CHAPTER 1 INTRODUCTION

1.1 Background

Semarang City, the capital of Central Java Province, had the population of 1,252,000 in 1996. The city and its surrounding areas suffer almost every year from floods in rainy seasons and from shortage of water supply in dry seasons. The problem of water shortage will be aggravated further in the future due to the recent trend of population concentration in the urban area.

To mitigate these chronic economic problems and to enhance the economic development and stabilization of people's livelihood. "The Master Plan on Water Resources Development and Feasibility Study for Urgent Flood Control and Urban Drainage in Semarang City and Suburbs" was prepared by Japan International Cooperation Agency (JICA) upon the request of the Indonesian Government in the period of 1992 to 1993. (refer to Fig. 1.1)

For the urgent realization of the proposed priority projects selected in the Master Plan, the Government of Indonesia requested further technical assistance from the Government of Japan in 1996. JICA then decided to dispatch another study team to carry out the detailed design of the priority projects. The study is named as "The Detailed Design of Flood Control, Urban Drainage and Water Resources Development in Semarang in the Republic of Indonesia" (hereinafter referred to as "the D/D Study"). (refer to Fig. 1.2)

1.2 Objectives of the Study

The objectives of the Study are to carry out the detailed design of the following three (3) components, (1) West Floodway/Garang River Improvement, (2) Construction of Jatibarang Multipurpose Dam and (3) Urban Drainage System Improvement, and to pursue transfer of technical knowledge to the counterpart personnel in the course of the Study.

The detailed design works includes the selection of suitable type of structures, structural and hydraulic analyses for the selected structures, preparation of drawings, work quantity calculation, preparation of the construction planning, estimate of the project cost, preparation of the pre-qualification and contract documents and preparation of general and technical specifications.

Further more, the necessary organization for the effective maintenance and operation of the structures designed is proposed.

1.3 General Conditions of Study Area

General

The study area is administratively covered by Semarang City and Semarang Regency (Kabupaten) in Central Java Province, which has 29 regencies (called as "Kabupaten" in Indonesian language) and 6 municipalities ("Kotamadya") as of 1997. The Municipality of Semarang (hereinafter called as "Semarang City") is one of those municipalities functioning as the capital city of Central Java Province as mentioned above situated between Long. 109°35'E and 110°50'E, and between Lat. 6°50'S and 7°10'S. Semarang City is composed of sixteen (16) Districts (Kecamatans) facing to the Java sea, of which total area is estimated at 382.11 km^2.

Climatic Characteristics

The study area is located in the northern central region of Java Island, where monsoon and trade wind give strong influence and two (2) distinct seasons, namely rainy season and dry season. The average annual rainfall amounts 2,378 mm according to the climatological data at BMG-Semarang station.

Geomorphology and Geology

The study area is located in the northern slope of Mt. Ungarang which has an altitude of 2,050 m. The area can be divided into three topographical types: mountainous region, hilly region and alluvial plain.

Garang River originates from Mt. Ungarang and flows down toward northward at the western area of Semarang City meeting with two (2) major tributaries, Kreo and Kripik rivers. Garang River changes its name to West Floodway in the down stream from Simongan Weir which is located at about 5.3 km upstream from the river mouth.

The Kreo River, on which Jatibarang Multipurpose Dam is planned, originates from Mt. Ungaran and flows approximately from south to north in the study area. In the mountainous and hilly regions, the river is characterized with steep slope because of the short stream length and large difference in ground elevation. The catchment area is long and slender. The geographical feature of the hilly area is still in the young stage development, with the vertical erosion being stronger than horizontal erosion.

Geology of this area is roughly divided into three categories; volcanic rock, sedimentary rock which is marine in origin, and alluvial deposits which cover these basement rocks. Volcanic rocks consist of lahar, lava flow of Mt. Ungaran, Notopuro Formation and intrusive rock. Sedimentary rocks consist of Damar Formation, Kalibiuk Formation, Banyak Member and Penyatan Formation.

The geology of the Central Semarang is alluvial deposits that cover the base volcanic and sedimentary rocks. Alluvial deposits consist of recent river deposits, flood plain deposits and shallow marine deposits.

Socio-Economic Condition

(1) Population

In Semarang City, the population is 1,252,000 in 1996 with the population density of 3,370 person/km2, and the number of household is counted at about 278,000. The future population of Semarang City is projected at 1,374,000 for the year 2005, which is the target year of priority project.

(2) Land Use

The land in the Garang River basin is classified into seven (7) categories such as agricultural land, water area, conservation area, industrial area, business area, housing area and others. The agricultural land includes paddy, upland fields and plantation. It covers predominantly large area (52.9 %) which consists of mainly small-scaled farmlands extending over the upper river basin. This pattern is particularly dominant in the area administered by the two regions. It is notable that both business and industrial area have minor shares (0.5% and 0.3%) in the basin. The land use pattern is summarized in the following table.

