JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF SETTLEMENT AND REGIONAL DEVELOPMENT
THE REPUBLIC OF INDONESIA

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

FINAL REPORT

COMPONENT C:
URBAN DRAINAGE SYSTEM IMPROVEMENT

VOLUME IV CONSTRUCTION PLANNING

AUGUST 2000

CTI ENGINEERING INTERNATIONAL CO., LTD.
IN ASSOCIATION WITH
PACIFIC CONSULTANTS INTERNATIONAL
AND
PASCO INTERNATIONAL INC.

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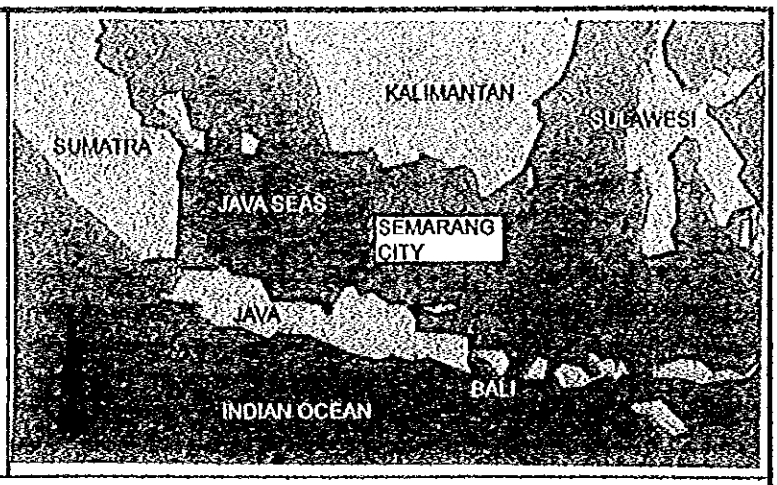
GENERAL MAP



