low-lying flat areas affected by the ongoing land subsidence. These areas should be protected from the high tide of Semarang Harbor by polder dikes as follows:

(a) Asin Drainage Area : Tambak Mas Barat Street, North Ring Road and left bank of Semarang River

(b) West Bandarharjo : right bank of Semarang River, North Ring Road and left bank of Baru River

(c) East Bandarharjo : right banks of Baru and Semarang rivers, North Ring Road and Ronggowarsito street

The crown elevations of these polder dikes should be higher than + 0.85 m above MSL of Jakarta Harbor, which is equivalent to 0.4 m of freeboard above HHWL of Semarang Harbor. However, the existing surface elevations of almost all sections of North Ring Road and Ronggowarsito Street are under the proposed lowest crown elevation of the polder dikes of + 0.85 m above MSL of Jakarta Harbor as shown in Fig. 4.3.2, according to the leveling survey results by the Study Team. In fact, around the crossing with North Ring Road and Ronggowarsito Street is habitually inundated by seawater. Although detailed design of this dike raising is not included in the scope of the detailed design of JICA Study, it is necessary to do it in the implementation stage of the project.

4.3.3 Comparative Study on Number of Pump Stations in Bandarharjo Drainage Area

Two alternative plans of number of pump stations in Bandarharjo Drainage Area are established and shown in Fig. 4.3.3.

Alternative-A is a plan with a single pump station in the area. In this plan, Baru River and Baru Retarding Pond is connected by a conveyance channel and act as one retarding pond. Therefore, one pump station and two retarding ponds work as a system.

Alternative-B is a plan with two pump stations in the area. One pump station at Baru River uses the river as a retarding pond while the other pump station near Semarng River has another retarding pond of its own. Two pump stations work independently.

After a comparative study shown in Fig. 4.3.3, alternative-A with one pump station at Baru River was adopted considering the low cost and simplicity of operation.

4.3.4 Definitive Plan of Asin River Drainage System

The definitive plan of Asin Drainage System involves following works. Location of each work is shown in Fig. 4.3.4.

(1) Asin Retarding Pond

Asin Retarding Pond is to have a storage volume of 24,000 m^3. Revetment for the retarding pond is wet masonry on the western periphery and concrete sheet pile on the eastern periphery. The employment of concrete sheet pile here is because it will act as water stop underground against Smerang River. The periphery of the pond is surrounded by a inspection road for maintenance purpose as well as access roads to the Asin Pump Station.

(2) Pumping Station Facilities

(a) Pump

Design Criteria for Asin Pump Station area shown in the table below.

Pump Capacity	8.86 m^3/s
Design Water Level Outside	EL 0.45 m *1
Design Water Level Inside	EL -2.50 m *2
Design Head	3.0 m

*1 M.H.W.L. (EL+0.25 m)+water surface slope of Semarang River (+0.1m) + allowance including the effect of future land reclamation (+0.1m)

*2 Equivalent to the Design Low Water Level of Asin River and the Retarding Pond

(b) Gate

Design criteria for Asin Gate are shown in the table below.

Design water level outside (Semarang River)	EL+0.45 m
Design bed elevation	EL-2.10 m
Freeboard	0.6 m
Design water level inside (Asin River)	EL-2.10 m
Design discharge	35 m^3/s

(c) Buildings for Management

The following buildings will be constructed in the Asin Pumping Station Complex.

Name of building	Total floor area (m^2)
Pump Conctrol Building	193
Management Office	121
Garage	199
Staff House	45

The operation and maintenance (O/M) of the Asin Pumping Station will be performed by Semarang Municipal Office. The number of staff for O/M and necessary facilities were discussed with Semarang Municipal Office. Three (3) personnels are to be engaged in the work of O/M and one of them will stay in the staff house with family. The Management Office include office space for control and a meeting room. Four trucks are expected to stay in the garage for transportation of garbage and dredged sediment.

(d) Bridge

Design criteria for a bridge of Asin Pump Station are shown in the table below. This bridge is exclusively used for operation and maintenance purpose.

Width	6 m
Span	20.0 m
Length	21.2 m
Design Load	BINA MARGA standard

(3) Asin Pumping Station

(a) General Layout Plan of the Pumping Station Complex

General layout plan of the pumping station is shown in Fig 4.3.5. The space around the pumping station is for garbage collection and transportation.

(b) Type of Pump

Screw Type Pump was selected after comparing four (4) types of pump as shown in Table 4.3.1. The main reasons of the selection are low cost and simplicity of operation and maintenance.

(c) Main Pump Specification

Three main pump units are installed in Asin Pumping station considering the maximum capacity of one unit and small risk of malfunction. Specification of the main pump is shown in the table below.

Type of Main Pump	Screw Pump
Lowest Water Level of Basin	LLWL = EL-2.60 m (0.1 m for loss at screen)
High Water Level of Spillway	HHWL = EL+0.65 m (0.2 m higher than H.W.L. outside)
Fill Point of Screw Pump	FP = -EL2.60 m (equal to L.L.W.L.)
Chute point of Screw Pump	CP = EL+1.20 m
Angle of Inclination of Screw Pump	= 30 degree
Required pump capacity	Q = 8.86 m^3/s
Designed number of main pump	N = 3 units
Installed Capacity of pump unit	3.0 m^3/s x 3 units
Head of Screw Pump	H = 2.5 + 2.6 = 5.1 m (MPP + L.L.W.L.)
Screw diameter	3.0 m
Pipe diameter	1.5 m
Number of flight	3
Length of Screw	10.2 m (H/ Sin)
Material of Screw	Steel (SS400)
Drive Unit	Diesel Engine 325 hp

(d) Control system

All main pumps will be operated manually.

(e) Trash screen

Only simple screen is proposed mainly for safety purpose.

4.3.5 Definitive Plan of Bandarharjo Drainage System

The definitive plan of Bandarharjo Drainage System is composed of the following works and the locations of which are shown in Fig. 4.3.6.

(1) Baru Retarding Pond

Plan of the Baru Retarding Pond is shown in Fig. 4.3.6. The periphery of the pond is surrounded by an inspection road for maintenance purpose .

(2) Pumping Station Facilities

The design criteria to be applied to the design of drainage pumps and other related facilities are described hereunder.

(a) Pump

Design criteria of pump is shown in the table below.

Pump Capacity	4.40 m^3/s
Design Water Level Outside	EL+ 0.35 m *1
Design Water Level Inside	EL -2.40 m *2

*1 M.H.W.L. (EL+0.25 m)+water surface slope of Semarang River (+0.1m)

*2 Equivalent to the Design Low Water Level of Baru River and the Retarding Pond

(b) Gate

Design criteria for the Baru Gate are shown in the table below.

Design water level outside	EL+0.35 m
Design bed elevation	EL-2.40 m
Freeboard	0.40 m
Design water level inside (Baru River)	EL-2.40 m
Design discharge	4.40 m^3/s

(c) Buildings for Management

The following buildings will be constructed in the Baru Pump Station site.

Name of Building	Total Floor Area (m^2)
Pump Control Building	156
Management Office	121
Garage	199
Staff House	45

The dimensions of the buildings are the same as the Asin Pump Station expecting same functions, except the Pump Control Building where the number of pump unit is smaller.

(3) Baru Pumping Station

(a) General Layout Plan of the Pumping Station Complex

General layout plan of the pumping station complex is as shown in Fig 4.3.7. The pump station is placed 31 m away from the high voltage electric transmission line according to the structure regulation. The layout is designed to accommodate all the buildings in the area of Baru River and minimize land acquisition.

(b) Type of Pump

Screw Type Pump is selected from the same reason as the Asin Pumping Station.

(c) Main Pump Specification

Tow main pump units are installed in Baru Pumping Station considering the maximum capacity of one unit and small risk of malfunction. Specification of the main pump is shown in the table below.

Type of Main Pump	Screw Pump
Lowest Water Level of Basin	LLWL = EL-2.50 m (0.1 m for loss at screen)
High Water Level of Spillway	HHWL =EL +0.55 m (0.2 m higher than H.W.L. outside)
Fill Point of Screw Pump	FP = EL-2.50 m (equal to L.L.W.L.)
Chute point of Screw Pump	CP = +1.20 m
Angle of Inclination of Screw Pump	= 30 degree
Required pump capacity	Q = 4.40 m^3/s
Designed number of main pump	N = 2 units
Installed Capacity of pump unit	2.3 m^3/s x 2 units
Head of Screw Pump	H = 2.5 + 2.5 = 5.0 m (MPP + L.L.W.L.)
Screw diameter	2.6 m
Pipe diameter	1.3 m
Number of flight	3
Length of Screw	10.2 m (H/ Sin)
Material of Screw	Steel (SS400)
Drive Unit	Diesel Engine 267 hp

(d) Control system

All main pumps will be operated manually.

(e) Trash Screen

Only simple screen is proposed mainly for safety purpose.

(4) Construction of Wall along the Eastern Boundary of the Target Area

Concrete plan for the dike along the eastern boundary of the target area requires further discussion with the Railway Authority. Therefore, for the time being, following structures are planned and cost is estimated for project evaluation purpose.

Item	dimension and structure
Dike	L=1,000 m, max.height=0.9 m, width=0.2 m, plain concrete
Box culvert (1)	L=100 m, inner dimension; 2 m(width) 1 m (height)
Box culvert (2)	L=100 m, inner dimension; 4 m(width) 2 m (height)

4.4 Project Evaluation

4.4.1 General

In general, a project for public works concerning flood and/or inundation control will be evaluated taking engineering and economic aspects into consideration. The engineering aspects are studied on the technical feasibility of the project from the viewpoint of construction, operation and maintenance.

Economic analysis appraises a project under study in terms of national and/or regional social economy by comparing and measuring its economic costs and benefits. In other words, economic analysis evaluates a degree of economic impacts on a project under study that would bring about in the national and/or regional social economy.

4.4.2 Methodology

The Project Evaluation of this time is a review of the evaluation executed in the Feasibility Study conducted by JICA Study Team in 1993, so the way of the project evaluation from the viewpoint of economic aspects in this stage of the Project is the same manner applied for the evaluation in the Feasibility Study at that time, namely, the mesh method is applied for estimation of inundation damages in the central urban area of Semarang City for the works of

Drainage System Improvement. The mesh used in the study this time is shown in Fig.4.4.1. In this study, a mesh unit is a square with 500 m of each side.

Number of mesh units used in the Feasibility Study Stage was 26 units (actually inundated units were 23 units among them) for the said objective area of the central Semarang City for the drainage system improvement works mentioned above in the case of 5 year-return period of the design scale. However, the numbers of mesh units for the study this time has became 39 mesh units (actually inundated units : 36 units) because that the inundated area has enlarged from 6.322 km^2 consisting of 4.252 km^2 for Asin river basin, 0.580 km^2 for Bandarharjo West area and 1.490 km^2 for Bandarharjo East area to 6.624 km^2 consisting of 4.439 km^2 for Asin river basin, 0.580 km^2 for Bandarharjo West area and 1.605 km^2 for Bandarharjo East area because of land subsidence.

For estimation of existing damages and updated damageable value of properties consisting of buildings and indoor movables, an interview survey was made this time. Table 4.4.1 shows a result of the Survey. In this case, the unit construction costs of Rp.200,000/m^2, Rp.105,000/m^2 and Rp.60,000/m^2 for permanent houses, semi permanent houses and temporary houses to be newly build respectively for ordinary houses, and Rp.200,000/m^2 for buildings of industrial and business zones assuming that buildings located in those areas are permanent type with an average depreciation rate of 56 %, property tax of 10 % and a share rate of such non-livable area of 17.43 % as rivers and/or roads at the same rate in the said Feasibility Study. The unit construction costs are based on a Guideline of Compensation for Land and Buildings published by the Committee of Compensation for Properties of Semarang City.

Land use situation in the objective area and share rates of such house type as permanent houses, semi permanent houses and temporary houses to the total residential area are reviewed and revised by each mesh unit based on the field survey this time as shown in Table 4.4.1. Value of indoor movables are estimated by the percentages against the value of buildings at the rates of 60 % for residence, 83 % for industrial buildings, and 137.5 % for commercial/business buildings as same rates as those in the Feasibility Study.

If the drainage system improvement works would not be executed, the inundation damage would remain. In other words, the said inundation damages would be reduced when the said improvement works would be executed, and this amount of damages can be said as the benefit of the Project. In this case, an annual average damages, x, should be estimated corresponding to an annual average probability of exceedance by using a following formula:

$$\int_{-\infty}^{x} f(x)dx = 1 - W(x)$$

Here, W means an annual occurrence of damages. A design scale of inundation in the objective area is set at 5-year return period as same as that in the Feasibility Study. So, the annual occurrence of damages, W, can be calculated at 1/5. Therefore, the said annual average probability of exceedance is calculated at 0.80 (= 1 - 1/5). Damages corresponding to this annual average probability of exceedance is a direct benefit of the drainage system improvement works this time because that this damages might be reduced by the Project.