Land Use Pattern of Garang River Basin

Classification	Area (ha)	Share (%)
Agricultural Land	10,813	52.9
Water Area	110	0.5
Conservation Area	4,033	19.8
Industrial Area	58	0.3
Business Area	103	0.5
Housing Area	4,467	21.9
Others	846	4.1
Total	20,430	100.0

(3) Regional Economy

The Gross Regional Domestic Product (GRDP) in Central Java Province was Rp. 47

trillion as of 1995 at current price level with 18.62 % of the annual average growth rates at current price level, while GRDP in Semarang City was Rp.5.3 trillion as of 1995 with 18.99 % of growth rates.

In Semarang City, GRDP per capita was quite high comparing with those in average in whole Indonesia and in whole Central Java Province as Rp.4,305 thousand as of 1995 at current price level with 16.43 % of annual growth rate at current price level.

CHAPTER 2 CONSTITUTION OF THE PROJECT

The project of THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA consists of three components, Component A: West Floodway/Garang River Improvement, Component B: Construction of Jatibarang Multipurpose Dam and Component C: Urban Drainage System Improvement. (refer to Fig. 1.2)

Component A: West Floodway/Garang River Improvement

This component aims to improve West Floodway / Garang River to accommodate the design flood discharge of 790 m3/s which is equivalent to 100-year probability with Jatibarang Multipurpose Dam (25-year probability without the dam) for the stretch of about 10 km from the river mouth to the confluence of Garan and Kreo rivers including the reconstruction of Simongan Weir which is located about 5.3 km upstream from the river mouth and was constructed more than 100 years ago.

The component is further divided into three (3) contractual packages in accordance with the nature of the construction works.

Component B: Jatibarang Multipurpose Dam Construction

Jatibarang Multipurpose Dam has three functions, namely flood control, water resources development and hydropower generation and is planned to be constructed on Kreo River which is a major tributary of Garang River at about 23 km upstream from the river mouth.

The component is further divided into two (2) contractual packages in accordance with the nature of the construction works.

Component C: Urban Drainage System Improvement

This component aims to improve the drainage system in the central area of Semarang City to drain storm water of 5-year probability. The improvement works contains the construction of two (2) drainage pumping stations together with the retarding ponds and the improvement of the existing main drainage channels in the study area, Semarang, Asin and Baru rivers.

The component is further divided into three (3) contractual packages in accordance with the nature of the construction works.

CHAPTER 3 COMPONENT A: WEST FLOODWAY/GARANG RIVER IMPROVEMENT

3.1 Natural Conditions

3.1.1 River Features and Structure

Profile of River

Garang River flows from Mt. Ungarang to the north, meeting its two (2) major tributaries, Kripik and Kreo rivers, about 12 km and 10 km upstream from the river mouth, respectively (refer to Fig. 3.1). The whole catchment area of Garang River is about 204 km^2, which includes the catchment area of 70 km^2 for Kreo River and 34 km^2 for Kripik River. The total river lengths of Garang, Kreo and Kripik rivers are about 36 km, 24 km and 8 km respectively.

Simongan Weir exists at the lowermost end of Garang River (about 5.3 km upstream from the river mouth) giving a riverbed elevation difference of about 5 m between upstream and downstream as shown in Fig. 3.2. The downstream from the weir is called West Floodway (Banjir Kanal Barat), and the flood discharge from Garang River flows into Java Sea through the floodway.

A densely populated area spreads out in the lower reaches from the confluence of Kreo River, particularly, the down stream area from Simongan Weir is highly utilized as residential, commertial and industrial area.

Major River Structures

Simongan Weir, which was constructed at the end of 19^{th} century during the Dutch colonial period, is the major river structure of Garang River diverting river water to Semarang River from the right bank and an irrigation channel (city drainage channel) from the left bank. The weir also serves PDAM water intake that is located on the right river bank at 1.2 km upstream of the weir. At present, a total amount of 0.98 m^3/s is taken from the river by pumps for the municipal water.

There exist six (6) bridges spanning West Floodway/Garang River, one (1) railway bridge and five (5) road bridges.

3.1.2 River Flow Capacity

(1) West Floodway (River mouth to Simongan Weir)

(a) For the downstream stretch from North Ring Road to the river mouth, the flow capacity ranges from 200 m^3/s to 1,200 m^3/s.

(b) For the stretch between Railway Bridge and North Ring Road, although the flood walls are provided, the flow capacity does not reach 800 m^3/s.

(c) For the stretch between Railway Bridge and Simongan Weir, the figure indicates a high capacity of 800 m^3/s or more except for a portion immediately upstream of National Road Bridge.