SCALE
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JAVA SEA

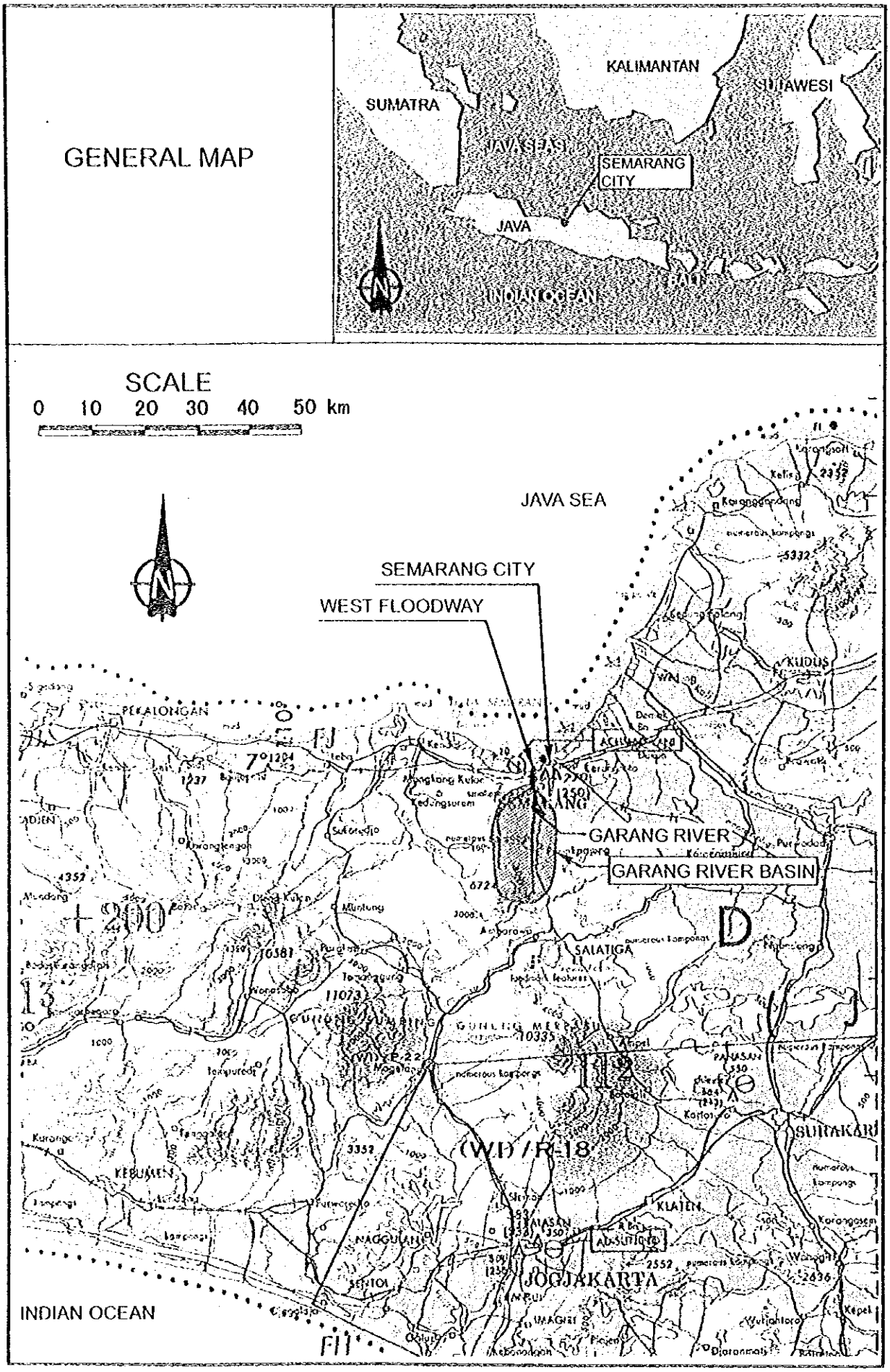
SEMARANG CITY

WEST FLOODWAY

GARANG RIVER

GARANG RIVER BASIN

INDIAN OCEAN


GENERAL MAP
KALIMANTAN
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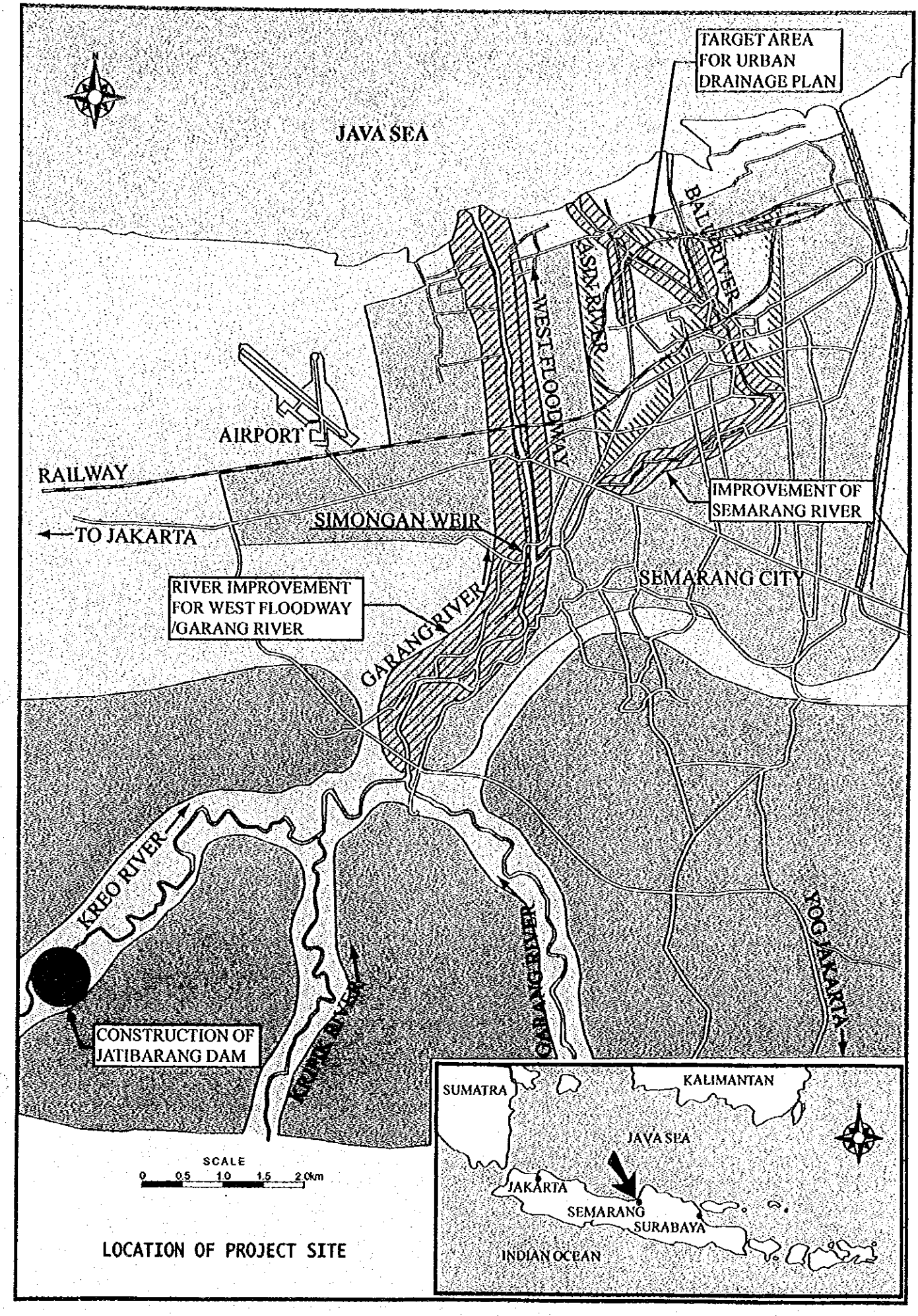
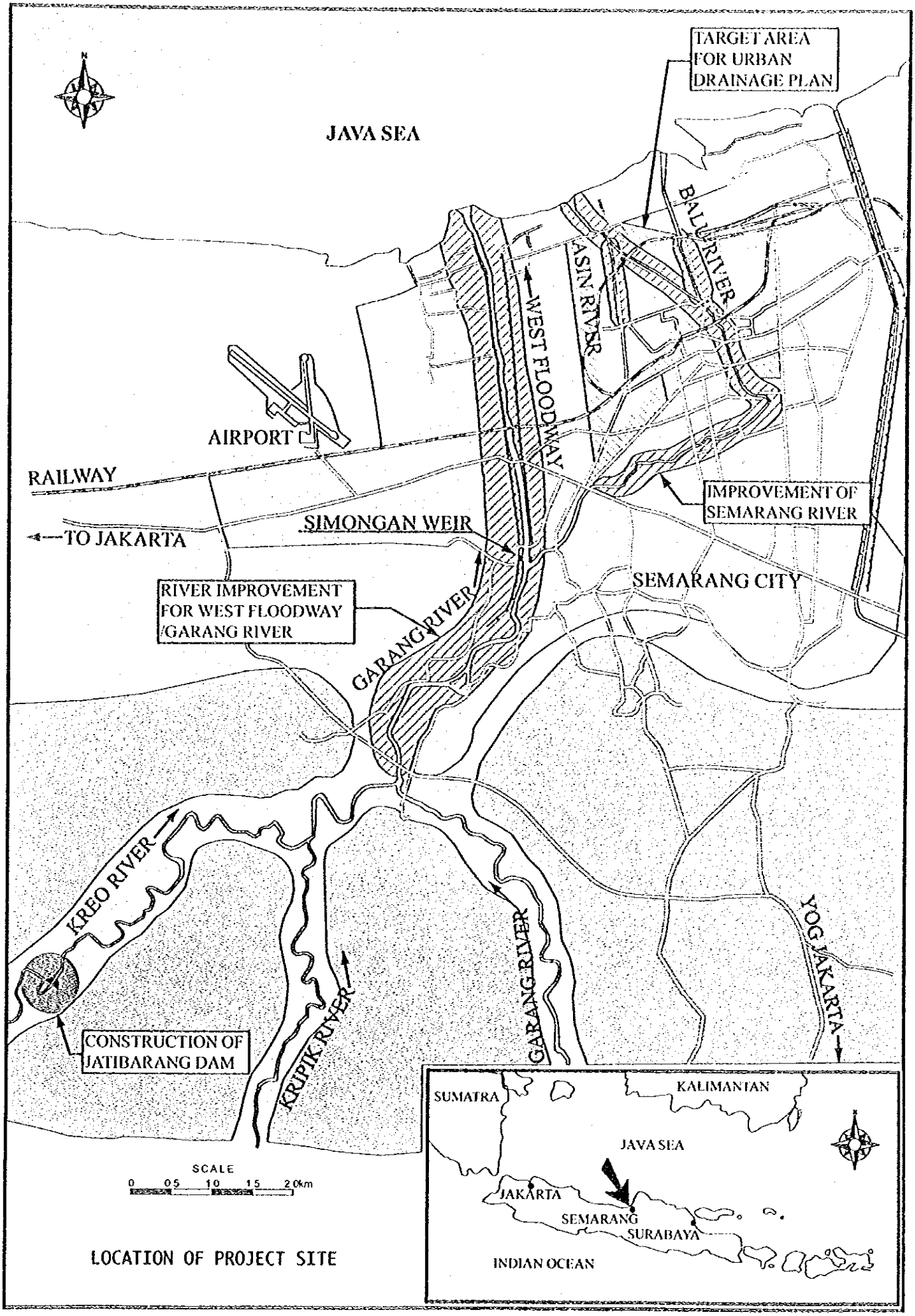


LOCATION OF PROJECT SITE



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1.1 Packaging of the Project

The component of the Urban Drainage System Improvement consists of three (3) packages, the Semarang River Drainage System Improvement, the Asin River Drainage System Improvement and the Bandarharjo Drainage System Improvement.

After the completion of the construction of all packages, Urban Drainage System will function effectively, but the construction works of these three packages executed independently during the construction period in principle.

1.2 Summary of construction works

The Urban Drainage System Improvement project is to be carried out to improve existing poor drainage facilities in the central area of Semarang city and consists of construction of two (2) drainage pumping stations, improvement and dredging of Semarang, Asin and Baru rivers.

The main work items and work volumes are summarized as below and the location is shown in Fig. 1.2.1.

Work Item	Semarang River Drainage System Improvement	Asin River Drainage System Improvement	Bandarharjo Drainage System Improvement	Total
Volume of Excavation and Dredging	60,200 m^3	170,900 m^3	118,500 m^3	349,600 m^3
Excavation	1,800 m^3	102,600 m^3	88,400 m^3	192,800 m^3
Excavation with Heavy Metal Treatment	-	31,800 m^3	25,400 m^3	57,200 m^3
Dredging with Heavy Metal Treatment	58,400 m^3	36,500 m^3	4,700 m^3	99,600 m^3
Concrete Works	1,520 m^3	6,360 m^3	7,070 m^3	14,950 m^3
Revetment Works	-	2,330 m	1,806 m	4,136 m
Dike Raising	7,206 m	228 m	-	7,434 m
Drainage Pumping Station	-	1 station	1 station	2 stations
Retarding Pond Exca.	-	31,000 m^3	30,400 m^3	61,400 m^3

Water Gate	-	B H 4.0 m x 3.46 m 2 gates	B H 4.0 m x 3.25m 1 gate	3 gates
Maintenance Office	-	1 lump sum	1 lump sum	2 lump sum
Maintenance Bridge	-	1 bridge	-	1 bridge
Reconstruction of Bridge	-	2 bridges	-	2 bridges
Box Culvert	-	B H 3.5 m x 2.0 m 194 m	B H 2.0 m x 2.0 m 815 m	1,009 m
Secondary Channel	-	-	577 m	577 m

1.3 Possible spoil bank areas

The total volume of the excavated and demolished material from the improvement works of Urban Drainage is estimated at 349,600 m³.

The possible spoil bank areas near the construction site were surveyed in the previous stage as shown in the table below and Fig. 1.2.2.

Area No.	Schedule	Area (ha)	Volume (m³)
1	1999 - 2003	150	6,800,000
2	1997 - 2000	200	3,000,000
3	2001 - 2008	-	2,800,000
4	2001 -	-	1,000,000
5	1999 -	-	4,000,000
6	- 2008	-	-
7	- 2003	-	-
8	- 2003	-	-
Total			17,600,000

In considering the land reclamation schedule and the distance from the construction site, the Area No.3 is the most prosperous area for a spoil bank.

1.4 Treatment of contaminated soil

According to the sediment analysis for the river bed of Semarang, Asin and Baru rivers, the dredged or excavated channel bed material include much amount of heavy metals and the heavy metals were found to be leached out and may contaminate ground water at a spoil bank area. Therefore, it shall be treated before dumping to a spoil bank. Presently a cement solidification method is adequate as the treatment method of the contaminated sediment in the channel. A 7 % ordinary Portland cement content per unit dry weight of soil is required as a suitable

treatment.

Dredged and excavated material in channels is hauled to a treatment area at the spoil bank area. The area is constructed by earthfill banks and the surface of banks are sealed by sheets to prevent contained water to infiltrate into the ground. Thickness of about 50 cm of drainage and protection layer for the sheet by soil and gravel is constructed and a concrete pit for dry up the contained water.

Dredged and excavated material will be spreaded about 30 to 40 cm in depth by bulldozer for swamp and dried up sufficiently by sunshine. After dry up cement shall be laid out according to the calculated spacing and mixed with the soil by means of a tractor with multi-disc plough which has an effective working width. Treated material is loaded to dump truck by backhoes and hauled out to the spoil area.

This process will be repeated in a treatment area but in order to continue the dry up by sunshine, dredging work is limited to be carried out only dry season.

Assuming that the 3 days stock of contaminated soil with 25 cm thickness, 10 days dry up period, 2 days for mixing and 3 days removal works from the area, the required treatment area to keep the dry up cycle becomes more than 131,000 m^2. The plan of the treatment area is shown in Fig. 1.3.1. The capacity and the number of the equipment for the construction of sedimentation basin and the treatment works are as below.

Backhoe	:	0.60 m^3	x	4	units
Bulldozer	:	21 t	x	4	units
Vibrating Roller	:	10 t	x	1	unit
Dump Truck	:	10 t	x	6	units
Tractor with Plough	:	100 PS	x	2	units

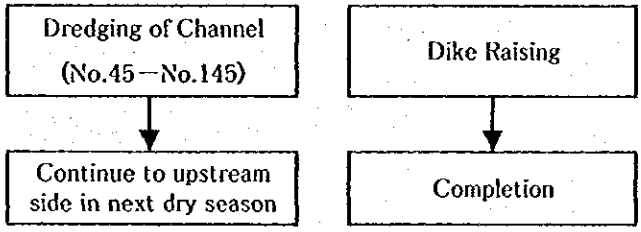
CHAPTER 2 SEMARANG RIVER DRAINAGE SYSTEM IMPROVEMENT (PACKAGE 1)

2.1 General

The construction works of the package 1 (Semarang River Drainage System Improvement) consists of a river dredging, raising of existing dike, closure of drainage outlets to Semarang River and rehabilitation of the existing inspection roads (refer to Fig. 1.2.1). According to the total construction volume of this package and the method of treatment of contaminated soil which described in the Clause 1.4 of Chapter 1, two dry seasons are necessary as a construction period of this package.