The economic internal rate of return (EIRR) is calculated and used as an index of economic feasibility. This EIRR is defined by the following formula:

$$\sum_{t=1}^{t=T} \frac{C_t}{(1+R)^t} = \sum_{t=1}^{t=T} \frac{B_t}{(1+R)^t}$$

where, T = the last year of the project life,

C_t = an annual economic cost flow of the project under study in year t,

B_t = an annual benefit flow derived from the project in year t, and

R = the Economic Internal Rate of Return (EIRR).

The project life is assumed at 50 years after completion of the said drainage system improvement works.

4.4.3 Inundation Damages

Inundation depth, its duration and frequency are shown in Table 4.4.2. These figures are the other results of the said interview survey. On the other hand, ground settlements along the coastal main road are recorded as ranging from 10 cm in minimum to 90 cm in maximum between 1983 and 1997. Using these data, probable inundation depths as of 2005 in a case of without the drainage system improvement works are estimated by each mesh unit as shown in the table. If the drainage system improvement works would not executed, the damage would remain due to inundation in these scales.

The same damage rate used in the Feasibility Study for each land use by inundation depth and inundation frequency resulted the said interview survey this time are applied for estimation of inundation damages multiplying to the said damageable value by each inundation depth.

As a result, the annual average probable damages are estimated at Rp.16,101 million in the whole objective area for drainage system improvement works. In this case, there will actually be damages to such public facilities as roads, bridges and, such indirect damages as commercial loss of shops and stores due to business disturbance, income decrease of people living there due to transportation stoppage caused by inundation and so on. However, these damages are neglected because of uncertainty of figures and/or rates.

4.4.4 Identification of Economic Benefit

The above mentioned annual average probable damages, namely the amount of Rp.16,101 million, are converted into the benefit due to drainage system improvement works. In this case, there will be such several kinds of benefit as decrease of medical expenditure due to decrease of incidence rate of disease due to improvement of living condition and so on. However, these benefits are neglected because of uncertainty of figures and/or rates.

4.4.5 Identification of Economic Cost

Economic cost of a project is identified as opportunity cost of the project. In this case, if goods and services would be invested in the project under study, they could no longer be utilized for other projects. This implies that the benefits of the other projects could have been created would be sacrificed. These sacrificed benefits of the other projects are called opportunity cost of the project. A project cost consists of foreign currency portion and local currency portion.

Firstly, a gross construction cost is estimated based on unit prices and work volume, and this gross construction cost includes net construction cost, engineering cost for supervision, cost for administration, corporation tax, cost for compensation, physical contingency and price contingency.

(1) Foreign currency portion

Using the said gross construction cost, an economic cost of the Project is estimated. In this study, the net construction cost includes labour cost, cost for materials, and cost for equipment. For the foreign currency portion, these costs for labour, materials and equipment are estimated in either Cost Insurance Freight (CIF) price or

Free on Board (FOB) price. These international prices are assumed to reflect economic cost directly.

Corporation tax is not included in the foreign currency portion because that the said tax should be paid by local currency based on the taxation regulation in Indonesia.

For economic evaluation of the Project, such transfer cost as contractor's overhead and profit should be deducted, and price contingency should be excluded because that comparison of cost and benefit is made by net present value.

(2) Local currency portion

Because it is presumed that local markets in developing countries are distorted by price controls and other regulations, prices in the domestic markets do not reflect economic scarcity of goods and services. This means that the prices can not be used to identify economic costs of local procurement and have to be converted into economic prices.

In economic analysis of a project, conversion factors are used to convert the costs in domestic markets into economic costs of a project.

Using export and import statistics, a standard conversion factor (SCF) is estimated. The SCF converts the domestic commodity prices into the economic prices that can be assumed to reflect the economic scarcity of the local costs (refer to Table 4.4.3).

However, the SCF is applied to only tradable goods. The economic cost of non-tradable goods and services have to be separately evaluated. Conversion factors of land, skilled and non-skilled labours are respectively estimated.

Economic wage of unskilled laborers to be employed for the construction works is assumed to be 90 % of the actual market wage, taking of the employment opportunity of laborers in the study area.

Economic cost of land compensation including other compensation cost such as the cost for removal of houses is assumed to be 100 % of the financial cost, taking account of the opportunity cost of land use.

(3) Total Economic Cost

The estimated economic cost is shown in Table 4.4.4, and summarized as follows:

Economic Cost for Drainage System Improvement Works

(Rp.10^6)

Year	FC portion	LC portion	Total
2000/01	1,869	4,079	5,948
2001/02	11,920	20,160	32,079
2002/03	14,624	20,844	35,469
2003/04	1,789	7,063	8,852
Total	30,202	52,146	82,348

(4) Cost for Operation/Maintenance and Replacement

Financial costs for operation/maintenance (OM cost) and annualized replacement cost (cost for R) are estimated by work items at Rp.804 million per annum. From these financial costs, an economic cost in total is estimated at Rp.759 million per annum by the same manner for estimation of the said economic construction cost. This cost for OM and R will be a burden to the Project until the end of the project life of 50 years after completion of the drainage system improvement works. Detail of calculation process is also shown in Table 4.4.4.

4.4.6 Economic Evaluation of Urban Drainage System Improvement

The evaluation of the drainage system improvement works as a component of the Project is made by using cash flows of the said costs and benefits as shown in Table 4.4.5. The results are also shown in that Table and summarized below.

EIRR (%)	15.13
B/C	1.29
NPV (Rp.10^6)	15,317

In this case, B/C rates are comparison of benefit and cost in present value of them, and NPV means net cash balance between benefits and costs also expressed by their present value. For calculation of present value, a discount rate of 12 % is applied as same as that in similar projects in Indonesia.

From the viewpoint of EIRR, the rate is slightly decreased from 15.7 % in the Feasibility Study stage to 15.1 % as indicated above. The rate of B/C has also decreased from 1.81 to 1.29. While the amount of net cash balance has increased from Rp.14,872 million in the Feasibility Study stage to Rp.15,317 million as shown in the above table. And, the annual average benefit has increased from Rp.10,059 million in the Feasibility Study stage to Rp.16,101 million as shown in Table 4.4.5.

It means that inundation damages have increased caused by ground settlement in inundation depth and inundation area in addition to increase of the value of properties due to price escalation, while the cost for the works has also increased because that such additional works as a new dike construction works belonging to the Baru Pump Drainage scheme and the treatment works of heavy metal content of river bed material to be dumped to spoil banks are added to the original plan in addition to the price escalation to make the works to correspond with the Definitive Plan level of this stage of the Project.

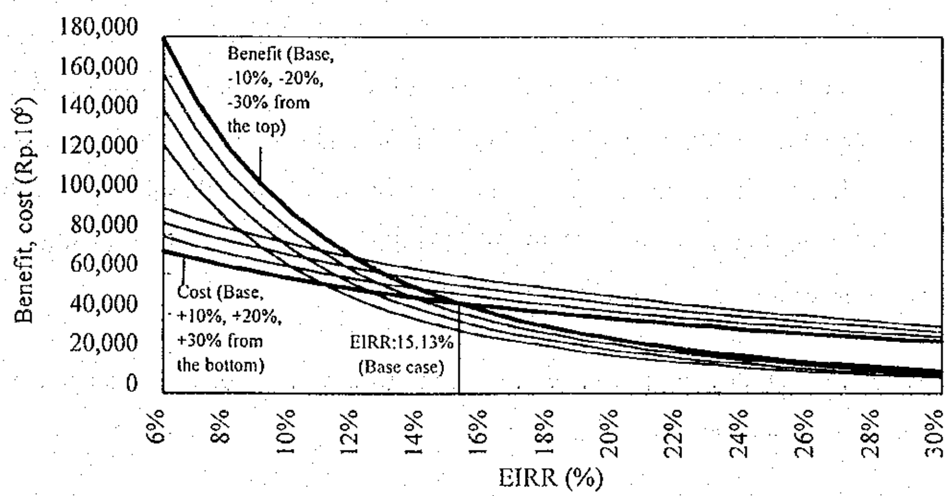
4.4.7 Sensitivity Test for the Urban Drainage System Improvement

The economic internal rate of return changes its value depending on the parameters employed for the calculation. Out of these parameters, the construction cost of the Project and its benefit are the most important determinants of the economic analysis.

Therefore, a sensitivity analysis is made for 16 combined cases including base case under the benefit of -10 %, -20 % and -30 %, and the cost of +10, +20 % and +30 % taking into account of fluctuation of the benefit and the cost to be likely to come at present economic situation in Indonesia.

A figure and a table hereunder show the results of sensitivity analysis for economic features.

Sensitivity of EIRR



The EIRR under both the benefit and the cost in base case is calculated as 15.13 % as mentioned above. And, nevertheless under the case of the benefit of 10 % decrease and the cost of 10 % increase , the EIRR is calculated as 12.63 % which is still keeping the rate of more than 12 % suggested by such international financing institutions as the World Bank.

Also in the case under the benefit is base estimation and the cost is increased by 20 %, and in the case under the benefit is decreased by 20 % and the cost is keeping as base estimation, the EIRRs are still keeping more than 12 % as 12.85 % and 12.38 % respectively as indicated in the above table.

It means that the drainage system improvement works as a component of the Project is economically sound in the case of (1) 20% increase in cost with the base case of benefit, (2) base case of the cost with 20 % decrease in benefit and/or (3) 10% increase in cost with 10% decrease in benefit.

4.4.8 Project Justification for Urban Drainage System Improvement

The EIRR of Drainage System Improvement Works for central area of Semarang indicates 15.1 %, and in the case of (1) 20 % increase in cost with the base case of benefit, (2) base case of the cost with 20 % decrease in benefit and/or (3) 10 % increase in cost with 10 % decrease in benefit, it is still keeping more than 12 %.

As mentioned in previous Sub-clause of this CHAPTER, the economic benefit excludes several benefits which might be derived from reducing the damages to such public facilities as roads, bridges and, such indirect damages as commercial loss of shops and stores due to business disturbance, income decrease of people living there due to transportation stoppage caused by inundation and so on by the reason of uncertainty. Such intangible benefits as decrease of medical expenditure due to decrease of incidence rate of disease due to improvement of living condition are also excluded in the said economic benefit because of uncertainty too. If these uncertain benefit could be quantified, it is sure that the EIRR will be higher than 12 % even if in the case of (1) 30 % increase in cost with the base case of benefit, (2) base case of the cost with 30 % decrease in benefit.

Accordingly, it may say that the Drainage System Improvement Works as a component of the Project has high economic viability as a whole.

TABLES

CHAPTER 4
FORMULATION OF DEFINITIVE PLAN

Table 4.3.1 COMPARISON OF PUMP TYPE

Type	HorizontalShaft axis Flow Pump	VerticalShaft axisFlow Pump	SubmersibleMotor Pump	Screw Pump
Structure	complicated	complicated	simple	very simple
Maintenance work	easy	slightly difficult	difficult on site works	very easy
Overhaul works on Site	easy	difficult	very difficult	very easy
Necessity of Spare Pump Unit	No	No	Yes	No
Noise level and Vibration	high	slightly high	low	low
Possibility of Cavitation	Yes	Yes	Yes	No
Possibility of Clogging by muddy water	Yes	Yes	yes	No
Possibility of Clogging by trash	Yes	Yes	Yes	No
Motor Capacity (indicated by ratio)	100	100	100	133
Construction works	slightly troublesome	slightly troublesome	easy	easy
Weight (indicated by ratio)	100	300	150	480
Life Span	very long	long	slightly short	very long
Spare Pump	not required	not required	required	not required
Installation cost*	140	150	130	100
Evaluation	B	D	C	A