(2) Garang River (Simongan Weir to Confluence of Garang and Kreo rivers)

(a) The flow capacity is relatively high at 800 m^3/s or more throughout the whole river stretches except a few portions. This high flow capacity is attributed to the high earth dikes and floodwalls constructed after 1990 flood.

(b) If the freeboard of 1.0 m is applied for the existing dikes and floodwalls, the average flow capacity decreases to about 600 m^3/s.

(c) In the upstream from Toll Road Bridge, the flow capacity is as low as about 600 m^3/s.

3.1.3 Floods and Flood Control Works

Major Floods and Flood Damages

The recent major floods, which brought tremendous damages to the areas along West Floodway/Garang River, occurred in 1973, 1990 and 1993. The Ministry of Public Works and the Semarang City Office confirmed the inundated area and damages/calamities of the above floods. Among these floods, the one in 1990 brought the biggest damages with total number of casualties of 47 and the total amount of damages of 8.5 billion Rupiah.

Previous and Ongoing River Improvement Works

Regional development projects for flood control implemented or ongoing in and around Semarang City are summarized below.

River	Project	Year	Remarks
1) Blorong	West Semarang Irrigation Project	1990	Improvement works with design scale of 20-year return period. Completed.
2) Silandak	Central Java River Improvement and Maintenance Project	1991	Construction of diversion channel with design scale of 50-year return period. Completed.
3) Garang	Central Java River Improvement and Maintenance Project	1992	Completed.
4) East Floodway	Dolok Penggaron Drainage Design Project	2000	Ongoing
5) Babon	Central Java River Improvement and Maintenance Project	1991	Improvement works with design scale of 5-year return period. Completed.
	Dolok Penggaron Drainage Design Project	2000	New diversion channel with design scale of 25-year return period. Ongoing

3.2 Formulation of Definitive Plan

3.2.1 Planning Criteria

(1) Flood Control Scheme

The flood control for West Floodway/Garang River is composed of two schemes; (a) the improvement of West Floodway/Garang River for the river stretch of about 9.8 km from the river mouth up to the confluence with Kreo River including the reconstruction of Simongan Weir, and (b) the construction of Jatibarang Multipurpose Dam on Kreo River.

(2) Flood Control Scale

After the improvement of West Floodway/Garang River, the river channel will be able to accommodate floods of 25-year return period or less. Further, after the completion of Jatibarang Multipurpose Dam, the design scale will be increased to 100-year return period with the improvement of West Floodway/Garang River.

(3) Design Discharge

In accordance with the proposed flood control scale as well as updated probable flood discharges in Garang river system, the design flood discharge for the river improvement has been determined as graphically shown below. The standard flood discharge of 1,010 m^3/s in the downstream from the confluence is reduced to 790 m^3/s by flood control effect of Jatibarang Multipurpose Dam. The discharge of 790 m^3/s corresponds to 25-year probable flood discharge when Jatibarang Multipurpose Dam is not projected.

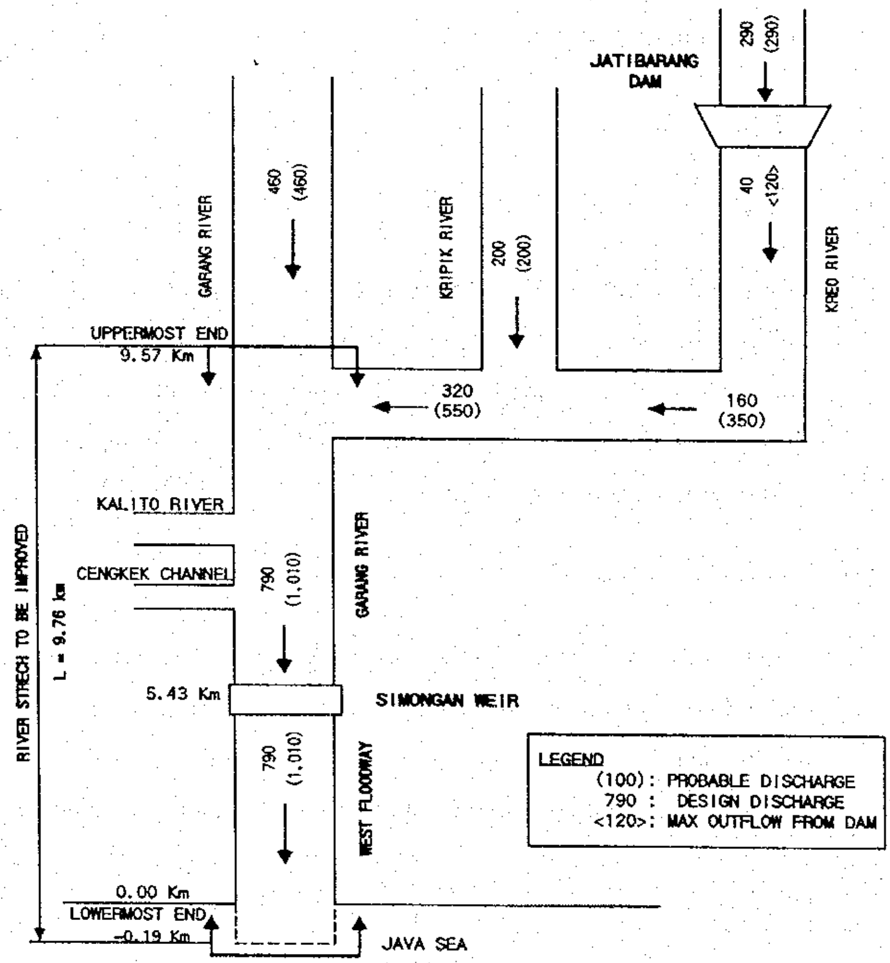
Return Period	Standard Flood Discharge at Simongan Weir	Design Flood Discharge at Simongan Weir *1
100-year	1,010 m^3/s	[redacted]
50-year	900 m^3/s	700 m^3/s
25-year	790 m^3/s	620 m^3/s