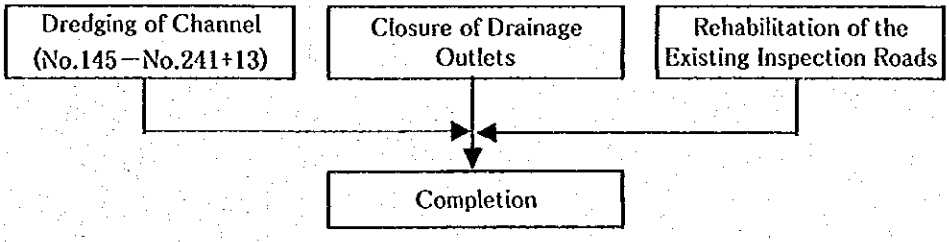
2.1.1 First Dry Season

Dredging of channel and dike raising works are carried out during first dry season and these items do not have tight relationship each other.



2.1.2 Second Dry Season

Dredging of channel at upstream side stretch, closure of drainage outlets to Semarang River and rehabilitation of the existing inspection roads is carried out during second dry season.



2.2 Semarang river improvement

2.2.1 Dredging

The dredging stretches of Semarang River in the Package 1 extend from No.45 to No.241+13 with the total length of 5.9 km and the total dredging volume is estimated at 58,400 m^3.

The dredging of Semarang River are carried out through dry season in accordance with the following procedures by channel profiles. Prior to the commencement of the dredging works in the channel, existing waste materials in the channel should be clean up step by step according to the working progress. The method of dredging works is described hereinafter dividing the whole dredging area into two sections.

(1) No.45 – No.160

The total length of dredging of this section is 3.5 km and the dredging volume is estimated at 42,100 m^3. Since the channel has a width of about 35 m~25 m and some bridges are spanned, a long arm backhoe setting at bank crest is applied. Dredged soil by means of backhoe is loaded to dump truck directly and will be hauled to a mixing yard which will be constructed in a spoil bank area located 3.1 km away through public roads.

(2) No.160 – No.241+13

The total length of dredging of this section is 2.4 km and the dredging volume is estimated at 16,300 m^3. Since the channel width is less than 12 m, ordinary backhoes are applied for dredging of river bed soil and loading to dump trucks. The loaded soil will be hauled to a mixing yard which will be located about 6.3 km away.

If there is not enough working clearance for dredging under bridges, mini backhoe and manpower with temporary coffering by sandbags is available for dredging. If clearance was less than 50 cm, after closing by sandbags a vacuum pump method will be applied to dredging works.

The capacity and the number of the equipment for the dredging works of the two sections are as below.

Small Backhoe : 0.02 m^3 x 1 unit

Backhoe	:	0.35 m^3	x	1	unit
Backhoe (Long arm)	:	0.35 m^3	x	2	units
Dump Truck	:	4 t	x	2	units
Dump Truck	:	10 t	x	8	units

2.2.2 Raising of existing dike

The dike raising works are done by wet stone masonry. The total length of raising dike and new dike is about 7.2 km along the channel. Raising height is variable between 0.14 m and 0.60 m, and crest width is fixed at 0.40 m.

The ground behind the existing dike will be excavated by small backhoe for additional wall and sand compaction for the foundation, wet stone masonry and backfill works follow. Working area is limited so as not to obstruct public traffics, so construction method using a small equipment and manpower is applied to the raising dike works.

The capacity and the number of the equipment for the raising works are as below.

Small Backhoe	:	0.02 m^3	x	1	unit
Dump Truck	:	4 t	x	2	units
Tamper	:	60/100 kg	x	4	units
Agitator Truck	:	4.5 m^3	x	1	unit
Truck with Crane	:	4 t	x	1	unit
Air Compressor	:	5.0 m^3	x	2	units

2.2.3 Improvement of Existing Inspection Road

After completion of the dike raising works, rehabilitation of the existing inspection road (No.45 -- No.241+13 of both sides of Semarang River) will be commenced from the beginning of the dry season of the 3rd year. Since dredging works and closure of drainage outlets works are carried out at the same time, the construction schedule should be adjusted to suit the balance of progresses of each work.

The existing inspection road on both sides of Semarang River is rehabilitated by the concrete block pavement after construction of the compacted sand foundation. The area that needs more compaction by disturbing of dike raising and other works is compacted by vibrating roller. Sand is spreaded by motor grader and compacted by tire roller on the base course or existing pavement. After curbstone installation

concrete blocks for pavement will be laid by manpower. The capacity and the number of the equipment for road improvement are as below.

Motor Grader	:	2.8	m	x 1	unit
Vibrating Roller	:	10	t	x 1	unit
Tire Roller	:	8/12	t	x 1	unit

2.3 Closure of all drainage outlets to Semarang River

In order to define the pumping drainage area, all of the drainage outlets into Semarang river should be closed in the lower reaches and Fig. 2.3.1 shows the existing drainage outlets to be closed in the project and the standard section of type of outlets.

After closing of drainage flow by sandbags, chipping work will be carried out and form work, reinforcement bar setting, plug concrete placing and curing follows under continuous dewatering by submersible pump. There are two types of drainage outlet and it is no problem to carry out a dewatering by pump with hoses in open channel type. But in case of a pipe culvert type, an upper slab portion should be removed to keep a space for pumping until the placing of plug concrete. If drainage flow was much, a valve will be embedded in plug concrete in order to keep drainage during concrete placing for upper slab portion. After completion of an upper slab concrete embedded valve for temporary drainage is closed finally. Concrete placing for plug and upper slab is carried out by agitator truck with chute in principle.

The capacity and number of construction equipment for closure are as below.

Air Compressor	:	5.0	m^3	x 1	unit
Backhoe	:	0.20	m^3	x 1	unit
Dump Truck	:	4	t	x 1	unit
Agitator Truck	:	4.5	m^3	x 1	unit
Generator	:	35	kVA	x 1	unit
Truck with Crane	:	4	t	x 1	unit

CHAPTER 3 ASIN RIVER DRAINAGE SYSTEM IMPROVEMENT (PACKAGE 2)

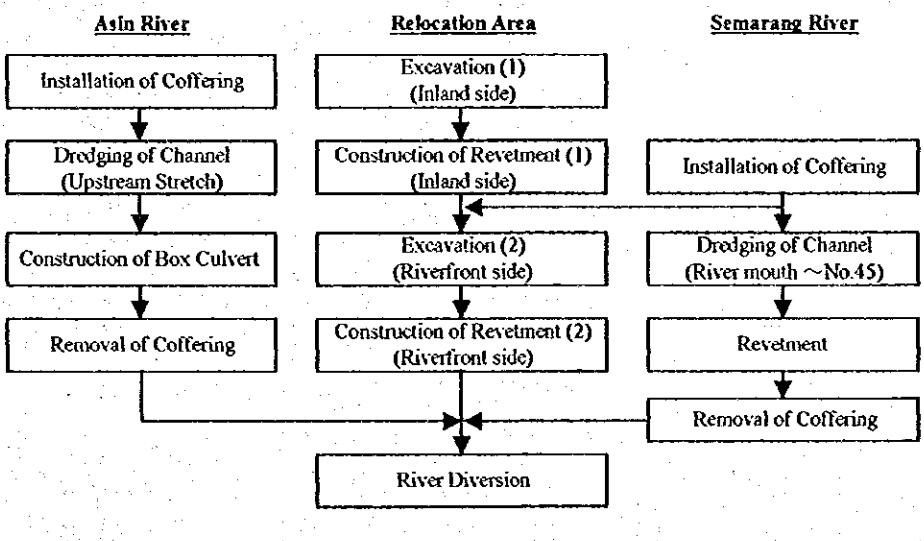
3.1 General

The construction works of the package 2 (Asin River Drainage System Improvement) consists of three main items, namely relocation and dredging of Semarang River, Asin river improvement, construction of Asin pumping station and a retarding pond. These main items have close relationships to each other and construction procedure is described below and shown in Fig. 3.1.1.

In consideration of the total amount of the construction work volume and the physical conditions of the site of this package, three dry seasons are necessary as a construction period.

3.1.1 First Dry Season

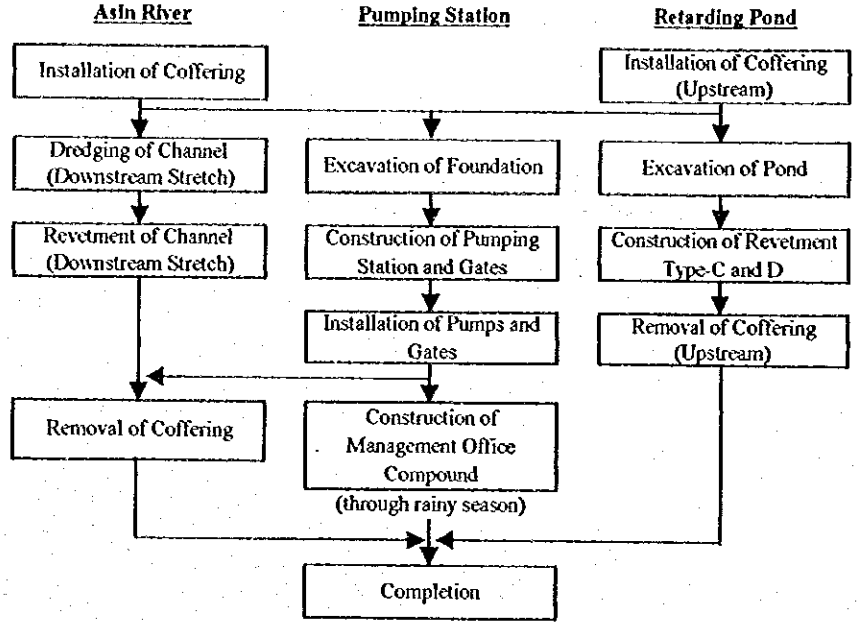
The relocation of Semarang River, the construction of a box culvert which is located at the upstream of Asin River and the dredging of the upstream stretch, and the dredging from river mouth to the distance-post No.45 is carried out in first dry season.