* based on quataiton of manufactures

Table 4.4.1 ESTIMATION OF DAMAGEABLE VALUE IN DRAINAGE AREA

Old No.	New No.	Location in mesh X	Location in mesh Y	Land use – In percentage (%) Green zone	Resi-dence	Indus-tries	Business zone	Land use – In hectare (ha) Green zone	Resi-dence	Indus-tries	Business zone	Percentage of house type of residence (%) Perma-nent	Semi-perm.	Tempo-rary	Damageable Value (Rp.10^6) – Buildings Green zone	Residence Perm.	Semi P.	Temp.	Sub-total	Industry	Business	Total	Indoor movables Residence	Industry	Business	Total
1	0	8	7	20%	45%	15%	20%	0.36	0.81	0.27	0.36	65%	25%	10%	0	208	42	16	266	178	237	680	159	147	325	632
2	00	9	7	55%	15%	15%	15%	1.09	0.30	0.30	0.30	50%	40%	10%	1	58	24	6	88	194	194	476	53	161	266	480
3		10	7	-	-	-	-	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4		11	7	-	-	-	-	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5		7	8	-	-	-	-	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	1	8	8	15%	55%	10%	20%	3.75	13.75	2.50	5.00	65%	30%	5%	2	3,507	850	135	4,491	1,635	3,270	9,398	2,695	1,357	4,496	8,548
7	2	9	8	30%	45%	10%	15%	6.99	10.48	2.33	3.49	65%	30%	5%	3	2,674	648	103	3,425	1,524	2,285	7,237	2,055	1,265	3,143	6,462
8	3	10	8	40%	35%	10%	15%	5.94	5.20	1.48	2.23	60%	30%	10%	3	1,223	321	102	1,646	971	1,456	4,076	988	806	2,002	3,795
9	4	11	8	30%	30%	10%	30%	2.67	2.67	0.89	2.67	65%	30%	5%	1	681	165	26	873	582	1,747	3,204	524	483	2,402	3,409
10	7	8	9	15%	70%	5%	10%	3.05	14.25	1.02	2.04	65%	30%	5%	1	3,635	881	140	4,655	666	1,331	6,654	2,793	553	1,831	5,176
11	8	9	9	20%	60%	5%	15%	5.00	15.00	1.25	3.75	65%	30%	5%	2	3,826	927	147	4,900	817	2,452	8,172	2,940	678	3,372	6,990
12	9	10	9	25%	60%	5%	10%	6.25	15.00	1.25	2.50	65%	30%	5%	3	3,826	927	147	4,900	817	1,635	7,355	2,940	678	2,248	5,866
13	10	11	9	20%	55%	10%	15%	5.00	13.75	2.50	3.75	60%	30%	10%	2	3,237	850	270	4,357	1,635	2,452	8,446	2,614	1,357	3,372	7,343
14	13	8	10	25%	50%	10%	15%	4.38	8.77	1.75	2.63	65%	30%	5%	2	2,236	542	86	2,863	1,146	1,720	5,731	1,718	952	2,365	5,034
15	14	9	10	20%	50%	15%	15%	5.00	12.50	3.75	3.75	65%	30%	5%	2	3,188	772	123	4,083	2,452	2,452	8,990	2,450	2,035	3,372	7,857
16	15	10	10	15%	60%	10%	15%	3.75	15.00	2.50	3.75	65%	30%	5%	2	3,826	927	147	4,900	1,635	2,452	8,989	2,940	1,357	3,372	7,669
17	16	11	10	15%	60%	10%	15%	3.75	15.00	2.50	3.75	65%	30%	5%	2	3,826	927	147	4,900	1,635	2,452	8,989	2,940	1,357	3,372	7,669
18	19	8	11	10%	55%	15%	20%	1.53	8.40	2.29	3.05	70%	25%	5%	1	2,307	432	82	2,821	1,498	1,997	6,317	1,693	1,243	2,746	5,682
19	20	9	11	20%	55%	10%	15%	5.00	13.75	2.50	3.75	70%	25%	5%	2	3,777	708	135	4,620	1,635	2,452	8,709	2,772	1,357	3,372	7,501
20	21	10	11	15%	65%	5%	15%	3.75	16.25	1.25	3.75	70%	25%	5%	2	4,463	837	159	5,459	817	2,452	8,731	3,276	678	3,372	7,326
21	22	11	11	10%	50%	10%	30%	2.50	12.50	2.50	7.50	70%	20%	10%	1	3,433	515	245	4,193	1,635	4,905	10,734	2,516	1,357	6,744	10,617
22	25	8	12	10%	60%	10%	20%	1.30	7.80	1.30	2.60	70%	25%	5%	1	2,143	402	77	2,622	851	1,701	5,174	1,573	706	2,339	4,618
23	26	9	12	10%	50%	10%	30%	2.50	12.50	2.50	7.50	70%	25%	5%	1	3,433	644	123	4,200	1,635	4,905	10,740	2,520	1,357	6,744	10,621
24	27	10	12	20%	35%	10%	35%	4.73	8.27	2.36	8.27	70%	25%	5%	2	2,272	426	81	2,780	1,546	5,410	9,738	1,668	1,283	7,439	10,390
25	31	8	13	10%	70%	5%	15%	0.94	6.57	0.47	1.41	70%	25%	5%	0	1,804	338	64	2,207	307	921	3,435	1,324	255	1,266	2,845
26	32	9	13	10%	55%	10%	25%	2.50	13.75	2.50	6.25	80%	15%	5%	1	4,316	425	135	4,876	1,635	4,087	10,599	2,926	1,357	5,620	9,902
	5	12	8	20%	40%	10%	30%	2.14	4.28	1.07	3.21	60%	35%	5%	1	1,006	308	42	1,357	699	2,097	4,154	814	580	2,883	4,277
	6	13	8	20%	50%	15%	15%	3.44	8.60	2.58	2.58	65%	30%	5%	2	2,192	531	84	2,808	1,686	1,686	6,182	1,685	1,400	2,319	5,403
	11	12	9	45%	35%	5%	15%	11.25	8.75	1.25	3.75	60%	30%	10%	6	2,060	541	172	2,772	817	2,452	6,048	1,663	678	3,372	5,714
	12	13	9	25%	55%	5%	15%	5.05	11.10	1.01	3.03	65%	30%	5%	2	2,832	686	109	3,627	660	1,980	6,270	2,176	548	2,723	5,447
	17	12	10	30%	45%	10%	15%	7.50	11.25	2.50	3.75	65%	30%	5%	4	2,869	695	110	3,675	1,635	2,452	7,766	2,205	1,357	3,372	6,934
	18	13	10	30%	40%	15%	15%	5.94	7.92	2.97	2.97	70%	20%	10%	3	2,175	326	155	2,656	1,942	1,942	6,542	1,594	1,611	2,670	5,875
	20	10	11	20%	55%	10%	15%	5.00	13.75	2.50	3.75	70%	25%	5%	2	3,777	708	135	4,620	1,635	2,452	8,709	2,772	1,357	3,372	7,501
	23	12	11	15%	35%	15%	35%	2.71	6.33	2.71	6.33	80%	15%	5%	1	1,988	196	62	2,246	1,775	4,142	8,164	1,348	1,473	5,695	8,516
	24	13	11	10%	30%	25%	35%	2.14	6.42	5.35	7.49	80%	15%	5%	1	2,015	198	63	2,276	3,498	4,897	10,672	1,366	2,903	6,733	11,002
	28	11	12	15%	40%	20%	25%	1.37	3.66	1.83	2.29	85%	10%	5%	1	1,222	75	36	1,334	1,198	1,498	4,030	800	995	2,059	3,854
	30	13	12	10%	60%	10%	20%	0.37	2.21	0.37	0.74	60%	30%	10%	0	519	136	43	699	240	481	1,420	419	200	661	1,280
	33	10	13	10%	30%	20%	40%	0.92	2.75	1.83	3.66	80%	15%	5%	0	863	85	27	975	1,198	2,396	4,570	585	995	3,295	4,874
	38	9	14	15%	30%	20%	35%	1.20	2.41	1.61	2.81	85%	10%	5%	1	803	50	24	877	1,050	1,838	3,766	526	872	2,527	3,925
Total								130.75	331.69	69.54	130.41															

(Note) 1. Standard construction price of building Permanent - Rp 200 (thousand/m²)
Semi P. - Rp 105 (thousand/m²)
Temporary- Rp 60 (thousand/m²)

2. Depreciation : 56%
3. Tax: 10%
4. Reduction: 17.43% (for exculding rivers, roads and so on.)

5. - : Not included in the area for drainage system improvemen

Table 4.4.2 ESTIMATION OF DAMAGES DUE TO INUNDATION IN DRAINAGE AREA

Old No.	New No.	Location in mesh X	Location in mesh Y	Inundation depth (m) Existing depth	Existing sink	Probable depth	Dur (day)	Frequency (time/year)	Damage rate Buildings Green zone	Buildings Residence	Buildings Industries	Buildings Business zone	Indoor movables Residence	Indoor movables Industries	Indoor movables Business zone	Damaged Value (Rp.10^6) Buildings Green zone	Buildings Residence	Buildings Industries	Buildings Business zone	Indoor movables Residence	Indoor movables Industries	Indoor movables Business zone	Total
1	0	8	7	0.40	0.30	0.49	0.17	2.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	3	2	3	13	12	16	49
2	00	9	7	0.15		0.15	0.13	15.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	7	15	15	32	99	100	270
3		10	7	0.00		0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0	0	0
4		11	7	0.00		0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0	0	0
5		7	8	0.00		0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0	0	0
6	1	8	8	0.50	0.20	0.56	1.00	4.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	0	129	47	94	647	312	806	2,035
7	2	9	8	0.00		0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0	0	0
8	3	10	8	0.20		0.20	0.21	5.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	44	26	39	201	166	251	726
9	4	11	8	0.30		0.30	0.83	10.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	46	31	93	213	199	603	1,185
10	7	8	9	0.50		0.50	0.50	3.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	0	101	14	29	503	95	246	988
11	8	9	9	0.50		0.50	0.50	3.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	0	106	18	53	529	117	453	1,276
12	9	10	9	0.20	0.20	0.26	0.50	5.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	130	22	43	598	139	282	1,215
13	10	11	9	0.50		0.50	1.00	15.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	1	471	177	265	2,353	1,170	2,266	6,702
14	13	8	10	0.50		0.50	0.13	15.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	1	309	124	186	1,546	821	1,589	4,575
15	14	9	10	0.50		0.50	0.17	15.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	1	441	265	265	2,205	1,756	2,266	7,198
16	15	10	10	0.30		0.30	1.00	4.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	104	35	52	479	223	339	1,231
17	16	11	10	0.50		0.50	1.00	15.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	1	529	177	265	2,646	1,170	2,266	7,053
18	19	8	11	0.30	0.40	0.42	0.13	10.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	150	79	106	689	511	689	2,224
19	20	9	11	0.30		0.30	0.13	3.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	73	26	39	338	167	254	898
20	21	10	11	0.50	0.30	0.59	0.17	10.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	0	393	59	177	1,965	390	1,511	4,495
21	22	11	11	0.40		0.40	2.00	40.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	1	889	347	1,040	4,096	2,231	6,771	15,374
22	25	8	12	0.20		0.20	0.04	10.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	139	45	90	640	290	587	1,792
23	26	9	12	0.80		0.80	0.13	7.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	0	212	82	247	1,058	546	2,115	4,261
24	27	10	12	0.70	0.50	0.86	0.25	10.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	1	200	111	390	1,001	738	3,333	5,773
25	31	8	13	0.50		0.50	0.33	8.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	0	127	18	53	636	117	454	1,404
26	32	9	13	0.40		0.40	0.08	8.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	207	69	173	953	446	1,128	2,977
	5	12	8	0.40	0.60	0.59	2.00	8.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	58	30	89	265	191	579	1,211
	6	13	8	0.40		0.40	4.00	10.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	149	89	89	686	575	582	2,171
	11	12	9	0.40	0.30	0.49	2.00	15.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	2	220	65	195	1,016	418	1,270	3,185
	12	13	9	0.50		0.50	2.00	5.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	0	131	24	71	653	158	610	1,646
	17	12	10	0.40	0.40	0.52	2.00	8.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	1	156	69	104	718	446	677	2,171
	18	13	10	0.40		0.40	2.00	10.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	1	141	103	103	649	662	670	2,328
	20	10	11	0.40		0.40	0.13	10.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	1	245	87	130	1,128	558	846	2,994
	23	12	11	0.50	0.90	0.78	0.04	3.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	0	49	38	89	243	254	765	1,439
	24	13	11	0.50	0.70	0.72	0.13	10.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	0	164	252	353	819	1,669	3,016	6,274
	28	11	12	0.40	0.10	0.43	0.13	4.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	28	25	32	130	163	207	586
	30	13	12	0.40		0.40	0.13	4.00	0.021	0.005	0.005	0.005	0.041	0.041	0.025	0	15	5	10	68	33	66	198
	33	10	13	0.50		0.50	0.04	10.00	0.024	0.007	0.007	0.007	0.060	0.058	0.045	0	70	86	173	351	572	1,476	2,728
	38	9	14	0.00		0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0	0	0
Total																13	6,233	####	5,153	#####	17,416	39,090	100,632

Remarks

Damages rate by inundation depth

Inundation depth	Buildings Green zone	Buildings Residence	Buildings Industries	Buildings Business zone
0.00	0.0000	0.0000	0.0000	0.0000
0.01	0.0210	0.0053	0.0053	0.0053
0.50	0.0240	0.0072	0.0072	0.0072
1.00	0.0370	0.0109	0.0109	0.0109
1.50	0.0370	0.0109	0.0109	0.0109
2.00	0.0370	0.0152	0.0152	0.0152
2.50	0.0370	0.0152	0.0152	0.0152

Inundation depth	Indoor movables			
0.00	0.0000	0.0000	0.0000	0.0000
0.01	0.0000	0.0407	0.0411	0.0251
0.50	0.0000	0.0600	0.0575	0.0448
1.00	0.0000	0.0642	0.0613	0.0543
1.50	0.0000	0.0622	0.0626	0.0561
2.00	0.0000	0.0683	0.0632	0.0579
2.50	0.0000	0.0690	0.0632	0.0597

Annual average inundation damages:

Probable damages(Rp.10^6):	100,632
There will actually be damages to public facilities and indirect damages. However, those damages are neglected because of uncertainty.	
Return period (year):	5
Damage reduction probability:	0.80
Annual total damages:	20,126
Damages to be reduced:	**16,101**

Table 4.4.3 ESTIMATION OF STANDARD CONVERSION FACTOR

(Note)
Equaition for calculation of standard conversion factor (SCF):

$$\mathbf{SCF} = \frac{\textbf{Import amount + Export amount}}{\textbf{(Import amount + Import customs) + (Export amount - Export tax + Excise duties)}}$$

(Rp.10^6)

Year	Import amount	Export amount	Import customes	Export taxes	Excise duties
1992/93	36,016	33,967	3,223	9	2,242
1993/94	37,961	36,823	3,555	14	2,626
1994/95	46,129	40,053	3,218	120	3,001
1995/96	55,360	45,418	3,248	201	3,668
Total	175,466	156,261	13,244	344	11,537
				SCF=	0.93139

(Note) Refer to Tables 2.3.5 and 2.3.9.