*1 : Flood control by Jatibarang Dam is considered.

The design discharge of 790 m^3/s is applied to the river improvement of the river stretches from the river mouth up to the confluence with Kreo River.

Distribution of Design Flood Discharge
(100-year return period)

Unit: m^3/s



(4) Setting Design High Water Level

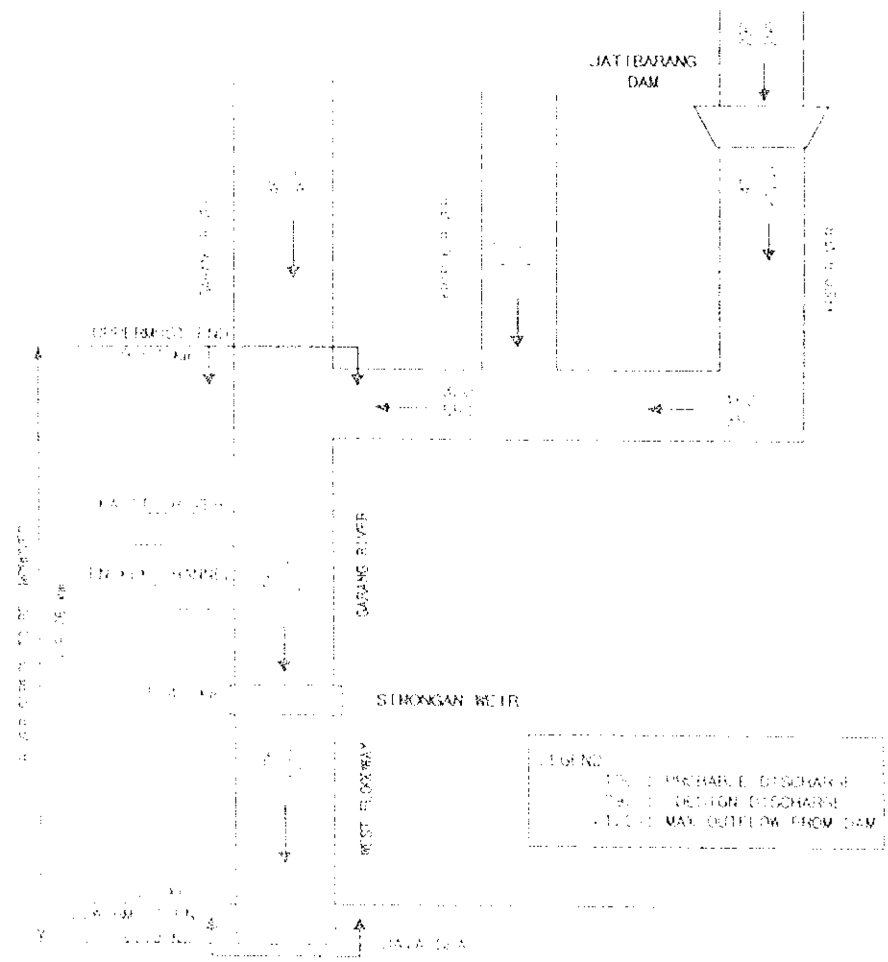
The design high water level is set below the hinterland ground level so as to minimize flood damage potential. The design high water level is, however, unavoidably set higher than the hinterland ground level for the low-lying downstream

Return Period	Simulated Flood Discharge at Simongan Weir	Design Flood Discharge at Simongan Weir *1
100-year	1,010 m^3/s	790 m^3/s
50-year	900 m^3/s	700 m^3/s
25-year	790 m^3/s	620 m^3/s

*1: Flood control by Jatibarang Dam is considered

The design discharge of 790 m^3/s is applied to the river improvement of the river stretches from the river mouth up to the confluence with Kreo River

Distribution of Design Flood Discharge
(100-year return period)
Unit: m^3/s



Setting Design High Water Level

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

(5) Discharge secured by Water Resources Development Works

After Jatibarang Multipurpose Dam Construction is completed, even if the serious draught with 10-year probability occurs, the minimum flow discharge of 2.69 m^3/s is assured at the confluence of Garang River and Kreo River by Jatibarang Multipurpose Dam. This flow discharge consists of the future municipal water of 2.04 m^3/s and flushing water of 0.65 m^3/s for Semarang River and the left bank downstream drainage channel.