3.1.2 Second Dry Season

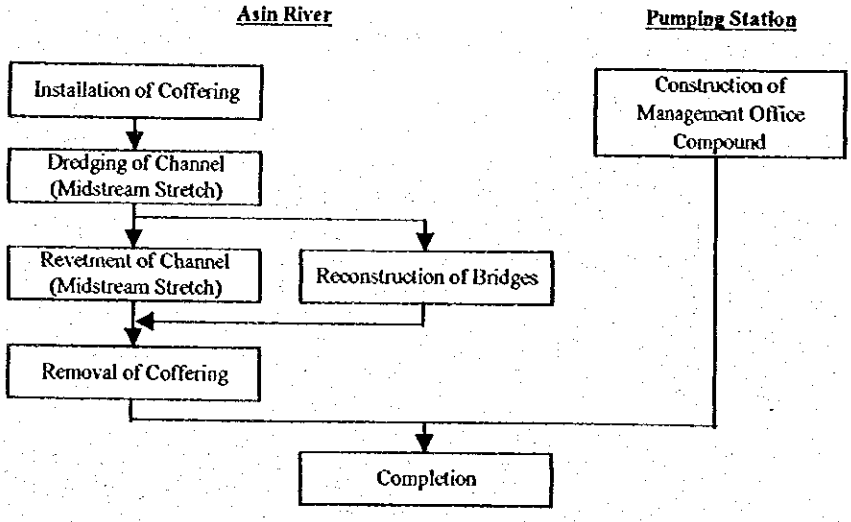
The construction of the Asin retarding pond and the Asin pumping station which is located at the west side of the retarding pond are main works in the second dry season. Dredging and revetment works of the downstream stretch of Asin River is carried out at the same time. The construction of the management office compound

will be carried out from the end of dry season through rainy season to the third year dry season.



3.1.3 Third Dry Season

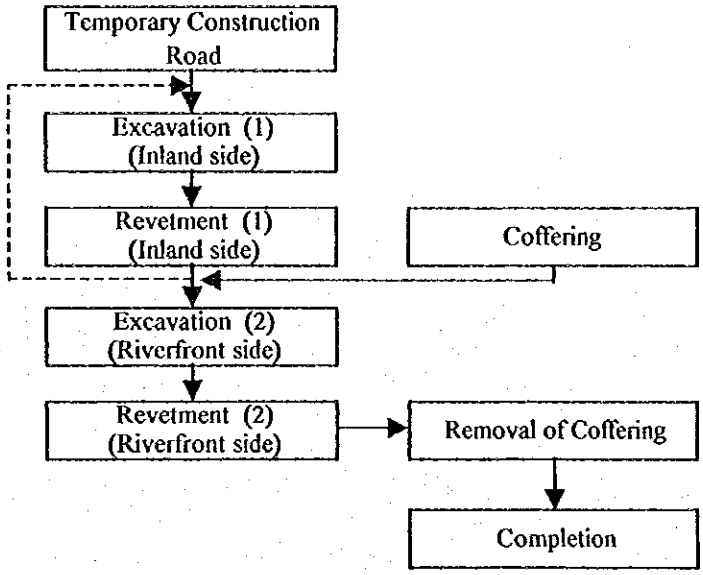
Asin river improvement at the midstream stretch and the management office compound of the pumping station are main works in the third dry season.



3.2 Relocation of Semarang River (No.29－No.45)

The length of the relocation area of Semarang River is about 400 m and river alignment is shifted to the right bank side to create an area for the retarding pond.

Therefore, this part of Semarang river improvement work is included in the Asin River Drainage System Improvement (refer to Fig. 3.2.1). Procedure of the relocation of Semarang River is shown in below.



3.2.1 Coffering

The most part of earth work of the relocation of Semarang River is inland side and cofferings are required at the up and down stream junction points. Since the water depth is about 2.8 m and a construction term is not so long, single steel sheet pile and earthfill are available for the coffering in this works. In accordance with the progress of the excavation of the inland side, cofferings should be constructed timely (refer to Fig. 3.2.2).

3.2.2 Earth work

A temporary construction road is connected from North Ring Road to the right bank inspection road and reached to the new channel area. According to the existing ground condition, ground water level is forecasted same as the sea level. Therefore, it is better to divide the construction area into several units, and 100 m is applied to as the length of one unit by attention to dewatering capacity by pumps. After completion of the excavation and revetment work of inland side, earth work of riverfront side is carried out under the protection of coffering described in the Sub-clause 3.2.1 of Chapter 3.

Excavation and loading works are done by backhoe and excavated good material which meets the specifications is used for embankment directly or through stock

pile and compacted by bulldozer. The capacity and the number of the equipment for the earth work are as below.

Backhoe	:	0.35 m^3	x	2	units
Dump Truck	:	10 t	x	5	units
Bulldozer	:	15 t	x	1	unit

3.2.3 Revetment

Wet stone masonry type revetment works will be commenced after completion of the earth work at each construction unit. Excavation of base concrete foundation is carried out at first and log pile driving, base concrete placing, gravel bedding, wet stone masonry and gabion mattress works follow. Concrete placing is done by agitator truck with chute. The capacity and number of the equipment for the revetment works are as below.

Backhoe	:	0.35 m^3	x	3	units
Dump Truck	:	10 t	x	6	units
Backhoe	:	0.20 m^3	x	3	unit
Vibratary Pile Driver	:	60 kW	x	1	unit
Tamper	:	60/100 kg	x	5	units
Portable Mixer	:	0.20 m^3	x	1	unit
Truck with Crane	:	4 t	x	3	units

3.2.4 River diversion

After completion of the channel excavation and revetment works related with the channel relocation, diversion of Semarang River is carried out by means of removal of cofferings.

Coffering by steel sheet pile type for revetment works and earthfill type for excavation works in the downstream side will be removed at first at the time of river diversion. Removal of all cofferings at the upstream side is followed, and a temporary earthfill is extended from existing right bank to left bank along the revetment line in order to close the existing Semarang River (refer to Fig. 3.2.3). This temporary earthfill is removed after driving the concrete sheet pile for revetment at the riverfront side. After diversion, a temporary earth cofferdam with single sheet piles is constructed at the confluence of Asin River in order to construct

the Asin pumping station, retarding pond and Asin river improvement. When the excavation of pumping station is commenced, a part of earthfill will be removed.

3.3 Asin river improvement

Asin river improvement includes the improvement of Asin River and the lower stretch of Semarang River. The features of the channel improvement are shown in the table below.

Total Length	2.1 km
Semarang River	0.9 km
Asin River	1.2 km
Box Culvert (upstream from No.57) B =4.2 m	194 m
Lowest elevation in the drainage area	EL -0.20 m
Design river bed elevation	EL -3.40 m
Inspection road	L =2,240 m

3.3.1 Coffring and dewatering

Since during dry season, an inflow to Asin River is mainly waste water from residential area and this inflow is estimated about 0.12 m^3/sec on an average, required numbers of temporary drainage pumps for the inflow are not so big. Coffering method by closing a half part of channel width does not have the advantage in the deep structural excavation under the narrow channel of Asin River. In consideration of these conditions, a coffering method which close the construction site by cofferings at the up and downstream ends of the site is more advantageous. Double steel sheet pile is applied to the cofferings and Asin River is divided into three construction sites. The first is the downstream area which includes the pumping station, the second is the midstream area which includes the reconstruction of two bridges and the last one is the upstream area which includes the outlet of new box culvert (refer to Fig. 3.3.1). The capacity and the number of the equipment for the cofferings are as below.

Backhoe	:	0.35 m^3	x	1	unit
Dump Truck	:	10 t	x	1	unit
Vibratary Pile Driver	:	60 kW	x	1	unit
Truck with Crane	:	4 t	x	1	unit

3.3.2 Dredging and excavation

(1) Semarang River mouth (No.0) – No.29

The length of this stretch is about 0.9 km. Since the width of the channel is more than 35 m, the combination of clamshell grabbing and barge is applied for dredging. The dredged soil is hauled by barge and tugboat to a spoil bank located 1.8 km away.

(2) Asin River (No.0 – No.58)

After completion of the dewatering of closed construction sites, a few numbers of temporary construction roads are constructed from bank crests into the riverbed. Excavation of riverbed and a structural excavation of the revetment are done directly by backhoe. Excavated soil is hauled out by dump trucks to the spoil bank area which has sedimentation basins for treatment and is 3.3 km away from the site. A backfill material which meets the specification is selected from excavated material and stocked in or near the site. Remainder is hauled out to the spoil bank area.