Table 4.4.4 ANNUAL DISBURSEMENT OF CONSTRUCTION COST AND ESTIMATION OF ITS ECONOMIC COST
(Drainage System Improvement)

(Rp.10^6)

Cost item	Distribution																	
	2000/01			2001/02			2002/03			2003/04			2004/05			Total		
	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Total
Construction works	1,454	2,482	3,936	10,377	17,949	28,326	13,498	18,598	32,096	1,320	6,481	7,801	0	0	0	26,649	45,510	72,159
Preparatory works	1,454	2,482	3,936	242	414	656	242	414	656	485	827	1,312	0	0	0	2,423	4,137	6,560
Semarang river improvement	0	0	0	326	1,603	1,929	490	2,405	2,895	0	0	0	0	0	0	816	4,008	4,824
Asin drainage system	0	0	0	2,163	9,606	11,769	11,612	10,237	21,849	691	3,230	3,921	0	0	0	14,466	23,073	37,539
Bandarharjo drainage system	0	0	0	7,646	6,326	13,972	1,154	5,542	6,696	144	2,424	2,568	0	0	0	8,944	14,292	23,236
Engineering cost for supervision	392	211	603	1,401	754	2,155	953	513	1,466	448	241	689	0	0	0	3,194	1,719	4,913
Tax	0	454	454	0	3,048	3,048	0	3,357	3,357	0	849	849	0	0	0	0	7,708	7,708
Compensation cost	0	1,012	1,012	0	0	0	0	0	0	0	0	0	0	0	0	0	1,012	1,012
Sub total	1,846	4,159	6,005	11,778	21,751	33,529	14,451	22,468	36,919	1,768	7,571	9,339	0	0	0	29,843	55,949	85,792
Administration	0	346	346	0	1,983	1,983	0	2,247	2,247	0	546	546	0	0	0	0	5,122	5,122
Sub-total	1,846	4,505	6,351	11,778	23,734	35,512	14,451	24,715	39,166	1,768	8,117	9,885	0	0	0	29,843	61,071	90,914
Phisical contingency	185	416	601	1,178	2,175	3,353	1,445	2,247	3,692	177	757	934	0	0	0	2,985	5,595	8,580
Sub-total	2,031	4,921	6,952	12,956	25,909	38,865	15,896	26,962	42,858	1,945	8,874	10,819	0	0	0	32,828	66,666	99,494
Price contingency	188	1,278	1,466	1,626	9,340	10,966	2,532	12,654	15,186	377	5,208	5,585	0	0	0	4,723	28,480	33,203
Total	2,219	6,199	8,418	14,582	35,249	49,831	18,428	39,616	58,044	2,322	14,082	16,404	0	0	0	37,551	95,146	132,697
Financial cost (Total-Price conti.)	2,031	4,921	6,952	12,956	25,909	38,865	15,896	26,962	42,858	1,945	8,874	10,819	0	0	0	32,828	66,666	99,494
Economic cost	1,869	4,079	5,948	11,920	20,160	32,079	14,624	20,844	35,469	1,789	7,063	8,852	0	0	0	30,202	52,146	82,348

Remarks:

1. Price share rates of construction:

	2000/01 FC	2000/01 LC	2001/02 FC	2001/02 LC	2002/03 FC	2002/03 LC	2003/04 FC	2003/04 LC
- Labour	0%	12%	0%	10%	0%	12%	0%	13%
- Equipment and Material	100%	88%	100%	90%	100%	88%	100%	87%

2. Tax : 10 % for construction and engineering services.
3. Contractor's overhead & profit: 8%
4. Standard conversion factor: 0.9314 (Refer to Table 4.8.3)
5. Shadow wage rate (economic wage rate): 90%
6. Price : As of October 1997.
7. Conversion rate : US$ 1.00 = Rp.2,971 and \100 = Rp.2,437.

8. Operation/maintenance and replacement cost:

Annualized work item	F.C.	L.C.	Total
Power consumption:	0	62	62
Periodical inspection:	0	4	4
Pump replacement cost:	83	21	104
Maintenance for civil:	0	574	574
Administration:	0	60	60
Financial cost	83	721	804
Economic cost	83	676	759

Table 4.4.5 CALCULATION OF ECONOMIC INTERNAL RATE OF RETURN (DRAINAGE SYSTEM IMPROVEMENT)

(Rp.10^6)

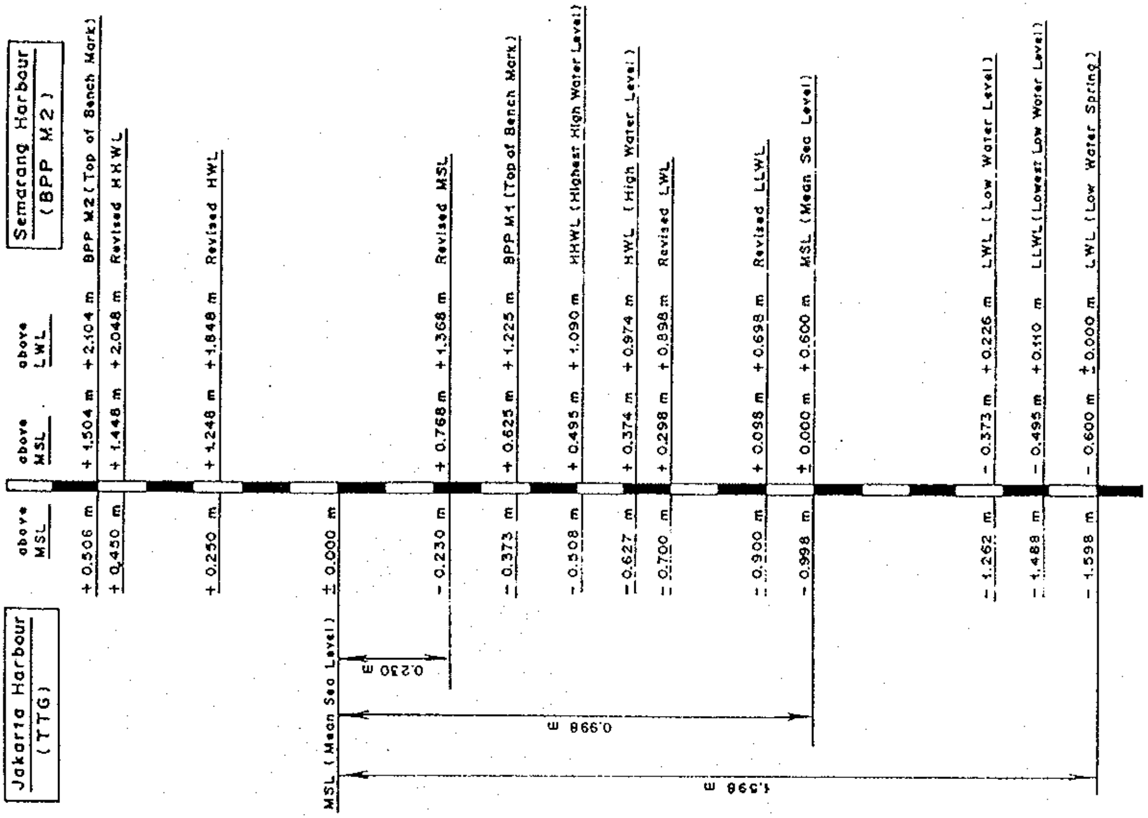
Year in order	Year	Cost				Benefit	Cash balance
		Construction cost		Cost for	Total		
		F/C	L/C	O/M & R			
1	1998/99	0	0	0	0	0	0
2	1999/00	0	0	0	0	0	0
3	2000/01	1,869	4,079	0	5,948	0	-5,948
4	2001/02	11,920	20,160	0	32,080	0	-32,080
5	2002/03	14,624	20,844	0	35,468	0	-35,468
6	2003/04	1,789	7,063	0	8,852	0	-8,852
7	2004/05			759	759	16,101	15,342
8	2005/06			759	759	16,101	15,342
9	2006/07			759	759	16,101	15,342
10	2007/08			759	759	16,101	15,342
11	2008/09			759	759	16,101	15,342
12	2009/10			759	759	16,101	15,342
13	2010/11			759	759	16,101	15,342
14	2011/12			759	759	16,101	15,342
15	2012/13			759	759	16,101	15,342
16	2013/14			759	759	16,101	15,342
17	2014/15			759	759	16,101	15,342
18	2015/16			759	759	16,101	15,342
19	2016/17			759	759	16,101	15,342
20	2017/18			759	759	16,101	15,342
21	2018/19			759	759	16,101	15,342
22	2019/20			759	759	16,101	15,342
23	2020/21			759	759	16,101	15,342
24	2021/22			759	759	16,101	15,342
25	2022/23			759	759	16,101	15,342
26	2023/24			759	759	16,101	15,342
27	2024/25			759	759	16,101	15,342
28	2025/26			759	759	16,101	15,342
29	2026/27			759	759	16,101	15,342
30	2027/28			759	759	16,101	15,342
31	2028/29			759	759	16,101	15,342
32	2029/30			759	759	16,101	15,342
33	2030/31			759	759	16,101	15,342
34	2031/32			759	759	16,101	15,342
35	2032/33			759	759	16,101	15,342
36	2033/34			759	759	16,101	15,342
37	2034/35			759	759	16,101	15,342
38	2035/36			759	759	16,101	15,342
39	2036/37			759	759	16,101	15,342
40	2037/38			759	759	16,101	15,342
41	2038/39			759	759	16,101	15,342
42	2039/40			759	759	16,101	15,342
43	2040/41			759	759	16,101	15,342
44	2041/42			759	759	16,101	15,342
45	2042/43			759	759	16,101	15,342
46	2043/44			759	759	16,101	15,342
47	2044/45			759	759	16,101	15,342
48	2045/46			759	759	16,101	15,342
49	2046/47			759	759	16,101	15,342
50	2047/48			759	759	16,101	15,342
51	2048/49			759	759	16,101	15,342
52	2049/50			759	759	16,101	15,342
53	2050/51			759	759	16,101	15,342
54	2051/52			759	759	16,101	15,342
55	2053/54			759	759	16,101	15,342
56	2054/55			759	759	16,101	15,342
Total		30,202	52,146	37,950	120,298	805,050	684,752

In the condition of discount rate at 12 %:

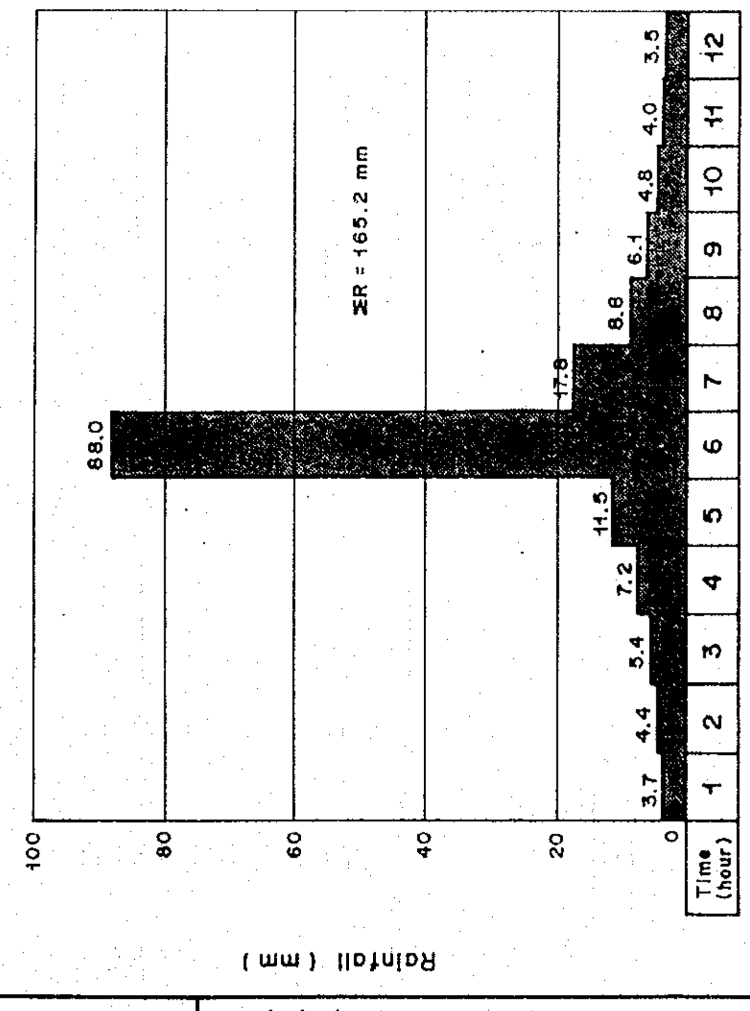
Net Present value (NPV):	52,425	67,742	15,317
Internal rate of return (EIRR):			15.13%
B/C			1.29