3.2.2 Flood Control Works

(1) Concept of Flood Control

The improvement works is projected based on the following concepts.

- To increase the flow capacity of river channel and to prevent flood overflow from river banks/dikes particularly in West Floodway,
- To make the flood water level below the hinterland ground level in Garang River, and
- To eliminate the dam-up effect of flowing water owing to the existing fixed type Simongan Weir.

(2) Flood Control Measure

To attain these purposes, the river improvement of West Floodway/Garang River, and reconstruction of the existing Simongan Weir are proposed as follows.

Major Project Works	River Stretch/Location
1. West Floodway Improvement	L = 5,437 m
- Dredging of downstream channel	L = 2,150 m
- Excavation of existing floodplain	L = 5,250 m
- Raising/Reinforcing of Existing Floodwall	L = 2,510 m
- Embankment for dike in river mouth area	L = 760 m
2. Garang River Improvement	L = 3,907 m
- Riverbed Excavation/Deepening	L = 3,780 m
- Excavation of existing floodplain	L = 3,780 m
3. Reconstruction of Simongan Weir	
- Gated Weir with Intake Structure	5.43 km from river mouth

Since the Railway Bridge located at 3.7 km upstream from river mouth dose not have enough clearance against the design high water level, the existing bridge superstructure will be raised with a required clearance of 1.0 m. Also, the existing piers and abutments will be reconstructed to ensure the structural stability after the channel excavation was made.

For stabilizing riverbed excavated and protecting river banks, river structures such as ground sill, revetment and groin are provided properly as well. As supplementary works, the existing drainage and intake structures, and bridges which may be affected by the river improvement works, will be re-constructed or reinforced to maintain their existing functions. Besides, in view of maintenance and use of river channel and structures, and preservation of river environment, waterfront and environmental related facilities are provided.

(3) Reconstruction of Simongan Weir

The existing Simongan Weir of fixed type primarily causes the serious floods in the upstream by its dam-up effect on flood water. Eliminating this adverse effect and lowering the water level in the upstream stretches is considered as the most effective river improvement measure for Garang River. On the other hand, Simongan Weir, at present, plays an important role in supplying both municipal water for Semarang City and flushing water for Semarang River and the irrigation channel throughout a year.

To fulfill both functions of flood control and water supply, the existing fixed type Simongan Weir needs to be reconstructed to a gated weir which has flexible functions of flood control and water supply.

3.3 Detailed Design

3.3.1 River Improvement

The river stretch to be improved is divided into two sections, West Floodway and Garang River.

<u>West Floodway Channel</u>

River improvement of West Floodway is made focusing on the floodplain excavation and raising the existing floodwalls to enlarge the flood flowing cross sectional areas without excessive deepening of the low water channel.

(1) Alignment of River Channel and Dike (refer to Fig. 3.3)

The centerline of design low water channel is aligned to be an almost straight using fairly gentle curvature at bending portions. Besides, the floodplain excavation is made on the spacious side of floodplain spreading on the right bank. Earth dike is constructed along the right bank in the river section between North Ring Road Bridge and the river mouth to protect the land development area from flood damage. The dike alignment is made in parallel with the alignment of low water channel bank keeping a distance of 10 m in order to ensure the dike stability and to lead flood flow smoothly to the sea.

(2) Longitudinal Profile (refer to Fig. 3.4)

Design High Water Level

At the river mouth, the D.H.W.L is set at EL. +0.500 m that is a little higher than the highest high water level of EL. +0.450 m. In the stretch between North Ring Road Bridge and Railway Bridge, the D.H.W.L is set below the crest level of existing floodwall. On the other hand, in the upstream stretch from Railway Bridge to Simongan Weir, it is set lower than the existing riverbank surface elevation having the required freeboard of 1.0 m.

Design Riverbed

The design riverbed profile principally follows the existing average riverbed profile to avoid unbalanced scouring and sedimentation as well as to minimize relocation and modification of the existing river structures. Based on this design concept, a flat riverbed profile with the elevation of EL.-2.500 is adopted for the downstream stretch from WF30 to the river mouth. For the upstream stretch from WF30 to Simongan Weir, the channel is designed with the riverbed slope of 1/2,650.