Dredging and excavation work is carried out during dry season by adoption of the treatment method of contaminated soil by mixing with cement and the coffering method by the cross section closing. The capacity and the number of the equipment for the dredging and excavation are as below.

Clamshell Grabbing	:	1.0 m^3	x	1	unit
Pontoon	:	100 m^3	x	1	unit
Barge (for hauling)	:	100 m^3	x	2	units
Tugboat	:	15 t	x	1	unit
Backhoe	:	0.35 m^3	x	2	units
Dump Truck	:	10 t	x	7	units

3.3.3 Revetment

For Asin river improvement, type-B and type-C revetment are applied. Type-B revetment is used for a section with wide construction space, while type-C revetment is applied for a section with limited space for the construction. Revetment types applied in Asin River is shown in the table below (refer to Fig. 3.3.2).

Cross Section No.	Type
No.3－No. 7 (right bank)	C (concrete sheet pile) *1
No.7－No.57 (right bank), No.3- No.57 (left bank)	B (vertical wet masonry)

*1 Type-C revetment is applied here in order to proceed the construction work without disturbing or resettling the houses near by.

Within a work site of 25～30 m, the construction works are proceeded with the procedure of excavation works, guide beam setting, concrete sheet pile driving and backfill. Concrete sheet pile driving of revetment type-C will be commenced after excavation reach to EL.-2.70 m. After completion of all works in the work site, the construction works are shifted to and continued in the next work site.

Log pile driving of revetment type-B is commenced after excavation reached to EL.-3.50 m and remaining excavation to EL.-3.70 m is followed. At the connecting channel, after the completion of the excavation to EL.-3.70 m, excavation of base concrete foundation and log pile driving are done by backhoe. Base concrete and placing top concrete of type-1 is directly done from agitator truck with chute. Filling and wet stone masonry work follows. The capacity and the number of the equipment for revetment works are as below.

Backhoe	:	0.35	m^3	x 3	units
Dump Truck	:	10	t	x 6	units
Vibratary Pile Driver	:	60	kW	x 1	unit
Tamper	:	60/100	kg	x 10	units
Portable Mixer	:	0.20	m^3	x 2	units
Truck with Crane	:	4	t	x 3	units

3.3.4 Box culvert

The features of Asin River box culvert (upstream side from No.57) are shown in the table below (refer to Fig. 3.3.3).

Length of culvert	194 m
Channel slope	I =1/1000
Dimension of inside	3.50 m B x 2.00 m H

A drainage channel with box culvert is constructed under the public road. A temporary retaining wall by steel sheet pile is required during the construction period in order to minimize the open cut area. A temporary coffering by sandbags at the inlet and steel sheet pile at the outlet are constructed respectively.

After driving sheet pile for the temporary retaining wall, excavation works are carried out by a backhoe and a dump truck. A selected material from excavated one should be stocked near the construction area for backfilling. Concrete placing for the box culvert is carried out by a concrete pump or agitator trucks with chute. The capacity and the number of the equipment for the construction of the box culvert are as below.

Backhoe	:	0.35 m^3	x 1	unit
Dump Truck	:	10 t	x 1	unit
Vibratary Pile Driver	:	60 kW	x 1	unit
Concrete Pump	:	60 m^3/h	x 1	unit
Agitator Truck	:	4.5 m^3	x 3	units
Tamper	:	60/100 kg	x 2	units
Truck with Crane	:	4 t	x 1	unit
Air Compressor	:	5.0 m^3	x 1	unit
Engine Generator	:	35 kVA	x 1	unit

3.3.5 Bridges

The features of the construction of the Asin river bridges are shown in the table below. The design widths are exactly same as the existing structures, as these are compensation works.

Name of Bridge	Asin No.1	Asin No.2
Location	No.25	No.35
Width	9.60 m	8.25 m
Span Length	20.0 m	20.0 m
Bridge Length	21.8 m	21.8 m
Design Load	BINAMARGA standard	BINAMARGA standard

The works for the both bridges will be done at the same time as the works can executed within the same cofferings. After the channel excavation near the abutments is finished, the existing superstructures and substructures will be demolished and excavation of substructure foundations and PC pile driving works follow with temporary retaining wall if necessary. Concrete placing of the substructures is done by concrete pump and backfill works are carried out.

Each main girders of the superstructures is constructed at the working area in the site or manufactured in a factory and transported to the site. Self-weight of one (1) piece of the main girder becomes about 26 t and the length of that is 21.80 m. By

means of the temporary support which installs at the center of the span, a 50 t crawler crane is applied to the erection of main girders on the substructures.

Diaphragms and precast panel plates are unloaded by 25 t truck crane. After installation of precast panel plates, reinforcing bar will be set on the panel plates and outer forms for slab concrete installed. Placing works for slab concrete are carried out carefully by concrete pump with agitator trucks. The capacity and the number of the equipment for the bridge construction works are as below.

Backhoe	:	0.35 m^3	x	1	unit
Giant Breaker	:	600/800 kg	x	1	unit
Dump Truck	:	10 t	x	2	units
Diesel Pile Hammer	:	3.5 t	x	1	unit
Crawler Crane	:	50 t	x	1	unit
Truck Crane	:	25 t	x	1	unit
Concrete Pump	:	60 m^3/h	x	1	unit
Agitator Truck	:	4.5 m^3	x	3	units
Air Compressor	:	5.0 m^3	x	2	units
Truck with Crane	:	4 t	x	1	unit

3.4 Asin pumping station

The river diversion into the new river channel will be done at the end of the first dry season. The pumping station works will be carried out in the same period as the retarding pond construction at the beginning of the dry season of second year. Main works consist of the construction of the pumping house, gate structure and management office compound.

3.4.1 Coffering and dewatering

A part of concrete sheet piles which are the permanent structure (revetment around the pump station area) are used as a part of the temporary coffering and earthfill with single steel sheet piles connected to that (refer to Fig. 3.2.3).

The Asin pumping station is located at the downstream end of Asin River and the total inflow during dry season is estimated 0.12 m^3/sec as described in Sub-clause 3.3.1. In considering of the ground water seepage and rain fall during construction period in the dry season, the number of pumps for dewatering at the pumping station site are assumed as the table below.

Specification	Number of pump	Remarks
ϕ 200 mm	4	Fixed with sump pit
ϕ 160 mm	2	Movable
ϕ 180 mm	3	Movable

3.4.2 Pumping station

(1) Excavation and pile driving

When the structural excavation reached to EL.-0.30 m, driving PC pile and concrete sheet pile whose pile head elevation is almost same as the excavated level are carried out. And when the excavation reached to EL.-4.50 m, remaining driving works of PC pile and sheet piles are commenced (refer to Fig. 3.4.1). The capacity and the number of the equipment for excavation and pile works are as below.

Backhoe	:	0.35 m³	x	1	unit
Dump Truck	:	10 t	x	2	units
Bulldozer	:	15 t	x	1	unit
Vibrating Roller	:	10 t	x	1	unit
Diesel Pile Hammer	:	3.5 t	x	1	unit
Vibratary Pile Driver	:	90 kW	x	1	unit
Truck with Crane	:	4 t	x	1	unit

(2) Concrete placing

After completion of PC pile and sheet pile driving works, slab concrete works will be commenced. In principle, concrete placing of the pumping station is separated into the slab and the wall portions. In consideration of a construction joints the maximum concrete volume in the slab portion becomes about 160 m^3 and 50 m^3 in the wall portion. These concrete placing are done by a concrete pump and agitator trucks. Since the maximum wall height becomes higher than 6 m, the height of one lift is limited within 3.5 m and a careful speed control of the concrete placing is required.

Secondary concrete below the screw pump is placed under spinning the screw after the completion of whole operation system. The capacity and the number of the equipment for concrete placing works are as below.

Truck Crane	:	20 t	x	1	unit

Truck with Crane	:	4	t	x 1	unit
Concrete Pump	:	60	m^3/h	x 1	unit
Agitator Truck	:	4.5	m^3	x 4	units
Air Compressor	:	5.0	m^3	x 1	unit

(3) Pump installation

After completion of the concrete placing of the pumping house, installation work of pump facilities are commenced. Pumps which are manufactured in a factory are transported to the pumping station area by 20 t trailer through the inspection road on the left bank of Semarang River. In considering of the self-weight of one unit of pump and the distance between installation place of pump and location of crane, 100 t crawler crane is applied to the installation works. After installation of pumps the remaining works are continued. The capacity and the number of the equipment for the installation works are as below.

Crawler Crane : 100 t x 1 unit

3.4.3 Gate Structure

(1) Excavation and pile driving

Bottom elevation of the gate slab concrete is EL.-3.41 m, which is about 3.1 m higher than the neighboring pumping station slab. Therefore, after the wall concrete of pumping station reached to the EL.-3.41 m, excavation of gate foundation is to be commenced. After the completion of the concrete placing and backfill at the portion of the neighboring pumping station, driving works of PC pile and steel sheet pile will follow.

(2) Concrete placing

After completion of PC pile and steel sheet pile driving works, slab concrete placing follows. Concrete volume at the slab portion becomes about 150 m^3 and 50 m^3 at the center pier portion. These concrete placing are done by concrete pump at one time. After completion of the control house slab concrete, gate operation apparatus is installed and control house construction works follows again.

(3) Gate installation

Gate installation works are commenced after completion of the placing control

house slab concrete by 25 t truck crane set at the left bank of Asin River. The capacity and the number of the equipment for the installation works are as below.