FIGURES

CHAPTER 4
FORMULATION OF DEFINITIVE PLAN

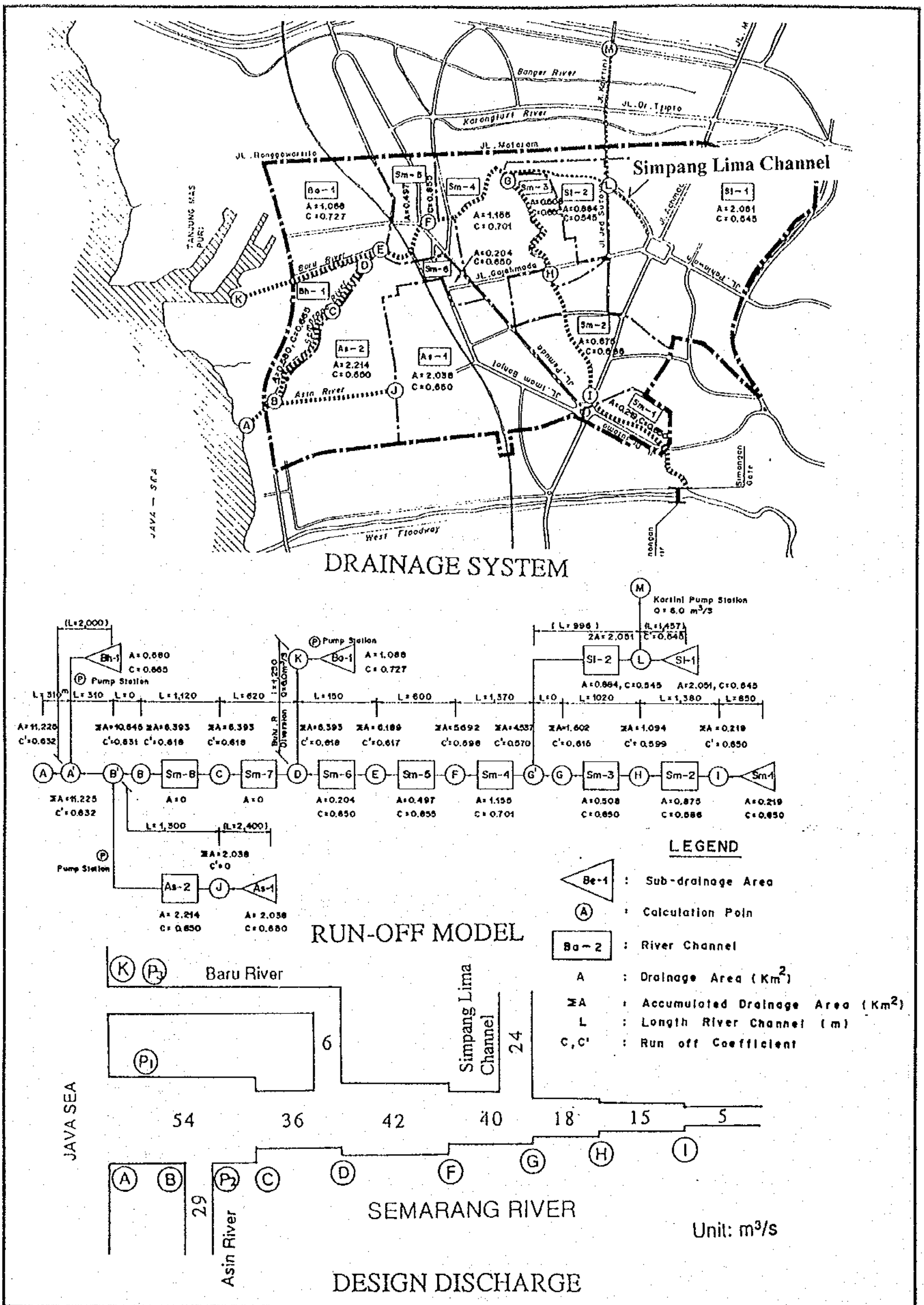


TIDAL LEVEL OF SEMARANG HARBOR



DESIGN RAINFALL FOR PUMP DRAINAGE

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. 4.1.1 DESIGN RAINFALL FOR PUMP DRAINAGE AND TIDAL LEVEL AT SEMARANG HARBOR
JAPAN INTERNATIONAL COOPERATION AGENCY	

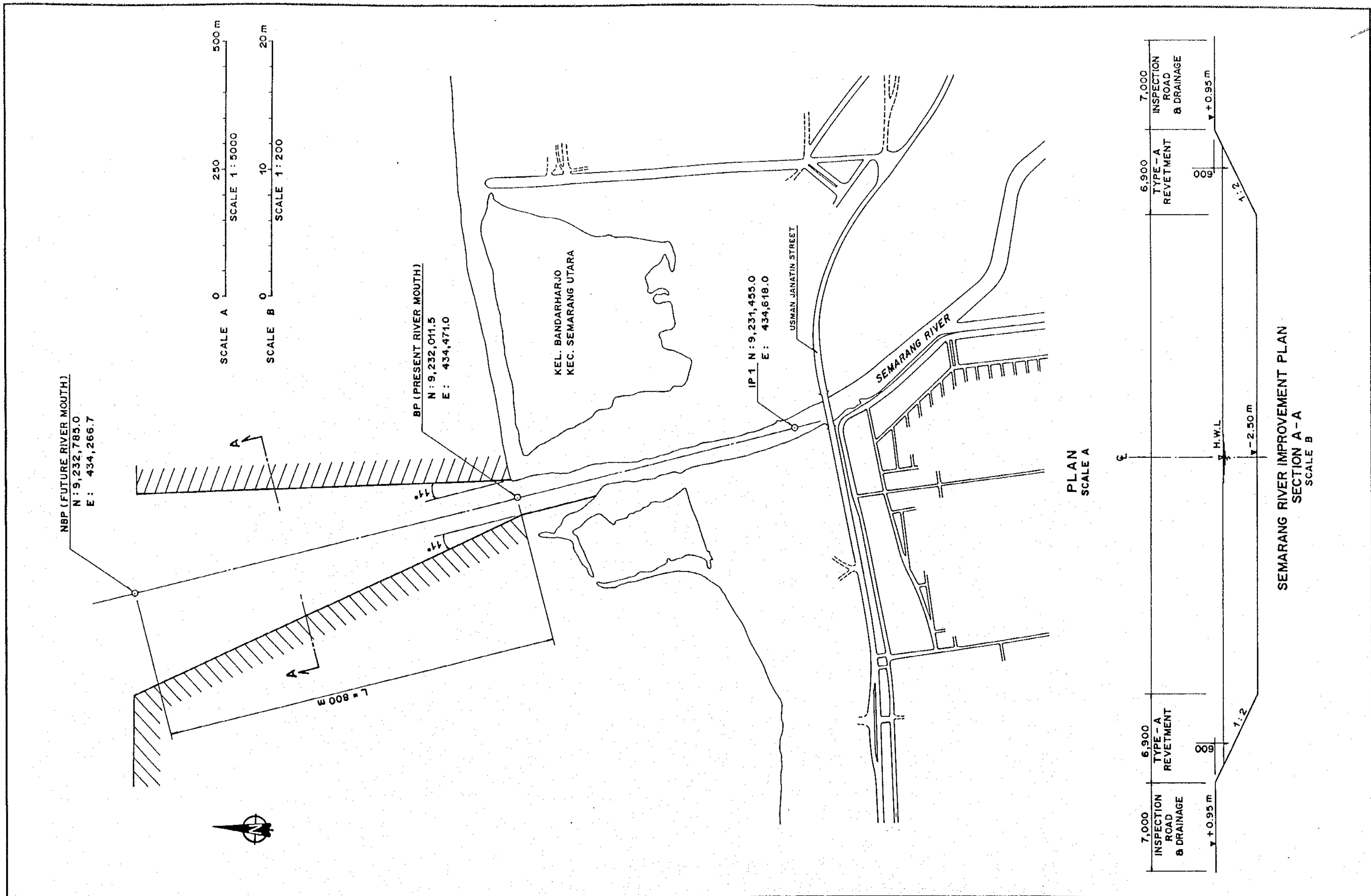


THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

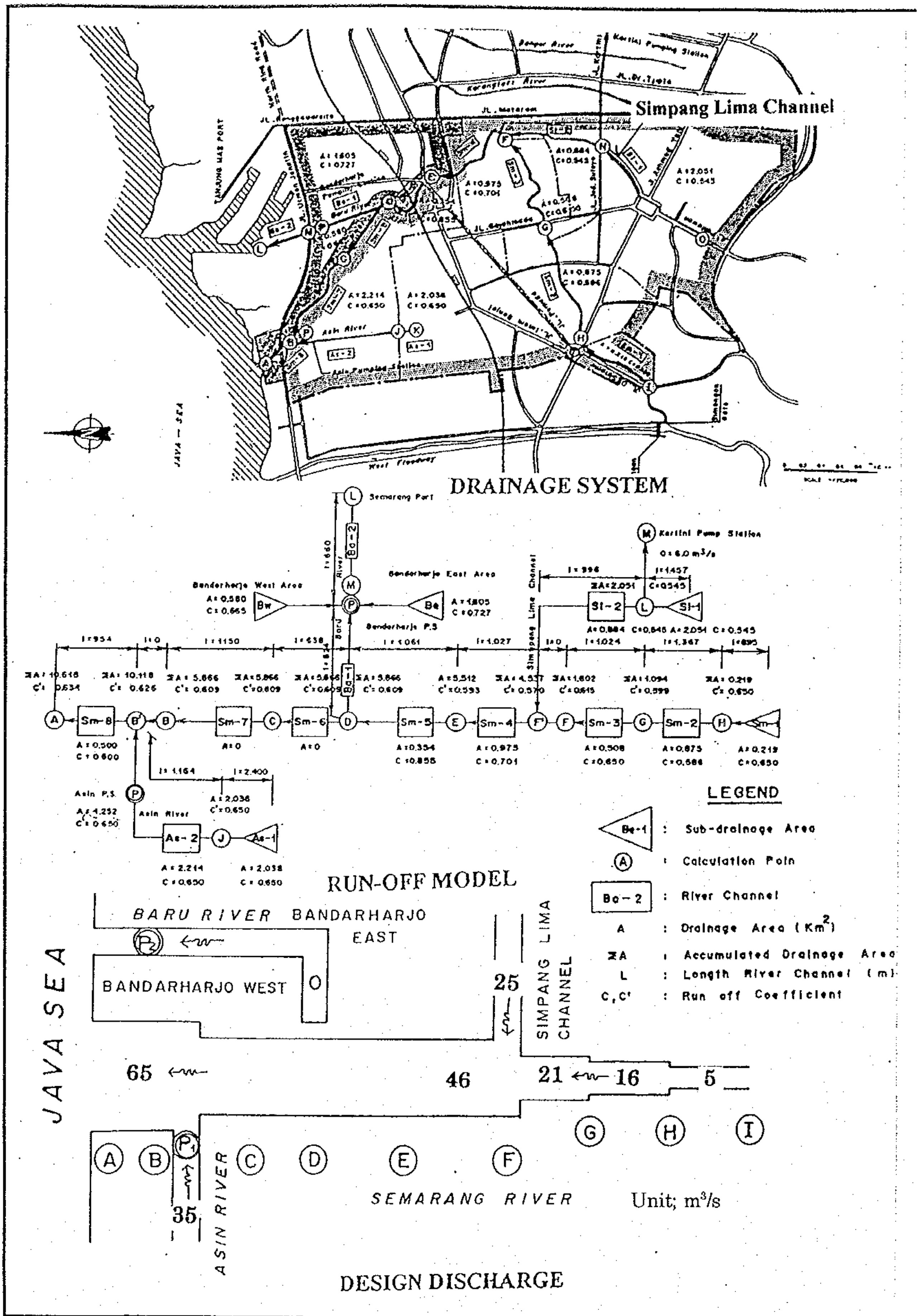
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 4.2.1