(3) Cross Section (refer to Fig. 3.5)

The double trapezoidal cross section (compound cross section) with a side slope of 1:2 (vertical to horizontal) is employed in the whole river stretch except the narrow channel portion. The elevation of floodplain is set to be 3.0 to 3.5 m higher than the design riverbed, so that the frequent inundation on the floodplain can be avoided.

(4) Bridge and Clearance

The clearance of bridge girder against the D.H.W.L was examined for the existing five bridges. It was found that the Railway Bridge has a clearance of 0.34 m, which dose not meet the required clearance of 1.0 m. The superstructure of the bridge raising, therefore, was decided.

Garang River Channel

Aiming at lowering high flood stage, the riverbed excavation and reconstruction of Simongan Weir are employed as the major improvement works.

(1) Alignment of River Channel and Dike (refer to Fig. 3.6)

The riverbed of the low water channel is, in principle, planned to be excavated without any big modification of channel alignment. For the channel alignment in the meandering sections, the excavation is made mostly in the convex sides to make smooth curves.

(2) Longitudinal Profile (refer to Fig. 3.7)

Design High Water Level

In the downstream stretch between Simongan Weir and WF124, the design high water level is set to be lower position than the hinterland ground elevation by lowering the riverbed by about 1.5 m.

In the upstream reaches between WF124 and WF184, the D.H.W.L is placed at the position more than 1.0 m below the existing crest of dikes/floodwalls, so that the existing dikes/floodwalls can be effective with a required freeboard.

Design Riverbed

The riverbed elevation at Simongan Weir is set at EL.1.500 m, which is 2.684 m higher than the downstream riverbed. Both riverbeds are connected with a adequate transition section in the form of steps.

(3) Cross Section (refer to Fig. 3.8)

Considering the existing cross sectional shape of channel, the double trapezoidal cross section (compound cross section) with a side slope of 1:2 (vertical to horizontal) is employed for the whole river stretches.

For the narrow channel in the upstream of Simongan Weir, the channel widening is limited to 35 m at the riverbed position due to the existing narrow channel topography and social constraints. Further, the side slope of 1: 0.5 is used for some portions to avoid encroachment of public road.

3.3.2 Reconstruction of Simongan Weir

<u>Conditions on Weir Design</u>

(1) Requirements of Weir Design

The weir is designed to satisfy the following hydraulic requirements.

- To have the sufficient flood flowing area to let the design discharge of 790 m^3/s pass safely to West Floodway,
- To maintain the proper channel water level (EL. 5.200 m) for PDAM's water intake and to divert maintenance flow to Semarang River (0.50 m^3/s) and the left bank irrigation channel (0.15 m^3/s), and
- To discharge sediment on the upstream riverbed through the gates.

(2) Location

The new weir is constructed at the same location as the existing fixed weir for the reasons such as easy operation and maintenance of facilities, high flood control ability and economy of construction (refer to Figs 3.3 and 3.6).

(3) Type of Gate

The weir is designed to have both flood discharge gate in the center portion of river course and sediment flush gate at right and left sides of flood discharge gate. As a type of gate, a shell type steel roller gate and a steel girder type roller gate are employed for the flood discharge gate and sediment flush gate, respectively.

<u>Structural Features</u>

(1) Layout Plan of Weir

Reconstruction of Simongan Weir is made with the major structural components of the main weir body with foundation piles, three (3) flood discharge gates, two (2) sediment flush gates, intake structures and gates on both right and left river banks, protection works for riverbank and riverbed, gate control/management buildings and maintenance bridge. The general plan and structural features of the weir are shown in Figs. 3.9 to 3.11.

(2) Intake Structure

The existing intake structures are reconstructed in parallel with construction of the main weir. The structures are placed at the same locations.

(3) Maintenance Bridge

Maintenance and approach bridges are provided spanning the river channel at the weir. The bridge is used for the maintenance/repairing works, periodical inspection, installation of temporary gate and so on. The bridge width is determined to be 7.0 m taking width of construction equipment for maintenance works into consideration.

Preservation of Part of Existing Simongan Weir

The existing Simongan Weir was constructed in 1870's and the weir has become a historically valuable structure in Semarang City. However, the existing fixed type weir was proposed to be reconstructed to a gated weir to assure the flood flowing capacity under the design flood.

In view of the preservation of historic structure, it was proposed that a part of the weir should be preserved on the occasion of weir reconstruction. At the commencement of the detailed design, this issue was discussed with the Public Works Office (DINAS PU) of Central Java Provincial Government, and the preservation plan of the weir structure was confirmed. It consists of cutting off a part of the weir, transporting and reconstruction of the original structure at a public space near the Goa Kreo Park.

3.3.3 River Structures

In association with the river channel improvement works, such river structures as revetment, groin, riverbed protection, ground sill, drainage sluice/outlet and maintenance facilities are designed.