Truck Crane : 25 t x 1 unit

3.4.4 Bridge

The features of a bridge of Asin pumping station are shown in the table below. This bridge is exclusively used for operation and maintenance purpose.

Width	5.00 m
Span Length	20.00 m
Bridge Length	21.80 m
Design Load	BINA MARGA standard

The substructure which locates at the pumping station side should be completed before the commencement of the backfilling at this side. The features of the operation bridge is same as the Asin river bridges except the width. Therefore equipment and procedure for the erection of this bridge is also same as Asin river bridge. The capacity and the number of the equipment for the bridge are as below.

Diesel Pile Hammer	:	3.5 t	x 1	unit
Crawler Crane	:	50 t	x 1	unit
Truck Crane	:	25 t	x 1	unit
Concrete Pump	:	60 m^3/h	x 1	unit
Agitator Truck	:	4.5 m^3	x 3	units
Air Compressor	:	5.0 m^3	x 1	unit
Truck with Crane	:	4 t	x 1	unit

3.4.5 Management Office Compound

A control office, a pumping house, a garage and a staff house are constructed at the pumping station area. After completion of pump installation works and pumping station bridge works, construction of these buildings should be commenced. The features of the buildings, the capacity and the number of equipment for the construction of control buildings are as below.

Control Office	One-story house	121.00 m^2
Pumping House	One-story house	193.30 m^2
Garage	One-story house	199.00 m^2
Staff House	One-story house	44.64 m^2

Backhoe	:	0.35	m^3	x	1	unit
Dump Truck	:	10	t	x	1	unit
Truck Crane	:	20	t	x	1	unit
Air Compressor	:	5.0	m^3	x	1	unit
Truck with Crane	:	4	t	x	1	unit
Portable Mixer	:	0.20	m^3	x	1	unit

3.5 Asin retarding pond

Retarding pond for Asin pumping station is located in the neighbourhood of the pumping station. The features of Asin retarding pond is shown in the table below.

Pond area	16,000 m^2
Retarding capacity	24,000 m^3
Available depth of retarding pond	1.50 m
Design river bed elevation	EL-2.70 m
Inspection road	L= 300 m

3.5.1 Earth work

The retarding pond construction area consists of the existing Semarang river bed and right bank plain, so ground conditions of each areas are completely different. A temporary construction road is constructed at the upstream side of the pond area. Then the excavation work is commenced by different methods which match the ground conditions. Since the decrease of trafficability of heavy equipment is predicted at the existing river bed area, excavation will be done by backhoe. At the right bank plain, bulldozer is applied to the excavation above ground water level, and that will be changed to backhoe below ground water level due to the actual excavation conditions. The capacity and the number of the equipment for earth works are as below.

Bulldozer	:	15	t	x 1	unit
Backhoe	:	0.35	m^3	x 3	units
Dump Truck	:	10	t	x 9	units

3.5.2 Revetment

Concrete sheet pile type revetment will be constructed before the excavation work except the area which temporary construction road is constructed. Wet stone

masonry type revetment at the left bank and the connection channel inlet and outlet portion is commenced after the completion of the excavation. Log piles are driven after the excavation of base concrete foundation, base concrete placing, gravel bedding, wet stone masonry, boulder filling and top concrete placing follows. The capacity and the number of the equipment for revetment works are as below.

Backhoe	:	0.35 m^3	x	2	units
Dump Truck	:	10 t	x	2	units
Backhoe	:	0.20 m^3	x	1	unit
Vibratary Pile Driver	:	90 kW	x	1	unit
Agitator Truck	:	4.5 m^3	x	1	unit
Tamper	:	60/100 kg	x	2	units
Truck with Crane	:	4 t	x	1	unit

3.5.3 Rehabilitation of Existing Inspection road

(1) Asin River

The existing inspection roads along the both sides of Asin River are rehabilitated. After completion of the revetment works on both banks and bridge works, inspection road works will be commenced. In principle, concrete blocks on the compacted sand are placed on the existing pavement. Some areas which lost the existing pavement by revetment works and others, should be repaired under the direction by the Engineer.

(2) Asin retarding pond

Inspection road at the retarding pond is on the left bank and connected to the distance-post No.45 of Semarang River. It is better to commence at the same time of the construction of inspection road at Asin River.

Sub base course, base course and compacted sand will be compacted by vibrating roller and tire roller, and concrete block pavements are carried out by manpower. In considering of work condition, all works about inspection road should be completed before start of rainy season. The capacity and number of the equipment for inspection road are as below.

Motor Grader	:	2.8 m	x	1 unit
Vibrating Roller	:	10 t	x	1 unit

Tire Roller	:	8/12 t	x	1 unit
Portable Mixer	:	0.20 m^3	x	1 unit

CHAPTER 4 BANDARHARJO DRAINAGE SYSTEM IMPROVEMENT (PACKAGE 3)

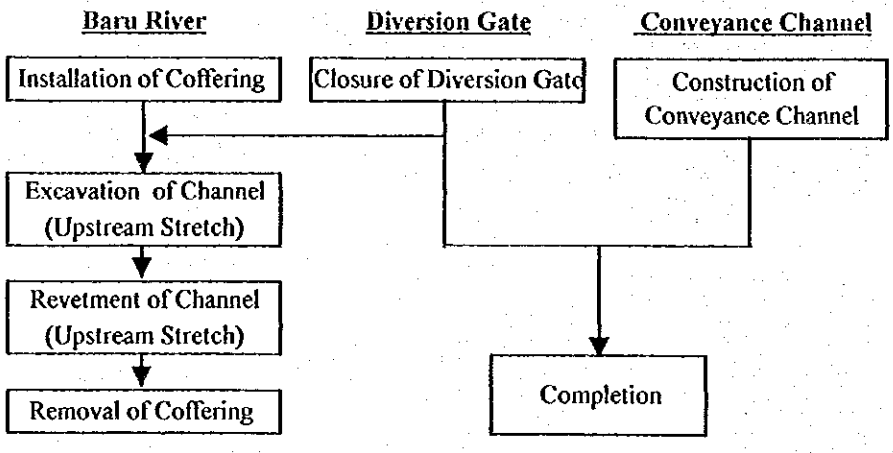
4. 1 General

Main work items of Bandarharjo Drainage System Improvement consists of the construction of Baru pumping station, Baru retarding pond, connection channels and Baru river dredging work. Since Baru pumping station is located within the existing Baru river channel, the construction period and method should be considered together with the channel dredging works. But the other items do not have tight relationship to the construction schedule each other.

In consideration of the construction volume and the number of work items in this package, three dry seasons are necessary as the whole construction period.

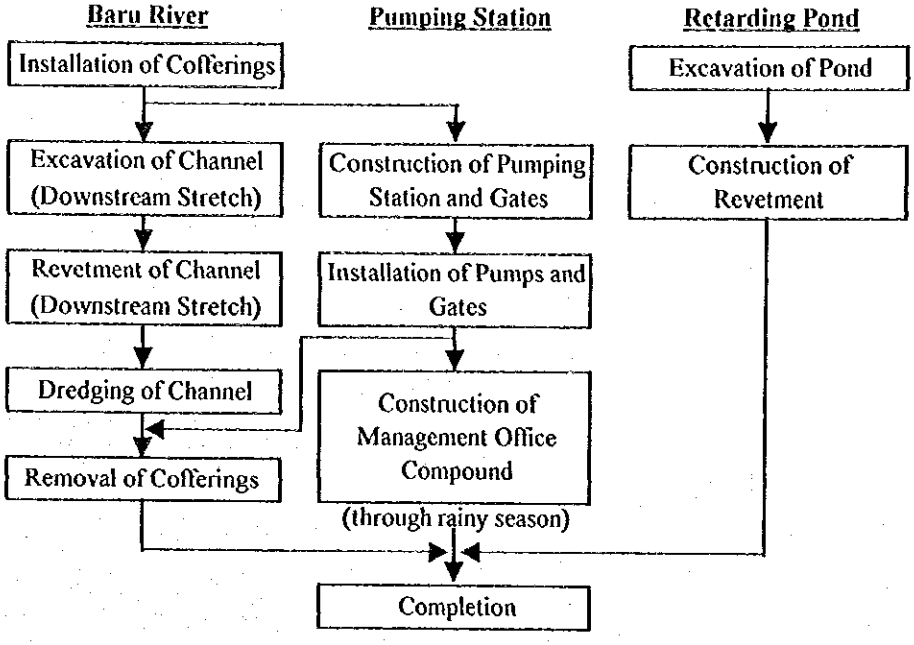
4.1.1 First Dry Season

Excavation and revetment of channel at upstream stretch, closure of diversion gate and Baru conveyance channel works are carried out in the first dry season.



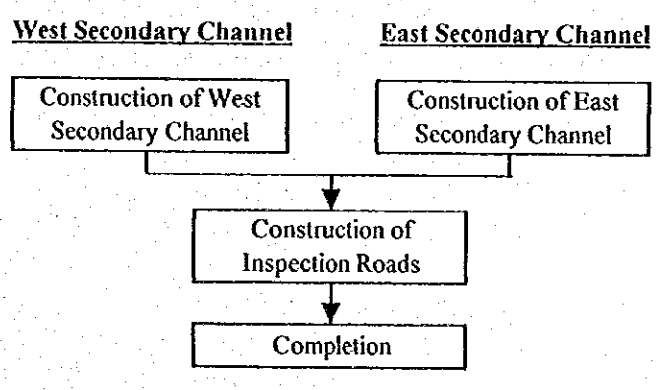
4.1.2 Second Dry Season

Excavation and revetment of channel at downstream stretch, Baru pumping station, Baru retarding pond construction works are carried out in the second dry season. The construction of the management office compound will be commenced from the end of dry season and carried out through rainy season to the third year dry season.