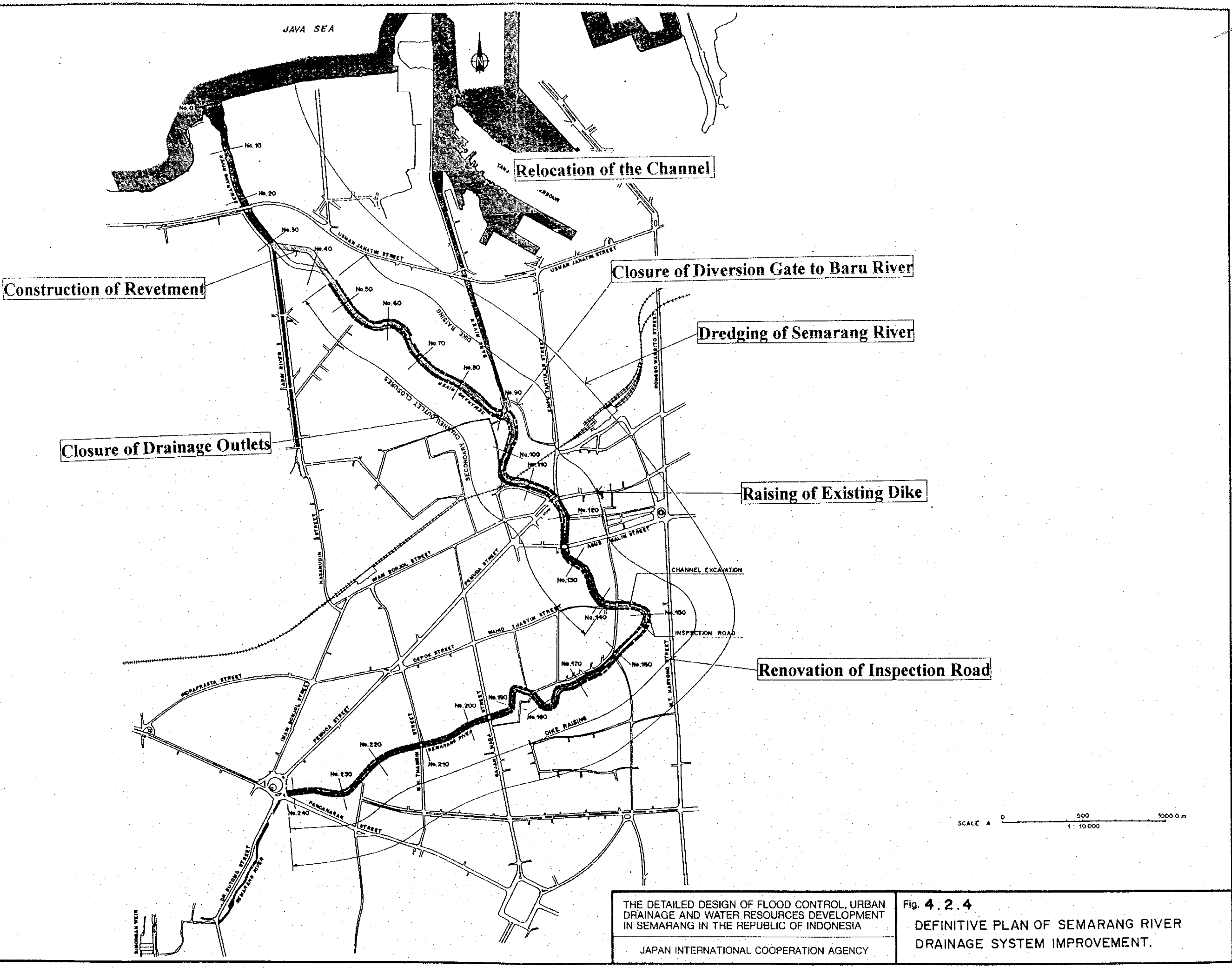
DRAINAGE SYSTEM AND DESIGN DISCHARGE OF SEMARANG RIVER IN PREVIOUS F/S



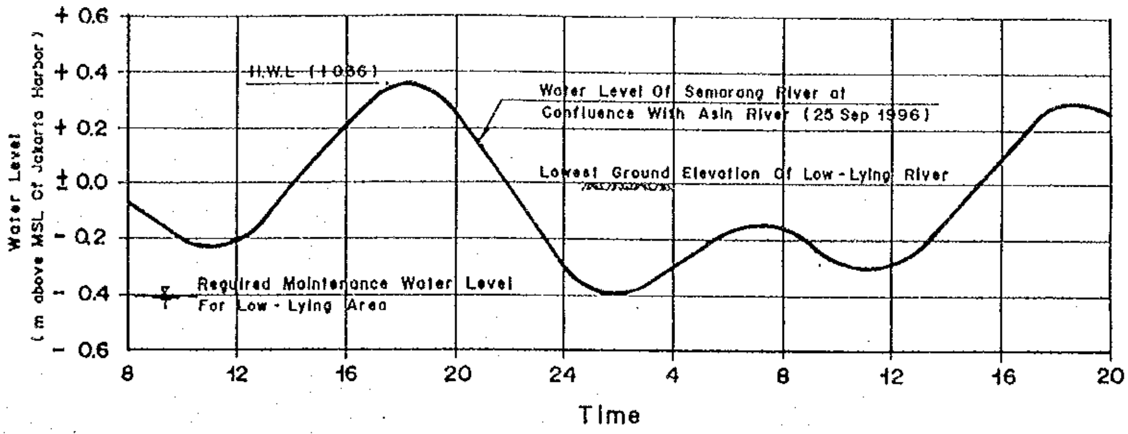
THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. 4.2.2
JAPAN INTERNATIONAL COOPERATION AGENCY	RECLAMATION PLAN



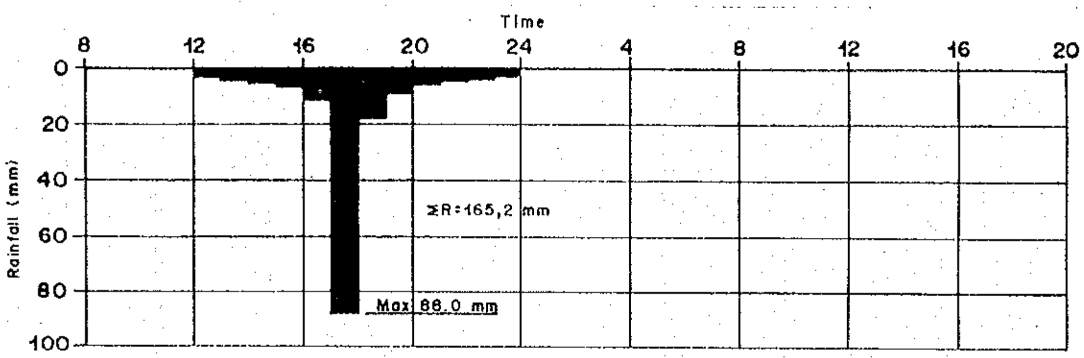
THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. 4.2.3
JAPAN INTERNATIONAL COOPERATION AGENCY	DESIGN DISCHARGE OF THE MAIN CHANNELS



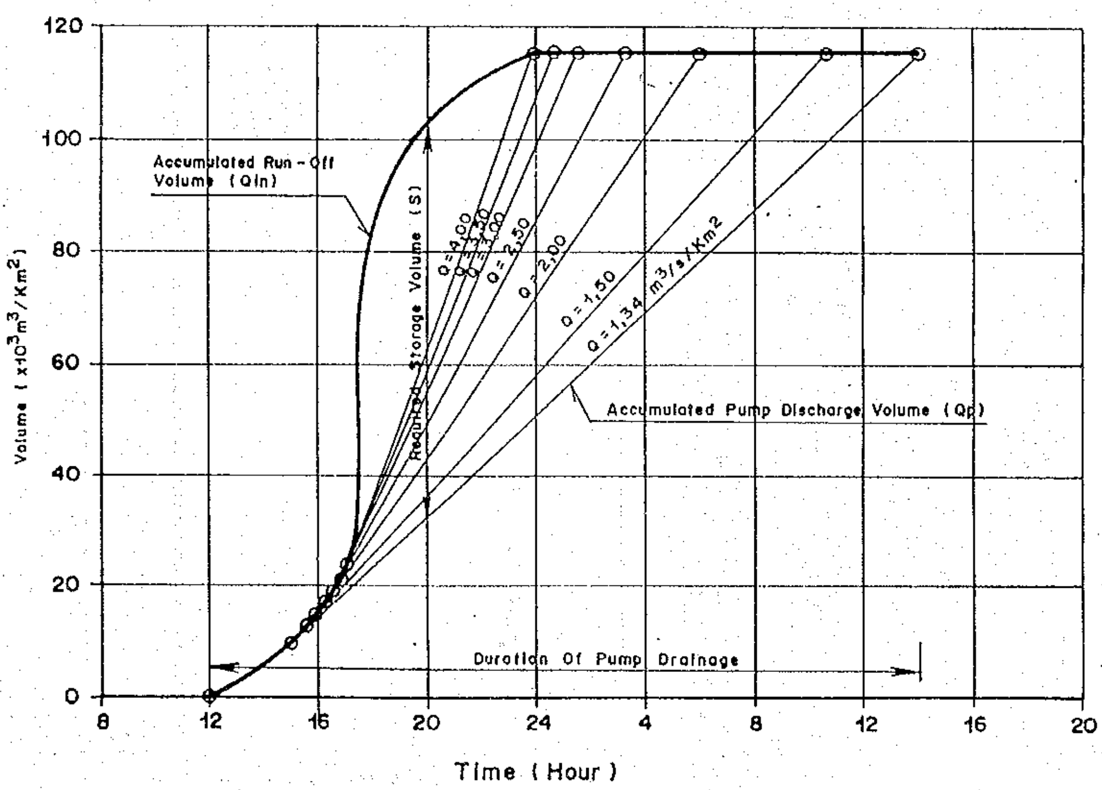
THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. 4.2.4 DEFINITIVE PLAN OF SEMARANG RIVER DRAINAGE SYSTEM IMPROVEMENT.
JAPAN INTERNATIONAL COOPERATION AGENCY	



DESIGN FLOOD LEVEL OF SEMARANG RIVER

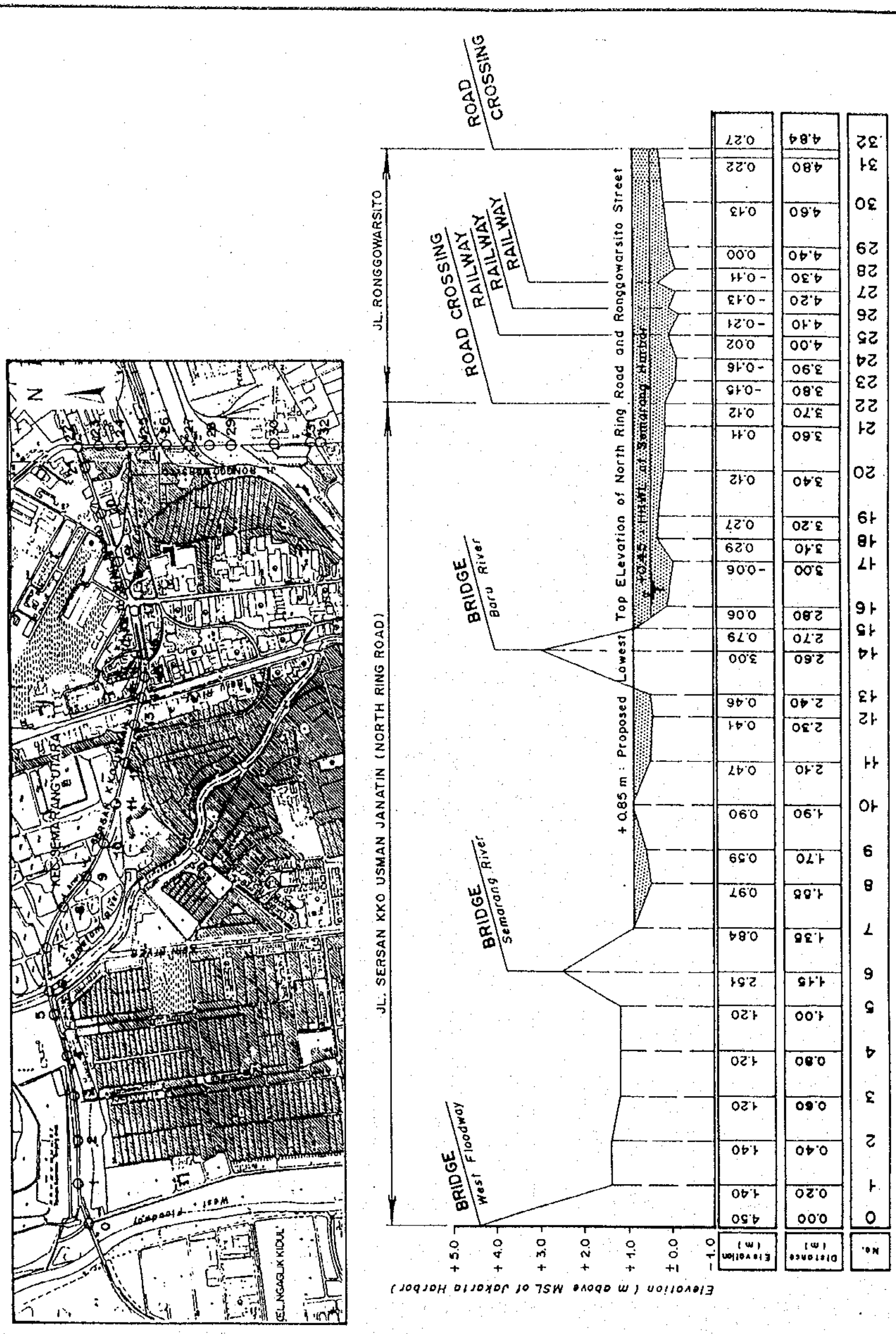


DESIGN RAINFALL FOR PUMP DRAINAGE



SPECIFIC PUMP CAPACITY AND STORAGE REQUIRMENT

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. 4.3.1
JAPAN INTERNATIONAL COOPERATION AGENCY	DESIGN FLOOD LEVEL, DESIGN RAINFALL AND RELATION BETWEEN SPECIFIC PUMP CAPACITY AND STORAGE REQUIREMENT