3.3.4 Raising of Railway Bridge

The existing railway bridge across West Floodway is a steel truss structure with three spans.

The abutments and piers of the bridge are made of wet stone masonry, and were constructed during the period of the Dutch colony. The bridge is operated and managed by the National Railway Corporation (PERUMKA).

Since the clearance between the bridge girder and the design high water level is only 0.34 m compared to the required clearance of 1.0 m, the steel truss structure will be raised by about 0.70 m as a compensation works of the river improvement works. In addition, the existing bridge abutments and piers are also reconstructed because they are affected, in terms of structural stability, by river excavation works.

Regarding the raising method, the existing bridge is raised at the same position in consideration of the aspects such as construction cost and social conditions along the railway truck. The raising works undertaken by the project are shown in Fig. 3.12.

3.4 Construction Plan

3.4.1 Packaging

The works of West Floodway/Garang River Improvement are divided into three (3) packages, namely, West Floodway and Garang River Improvement Works (Package-1), Reconstruction of Simongan Weir (Package-2) and Raising of Railway Bridge over West Floodway (Package-3). (refer to Fig. 3.13)

3.4.2 West Floodway and Garang River Improvement Works (Package-1)

The construction works of major work items are to be carried out in accordance with the following construction method.

(1) Preparatory Works

Preparatory works including equipment transportation facilities, electric power facilities, temporary material storage yards and temporary field building are prepared near the construction site before starting permanent works.

(2) Dredging

Dredging is done in the stretch between the river mouth and 1.9 km upstream by the combination of clamshell bucket with the capacity of 1.0 m^3 and pontoon of 200 t. Dredging material will be hauled to a spoil bank by a combination of a barge with the capacity of 100 m^3 and a tag boat of 15 t.

(3) Excavation

Excavation both below and above water level is to be done by back hoe with the capacity of 0.35 m^3 , and the excavated material will be hauled to a spoil bank by dump truck with the capacity of 10 t except materials which can be used for dike embankment. The above materials are hauled directly to the embankment site.

(4) Spoil Bank

As a possible spoil bank, a land reclamation area shown in Fig. 3.14 which is planned to be developed by a private developer at the coastal area near the river mouth of West Floodway and needs much more reclamation volume than excavation volume is proposed.

3.4.3 Reconstruction of Simongan Weir (Package-2)

(1) Staged Construction

The construction works of Simongan Weir are carried out by dividing the construction works into two stages in order to maintain the river flow during the construction period. The works are conducted during dry seasons from April to November to avoid the possibility of flooding in rainy seasons. The first stage construction works are done at the left bank side and the second stage is carried out for the remaining part on the right bank side.

(2) Demolition and Excavation

The existing weir structure will be demolished by giant breaker, then excavation of the foundation is done by back hoe. Demolished debris and excavated materials are hauled to the spoil bank which is same as for the river improvement.

(3) Pile Driving

Steel and PC sheet piles and PC piles are driven by vibratory pile driver and diesel hammer, respectively.

(4) Concrete Placing

Concrete will be mixed at a bathing plant in Semarang City or installed by a contractor. Mixed concrete is transported by track mixer from the bathing plant to the site and placed by concrete pump.

(5) Installation of Gate and Hoist

The flood discharge gates and sediment flushing gates are assembled in a factory in some pieces, then transported to the site. The transported gates in pieces are further assembled in one unit of gate at the gate position on a temporary stage using crawler crane. The installation of hoist is followed by the same crane.

3.4.4 Raising of Railway Bridge over West Floodway (Package-3)

The railway bridge is located at the point of 3.6 km upstream from the river mouth and is to be raised about 70 cm to have a clearance of 1.0 m above the design high water level, because the present clearance of about 34 cm is too small. Location of the new bridge shall be the same as the existing bridge but the piers are shifted to the Cirebon side by 5.0 m in order to decrease the traffic jam at the Semarang side at the time of the construction stage.

The raising of the existing railway bridge works consist of three main works, the raising and shifting of superstructures, reconstruction of the substructures and the raising of approach railway tracks.

3.4.5 Construction Time Schedule

The major works of both West Floodway/Garang River Improvement, Reconstruction of Simongan Weir and Raising of the Existing Railway Bridge are executed with the construction period of 34 months in accordance with the construction schedule as presented in Tables 3.1 to 3.3.

3.5 Operation and Maintenance

3.5.1 Operation Plan

The purposes of operation and maintenance (O&M) programs are as below;

- Ensure that the facilities are operated according to the design standards.
- Ensure safe operation of the facilities.
- Ensure the useful life of the facilities.
- Ensure that the established procedures are followed.
- Protect the environment and facilities provided in the flood control works.

- Promote cost efficient operation.
- Meet the legal and social obligation.