4.1.3 Third Dry Season

West secondary channel, East secondary channel and the construction of inspection roads are carried out in the third dry season.



4.2 Baru river improvement

Width of Baru River is about 20 m in the downstream side from bridge (distance-post No.29+8) and more than 30 m in the upstream side from bridge which located near North Ring Road.

A clearance under the bridge (No.29+8) is not enough to pass through for ships and pontoons for dredging works, and the width of 30 m in the upstream side of the bridge is too wide to dredge by a backhoe from landside. But by the closing of the diversion gate to Baru River (this is one of the Baru river improvement work items), the main inflow into Baru River during dry season becomes only the waste

water drainage from the residential area. The quantity is estimated about 0.06 m^3/sec, and this value is within the drainage capacity by means of the temporary pumping system.

Considering above conditions, a completely river closing by cross section using double steel sheet pile is applied to the coffering of the upstream side from the bridge (refer to Fig. 4.2.1).

4.2.1 Dredging and excavation

(1) Dredging in the downstream from the bridge (No.21～No.29+8)

The channel stretch between No.21 and No.29+8 with the length of about 170 m will be dredged. Since width of the downstream from the bridge (No.29+8) is about 20 m, dredging by long armed backhoe will be carried out in this area and dredged soil is hauled by dump truck to the spoil bank 1.0 km away.

(2) Excavation in the upstream from the bridge (No.29+8～No.70+13)

The channel stretch between No.29+8 and the Baru diversion gate with the length of about 850 m will be excavated. The upstream side from the bridge is divided into two working areas with cofferings by full cross section method in consideration of the total volume. The working area is closed completely by a temporary coffering described above and dewatered by a pump system during construction period. The number of pumps for dewatering are assumed as below table.

Specification	Number of pump	Remarks
ϕ 200 mm	3	Fixed with sump pit
ϕ 160 mm	2	Movable
ϕ 180 mm	3	Movable

After dewatering the closed area, temporary construction roads will be constructed from the bank crest into the riverbed by gentle gradient (refer to Fig. 4.2.1). Excavation by backhoe is carried out and excavated material is hauled to the spoil bank which is about 2.0 km away from the site by dump trucks.

The capacity and the number of the equipment for the dredging and excavation works are as below.

Backhoe : 0.35 m^3 x 1 unit

Backhoe (Long arm)	:	0.35 m^3	x	1	unit
Dump Truck	:	10 t	x	5	units

4.2.2 Revetment

For Baru river revetment, Type A-3 is applied (refer to Fig. 4.2.2). After completion of the excavation until EL.-2.40 m, structural excavation for base concrete foundation and log piling work will be commenced and the excavation until EL.-3.40 m followed. An agitator truck with chute carry out concrete placing works for the base and top concrete. The capacity and the number of the equipment for the revetment works are as below.

Backhoe	:	0.35 m^3	x	1	unit
Dump Truck	:	10 t	x	2	units
Backhoe	:	0.20 m^3	x	1	unit
Tamper	:	60/100 kg	x	4	units
Agitator Truck	:	4.5 m^3	x	1	unit
Portable Mixer	:	0.20 m^3	x	1	unit
Truck with Crane	:	4 t	x	2	units

4.2.3 Closure of diversion gate to Baru River

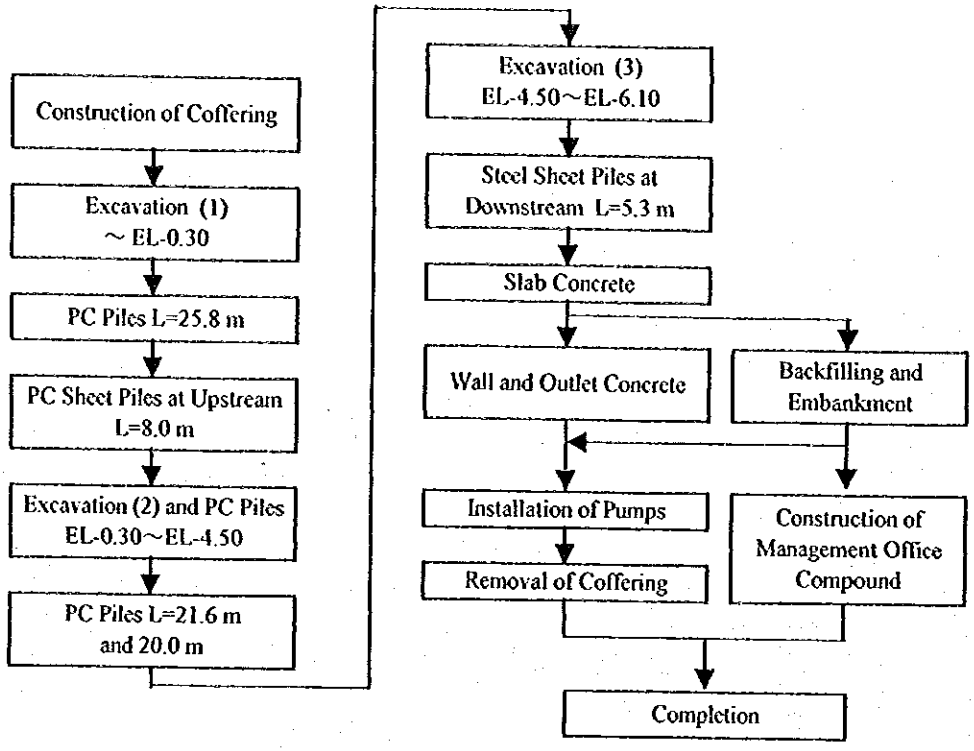
The existing diversion gate shall be closed by concrete wall. The closure work will be done at the same time as the excavation works in this area.

After driving of steel sheet piles, a slab concrete of closure structure will be placed first and wall concrete follows. Concrete placing will be done by a concrete pump or agitator trucks with chute. Typical cross section of closure is shown in Fig. 4.2.3. The capacity and the number of the equipment for the closure works are as below.

Vibratary Pile Driver	:	60 kW	x	1	unit
Truck with Crane	:	4 t	x	1	unit

4.3 Baru pumping station

General layout of the pumping station is as shown in Fig 4.3.1. The pumping station is located at 31 m away from the electric transmission line according to the structure regulation. Construction of Baru pumping station is carried out through a year in accordance with the following flow diagram.



4.3.1 Excavation and embankment

The excavation level of the pumping station becomes EL.-6.10 m at the bottom of the slab concrete, it means that the pumping station is 2.70 m deeper than the channel riverbed. Therefore, sandbags are used as the secondary coffering around the excavation area of the pumping station. If soil condition is not so stable, steel sheet piles are required as a temporary retaining wall around the pumping station. The excavation works are carried out by the combination of backhoe and dump truck.

Since there are a few kinds of piles in terms of pile head elevation at the pumping station, excavation schedule should be adjusted to the driving works of piles.

The embankment of the building construction area will be commenced after the completion of the revetment in this area and carried out step by step following the pumping house concrete placing elevation. Embankment material from the excavated material at the Baru retarding pond excavation will be spread by a bulldozer and compacted by a vibrating roller until the material is compacted to meet the specification.

The capacity and the number of the equipment for earth works are as below.

Backhoe	:	0.35	m^3	x	1	unit
Dump Truck	:	10	t	x	2	units
Bulldozer	:	15	t	x	1	unit
Vibrating Roller	:	10	t	x	1	unit
Tamper	:	60/100	kg	x	1	unit

4.3.2 PC piles and sheet piles

After excavation reaches to EL.-0.30 m and EL.-4.50 m, driving work of PC piles and sheet piles are carried out and excavation work is followed again. PC piles driving of EL.-6.10 m should be done at the same time of EL.-4.50 m in order to avoid the loss of work efficiency and driving trouble by soil compaction caused driven piles.

Between EL.-0.30 m and EL.-4.80 m, driving of PC piles and excavation work is carried out each other. The capacity and the number of the equipment for the pile driving works are as below.

Diesel Pile Hammer	:	3.5	t	x	1 unit
Vibratary Pile Driver	:	90	kW	x	1 unit

4.3.3 Concrete placing

(1) Pumping station

In principle, concrete placing of the pumping station is separated into slab and wall portions. After completion of driving works of PC piles and sheet piles, slab concrete work is commenced. With consideration of construction joints the maximum concrete volume at the slab portion becomes about 180 m^3 and 57 m^3 at the wall portion. In this case wall height becomes higher than 5 m, two-lift of concrete placing is applied and a careful placing speed control is required.

(2) Gate structure

After completion of PC piles and sheet piles driving works, slab concrete work is carried out and pier concrete works follow. In order to installation of the gate control apparatus, concrete placing of control house is stopped at EL.5.80 m of house slab and commenced again after the installation of apparatus.

Any kinds of concrete placing works at the pumping station and gate structure, concrete placing is carried out by means of a concrete pump and agitator trucks in principal. The capacity and the number of the equipment for the concrete placing are as below.

Truck Crane	:	20	t	x 1	unit
Truck with Crane	:	4	t	x 1	unit
Concrete Pump	:	60	m^3/h	x 1	unit
Agitator Truck	:	4.5	m^3	x 4	units
Air Compressor	:	11.0	m^3	x 1	unit

4.3.4 Pump and gate installation

(1) Pump

After completion of the pumping station concrete works and the embankment of the control building area, pump installation work is commenced. Two units of pumps will be transported from a factory to the site area through the upstream right bank road, and carefully installed at specified location using 100 t crawler crane.