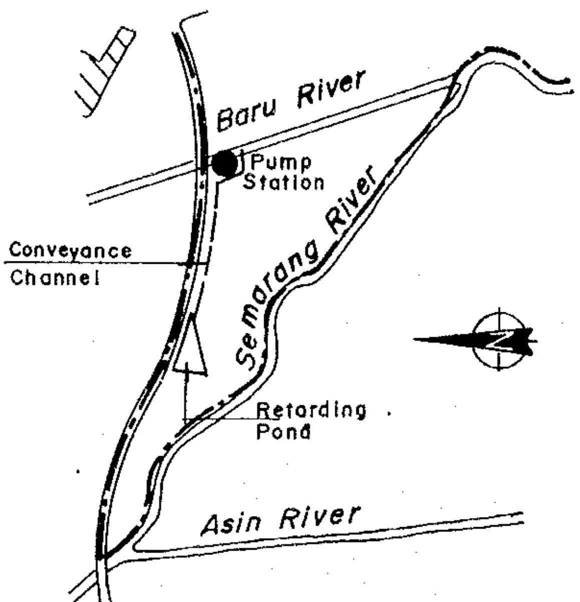


THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

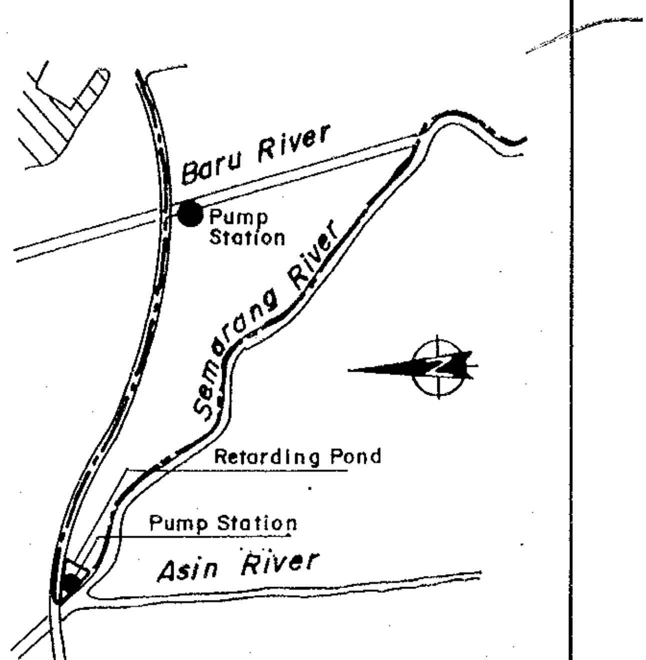
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 4.3.2

NECESSITY OF RAISING OF NORTH RING ROAD AND RONGGOWARSITO STREET

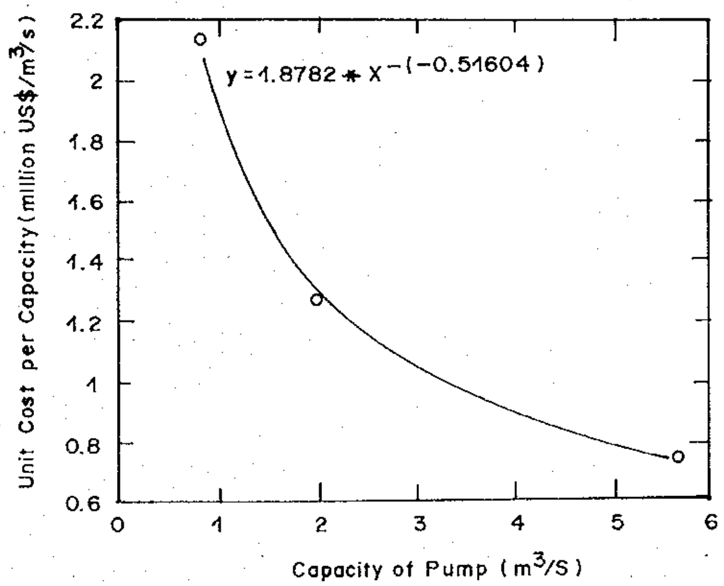


ALTERNATIVE A (ONE PUMP STATION)



ALTERNATIVE B (TWO PUMP STATIONS)

Relation between Capacity and Unit Cost of Pump



Comparison of Number of Pump Stations in Bandarharjo Area

		Pump Capacity/m^3/s		Cost (million US$)			
	No of Pump	No 1	No 2	Pump	Conveyance Channel	Retarding Pond	Total
Alternative-A	1	4.4	–	3.8	1.0	0.5	5.3
Alternative-B	2	1.16	3.24	5.3	0	0.3	5.6

THE DETAILED DESIGN OF FLOOD CONTROL URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

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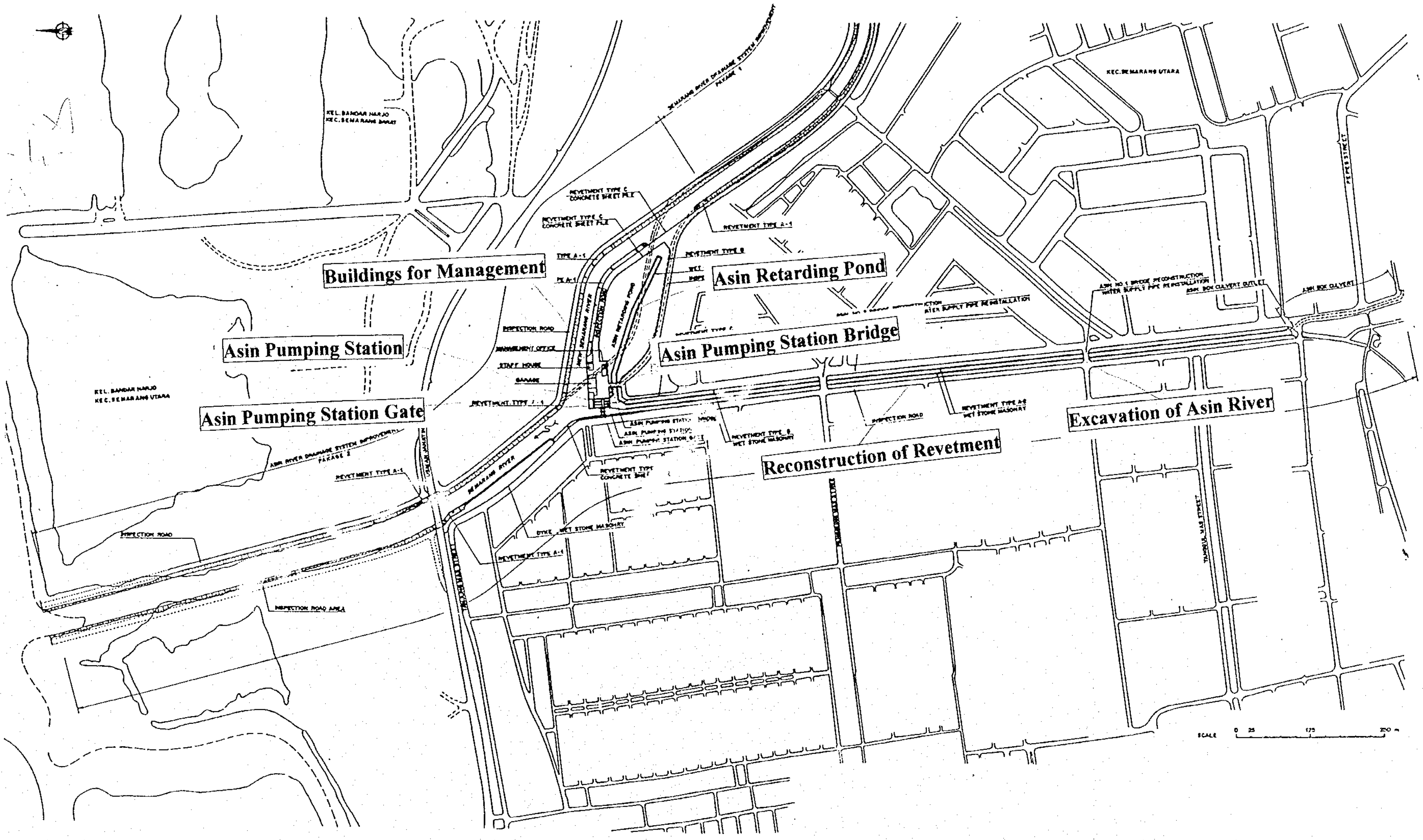
Fig. 4.3.3
ALTERNATIVE STUDY OF NUMBER OF PUMP STATIONS



THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

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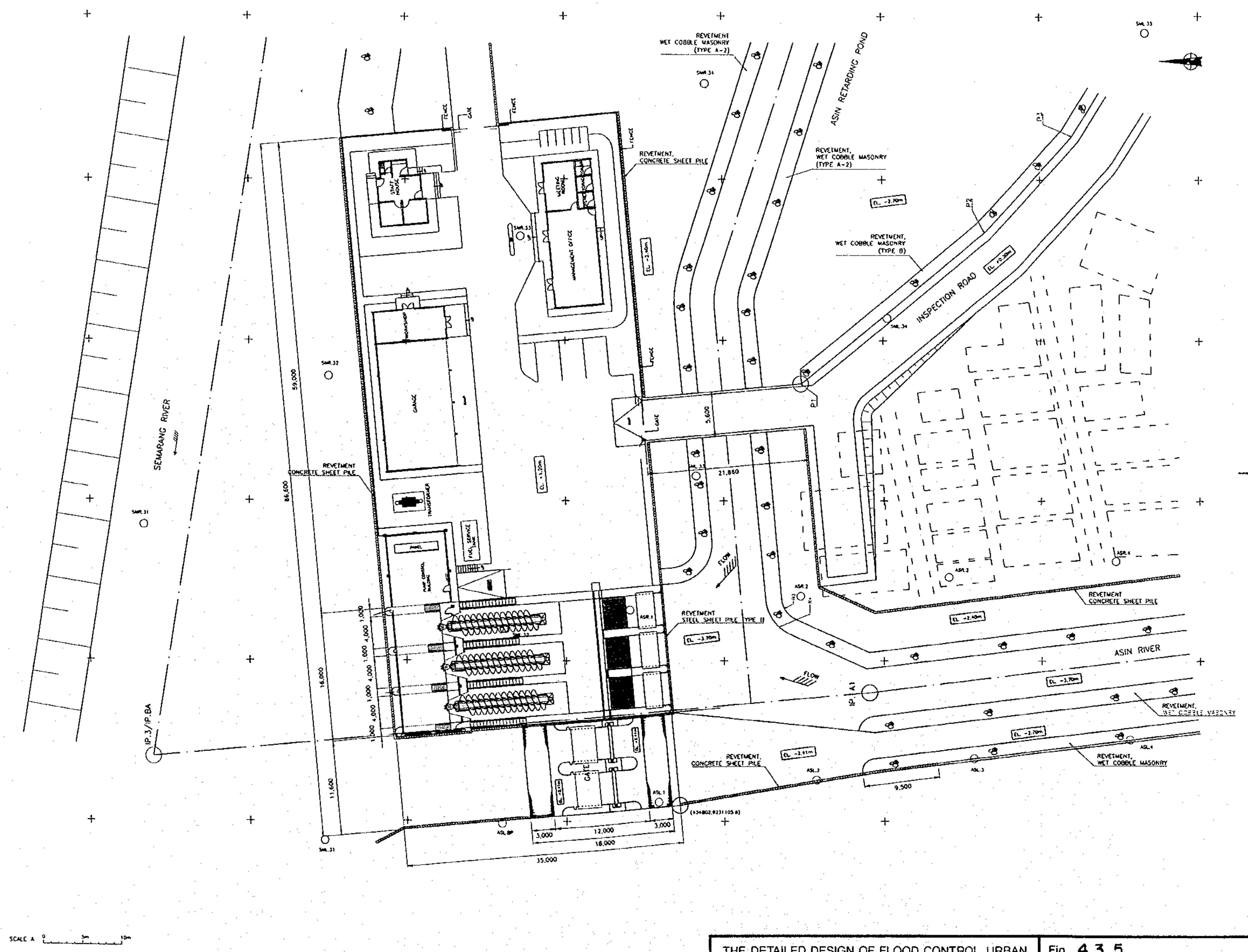
Fig. 4.3.4

DEFINITIVE PLAN OF ASIN RIVER DRAINAGE SYSTEM IMPROVEMENT



THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

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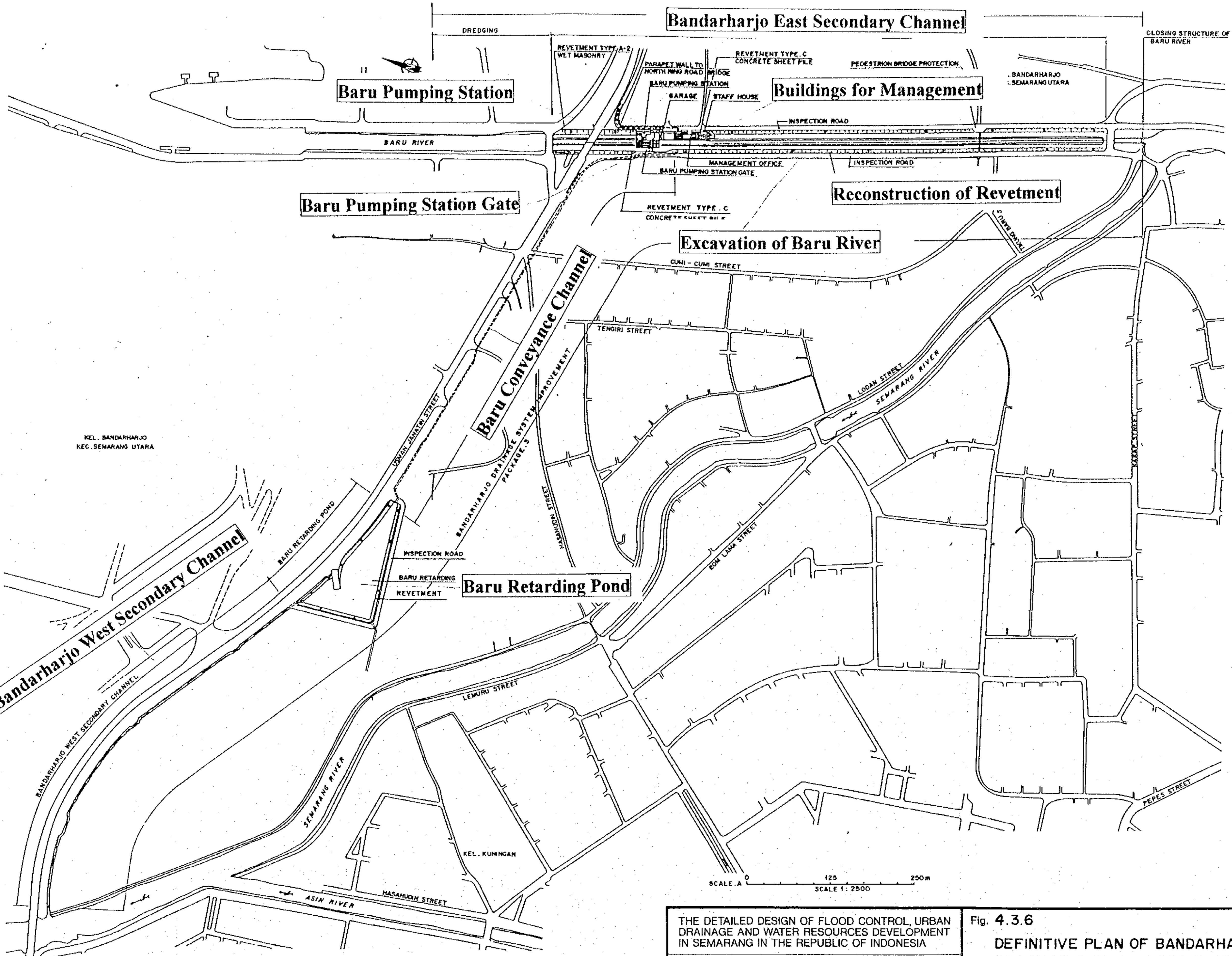
Fig. 4.3.5

ASIN PUMPING STATION



THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. 4.3.6 DEFINITIVE PLAN OF BANDARHARJO DRAINAGE SYSTEM IMPROVEMENT
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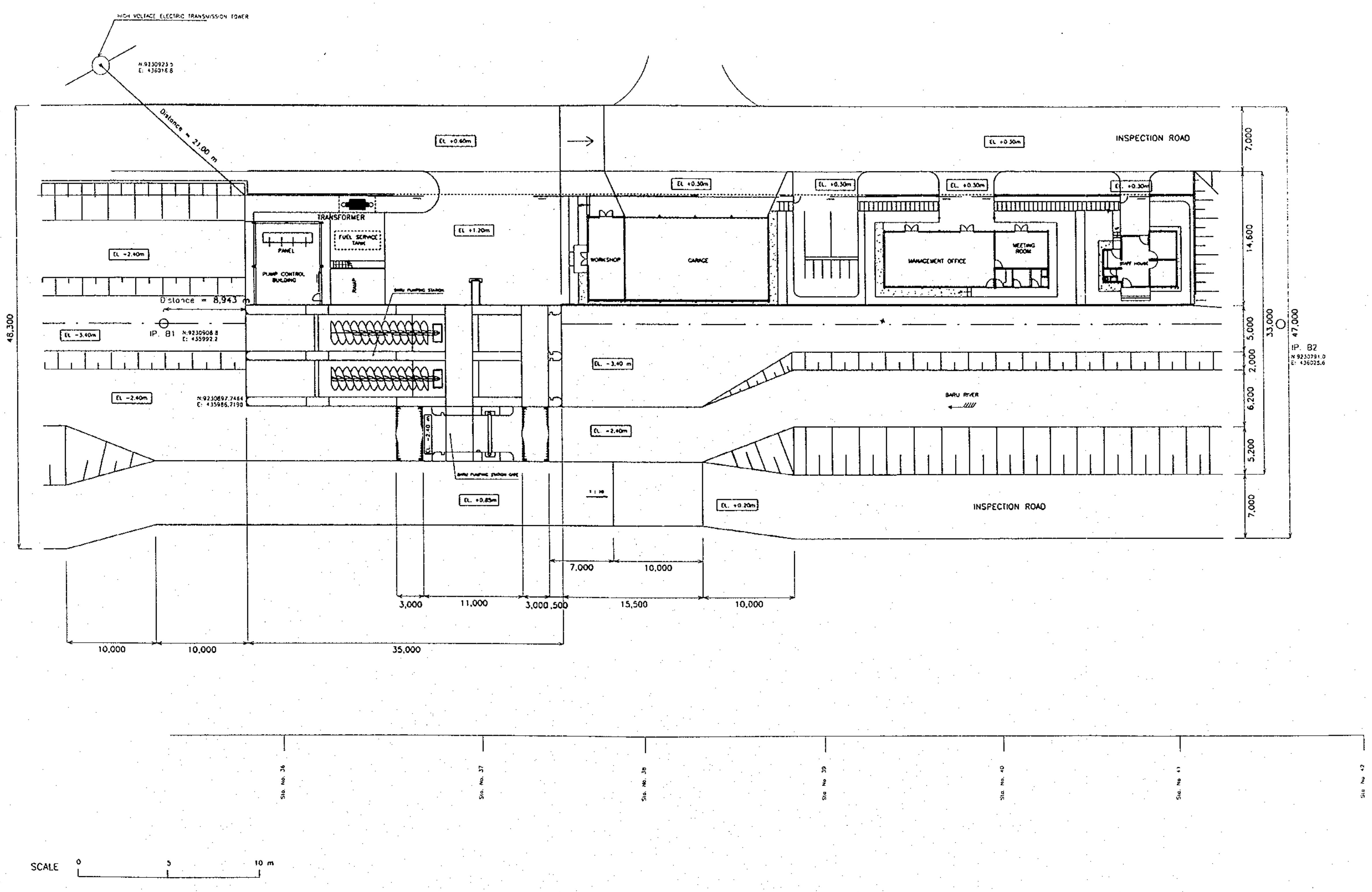
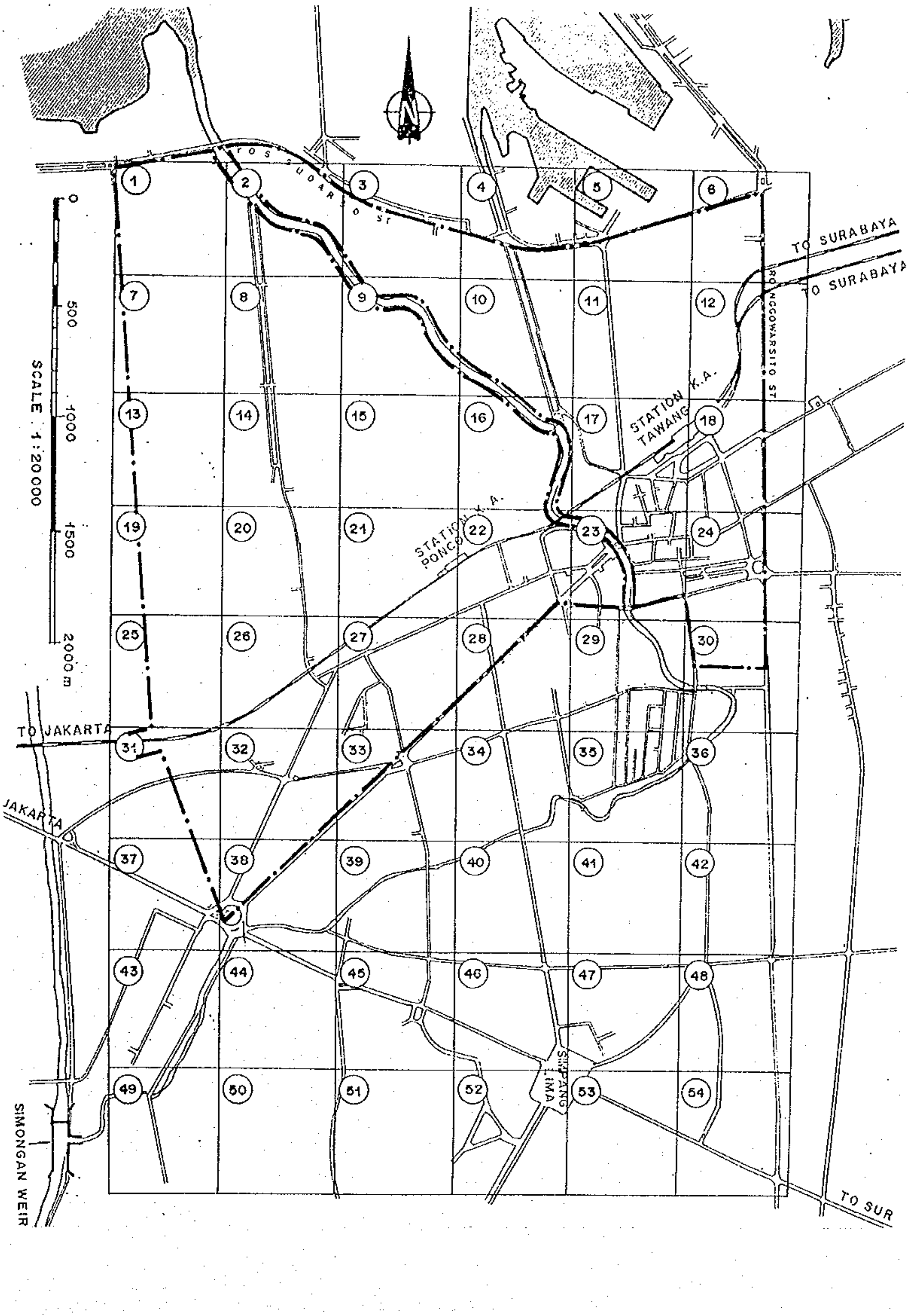


THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. 4.3.7
JAPAN INTERNATIONAL COOPERATION AGENCY	BARU PUMPING STATION



THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. 4.4.1
JAPAN INTERNATIONAL COOPERATION AGENCY	Meshed Area for Inundation Damage Estimation