(2) Gate

After completion of the pier concrete at EL.5.10 m of the gate structure and setting of guide frames, gate installation work is commenced. According to the installation conditions of gate, 20 t truck crane which sets at the left bank is applied to install. The capacity and number of the equipment for the installation works are as below.

Crawler Crane	:	100 t	x 1	unit
Truck Crane	:	20 t	x 1	unit

4.3.5 Management Office Compound

A control office, a pumping house, a garage and a staff house are constructed at the right bank. After completion of the revetment and embankment works, construction of these buildings is commenced and carried out through a year. The features of the buildings, the capacity and the number of equipment for the construction of control buildings are as below.

Control Office	One-story house	121.00 m^2
Pumping House	One-story house	155.80 m^2
Garage	One-story house	199.00 m^2
Staff House	One-story house	44.64 m^2

Backhoe	:	0.35	m^3	x	1 unit
Dump Truck	:	10	t	x	1 unit
Truck Crane	:	20	t	x	1 unit
Truck with Crane	:	4	t	x	1 unit

4.4 Baru retarding pond

Retarding pond for Baru pumping station is located at 600 m away from Baru River and along the North Ring Road. The features of Baru retarding pond is shown in the table below and Fig. 4.4.1.

Pond area	9,260 m^2
Retarding capacity	9,000 m^3
Available depth of retarding pond	1.00 m
Design river bed elevation	EL-2.40 m
Inspection road	L= 520 m

4.4.1 Excavation

After clearing and stripping of the pond area, temporary construction roads are extended from North Ring Road to an inspection road area to construct the part of foundation of the inspection road and use as a temporary dike. According to the workability of heavy equipment, dewatering and drying up the construction area should be continued and drainage water is pumped up outside of the temporary dike.

Excavated and gathered materials by bulldozer are loaded to dump truck by backhoe and hauled to a spoil bank located 1.1 km away from the site. But the excavated material which meets the specification should be used as the embankment material for the foundation of the inspection road.

In consideration to the total construction period of the retarding pond and the site conditions, excavation work (including the embankment work of the foundation of inspection road) should be completed within dry season. The capacity and number of the equipment for excavation are as below.

Backhoe	:	0.35	m^3	x	2	units
Dump Truck	:	10	t	x	5	units
Bulldozer	:	15	t	x	1	unit

4.4.2 Revetment

Wet masonry type A-4 is applied for the revetment of the retarding pond (refer to Fig. 4.4.2). After completion of the pond excavation near the revetment area, excavation for the revetment is commenced and log pile driving, base concrete placing, wet stone masonry, cobble stone filling and top concrete work follows. Base and top concrete are placed directly by an agitator truck with chute. Embankment of the inspection road foundation is followed by the top concrete work. After installation of precast concrete for curbstone, sub base course, base course, surface course and pavement works are carried out. The capacity and number of the equipment for revetment are as below.

Backhoe	:	0.35	m^3	x	1	unit
Dump Truck	:	10	t	x	2	units
Backhoe	:	0.20	m^3	x	2	units
Agitator Truck	:	4.5	m^3	x	1	unit
Portable Mixer	:	0.5	m^3	x	1	unit
Truck with Crane	:	4	t	x	1	unit
Tamper	:	60/100	kg	x	4	units

4.5 Baru conveyance channel

A conveyance channel connecting the Baru retarding pond with Baru River is designed as a box culvert type and temporary sheet pile wall is employed for the whole length for excavation because of the limited width of the work site. Manholes are constructed each 10 m. The features of Baru conveyance channel is shown in the table below.

Structure	Box culvert
Length	692 m
Dimension of inside	2.00 m x 2.00 m
Number of manholes	68

It is difficult to keep enough working space by open cut excavation method in the construction area because of close construction works to the houses and North Ring Road, so steel sheet piles are used for the temporary retaining wall during the

construction period. In order to avoid a long time construction at the existing roads, reasonable construction unit is required. Three blocks of box culvert (total length becomes about 60 m) is suited to one construction unit. Concrete placing works will be carried out by a concrete pump and agitator trucks and backfill follows. After completion of all construction units at the residential district, an inspection road work follows.

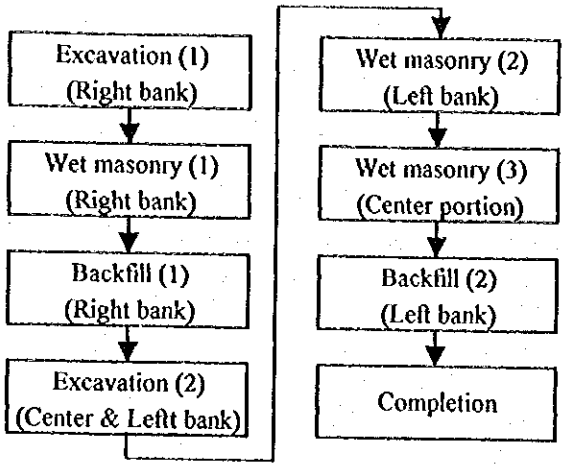
Since high ground water level is predicted in this area, it is better to complete all works before the start of rainy season. The capacity and number of the equipment for conveyance channel works are as below.

Backhoe	:	0.35	m^3	x 1	unit
Dump Truck	:	10	t	x 2	unit
Vibratary Pile Driver	:	60	kW	x 1	unit
Concrete Pump	:	60	m^3/h	x 1	unit
Agitator Truck	:	4.5	m^3	x 3	units
Tamper	:	60/100	kg	x 3	units
Motor Grader	:	2.8	m	x 1	unit
Vibrating Roller	:	10	t	x 1	unit
Tire Roller	:	8/12	t	x 1	unit
Truck with Crane	:	4	t	x 1	unit

4.6 West secondary channel

West secondary channel connects the Semarang River right bank and the Baru retarding pond along the North Ring Road. That is designed as an open channel type by wet stone masonry (refer to Fig. 4.6.1) and the total length becomes about 580 m.

A few numbers of temporary construction roads are constructed from North Ring Road to inspection road area along the secondary channel. One construction unit length of 100 m is applied to the channel works. After completion of one unit, the next unit is commenced by same procedure. The procedure in each construction unit is shown below.



Left bank : North Ring Road side
Right bank : Opposite side of N.R.Road

After completion of all works of the secondary channel, an inspection road works will be commenced.

A high ground water level is predicted in this area also, it is better to complete all works before rainy season start. The capacity and number of the equipment for west secondary channel are as below.

Backhoe	:	0.35	m^3	x	6	units
Dump Truck	:	10	t	x	12	units
Tamper	:	60/100	kg	x	6	units
Motor Grader	:	2.8	m	x	1	unit
Vibrating Roller	:	10	t	x	1	unit
Tire Roller	:	8/12	t	x	1	unit
Portable Mixer	:	0.20	m^3	x	1	unit

4.7 East secondary channel

East secondary channel is constructed at the right bank of Baru River as a box culvert under an existing road. Dimensions of the box culvert and the construction condition is almost same as the Baru conveyance channel, so same method and procedure of Baru conveyance channel (refer to Clause 4.5) is applicable.

CHAPTER 5 CONSTRUCTION TIME SCHEDULE

5.1 Conditions for planning

To establish the construction plan, estimation of the workable days is most important factor for construction schedule.

5.1.1 Workable days

(1) Dry and Rainy Seasons

One year is divided into the dry and rainy seasons for construction planning purpose as follows.

Dry Season	:	April to November (8 months)
Rainy Season	:	December to March (4 months)

(2) Construction Mode

Construction works, which are possible to be done even in rainy season by applying dewatering facilities, will be executed through a year. While construction works which are difficult to be done in rainy seasons will be executed in dry seasons.

(3) Suspension of Works by Precipitation

Period of the suspension of the works by precipitation (R mm) is assumed as below depending on the work items and the amount of precipitation.

Earth Works and Foundation Works	R ≥ 15 mm/day	one (1) day suspension
	R ≥ 30 mm/day	two (2) days suspension
Concrete Works and Installation of Gate	R ≥ 15 mm /day	one (1) day suspension

(4) Seasonal Workable Days

Since construction works along/within the river course are much influenced by rainfall and flooding, the construction period and workable days are estimated based on the rainfall data at the Semarang station for 10 years starting from 1987. In addition, national holidays and religious events are considered.

Workable days by season are calculated in Tables 5.1.1 to 5.1.4 and the result

is shown in Table 5.1.5. The summary of the workable days by season is tabulated below.

Work Items	Dry Season (Apr. – Nov.)	Rainy Season (Dec. – Mar.)	Through a Year
Earth Works and Foundation Works	176 days/8 mths = 22 days/mth	49 days/4 mths = 12 days/mth	225 days/year = 18 days/mth
Concrete Works and Installation of Gate	184 days/8 mths = 23 days/mth	68 days/4 mths = 17 days/mth	252 days/year = 21 days/mth

5.1.2 Daily Workable Hours

All construction works are planned to be carried out under the single shift working system of 9-hour labour per day including 2 hours of overtime work.

5.2 Construction Time Schedule, Mobilization and Demobilization of Construction Equipment

The balance of construction volumes including numbers of construction equipment and facilities is very important for cost estimation. The schedule of each package is shown below and detailed construction time schedule is shown in Tables 5.2.1 to 5.2.3 and Mobilization and Demobilization of Construction Equipment in Tables 5.2.4 to 5.2.6.