Simongan Weir

The gates of Simongan Weir are operated to maintain water level at the upstream of the weir at the normal time, to pass flood discharge safely to the downstream of the weir at flooding times and to flush sediment deposit on the upstream riverbed.

Drainage Facilities

The proposed drainage facilities equipped with gates are designed to be operation-free structures except a few drainage sluices. The sluice gates are operated manually and gate operation is established as described below.

(i) The gate shall be fully opened in usual time.

(ii) When the river water level rises and exceeds a certain level which is equivalent to the elevation of 1.0 m below ground level, the gate shall be promptly closed by hoisting down the spindle.

(iii) After closing the gate, when the water level in the river goes down lower than the elevation established above, the gate shall be opened again by hoisting up the spindle.

3.5.2 Maintenance Plan

(1) River Channel, Dike and River Structures

The following activities are proposed to maintain the river channel, dike and structures in good conditions.

(i) Periodical channel survey;

(ii) Dredging and/or excavation of river channel and river mouth when excess sediment is found on the riverbed;

(iii) Inspection of dike, floodwall and river banks;

(iv) Inspection and repairing of such river structures as revetment, groin, ground sill, drainage sluice/outlet and so on;

(v) Routine and emergency patrol along the river course; and

(vi) Removal of solid waste from the river course and cutting bush or shrub periodically to keep flow capacity of the river.

In addition to the above O&M activities, legal control of sand mining is indispensable in view of maintaining the riverbed stability and river structures.

(2) Simongan Weir

To maintain and to keep smooth operation of the weir, the following activities are proposed.

(i) Periodical inspection of gates, hoisting system and such weir facilities as weir body, apron, concrete block, gabion, maintenance bridge, control house and so on;

(ii) Periodical inspection of the intake structures on both river banks;

(iii) Painting gate leaf of weir and intake structure; and

(iv) Replacement of parts of gates or hoist or electrical equipment if necessary.

CHAPTER 4 COMPONENT B: JATIBARANG MULTIPURPOSE DAM CONSTRUCTION

4.1 Present Condition of Study Area

4.1.1 Features of Project Area

Features of Kreo River

Kreo River, on which Jatibarang Multipurpose Dam is planned, is the largest left tributary of Garang River. It originates from Mt. Ungarang and flows down in northeast direction forming deep valley at the hill region. The upper and lower reaches of Kreo River are sparsely populated and are used as farm lands, paddy fields, small-scale plantations or forest area.

Features of Damsite and Reservoir Area

The reservoir area located in the upstream of the damsite shows a wide basin shape surrounded by relatively large hills (refer to Fig. 4.1). It is presently used for paddy, upland, small plantation, woods and so on, and no people are living there. Goa Kreo Park with a symbolic cave as Moslem's holy place is situated on a residual hill projecting from the right bank. It will become isolated, but not affected when the reservoir is filled up with water. A pedestrian bridge will be constructed to approach Goa Kreo Park.

A power transmission line is crossing the reservoir area. At least four (4) towers have to be relocated as one of compensation works. State Electricity Company (PT Perusahaan Listric Negara) will take charge of elaborating relocation plan and design.

Topography at Damsite

The damsite on Kreo River has an advantage topographically with a wide valley in the upstream stretch, which changes into a deep V-shaped gorge at the proposed dam axis. The riverbed width is about 15 m at EL. 90 m at the dam axis. The side slope gradient is about 75 degrees from the riverbed to 20 m height on the left bank. And the side slope gradient is about 60 degrees from the riverbed to 40 m height on the right bank. The slope gradient of the above portion changes to 40 degrees for the left bank, and 30 degrees for the right bank. The gorge width is 175 m at the proposed dam crest elevation of EL. 157.0 m. The topographic characteristics of the left bank at the dam axis shows a thin and long right shape projecting into the river course. The right bank hill forms also a ridge shape projecting into the river course, but it is larger than the left thin ridge.

4.1.2 Floods and Flood Control Works

Floods and flood control works is mentioned in "CHAPTER 3 COMPONENT A: WEST FLOODWAY/GARANG RIVER IMPROVEMENT".

4.1.3 Water Utilization

<u>Existing Water Sources and Future Water Demand</u>

Water Supply Public Corporation (PDAM) is supplying public water in Semarang City, except a part of industrial and commercial water being pumped up from deep wells. The existing supply capacity of PDAM amounts to 1.853 m^3/s, of which approximately half volume of 0.901 m^3/s depends on the intake from Garang River. As of 1995, the Service ratio is still low at 33.4 %, water usage per capita is 170 l/day, and total water supplied amounts to 1.305 m^3/s.

The latest plan concerning future water demand up to target year 2015 have been arranged in "SFCP Final Project Preparation" Report in 1996, following confirmation from concerned officials (PDAM, BAPPEDA, Jratunseluna Project Office). According to the report, the future water demand in target year 2015 is 12.218 m^3/s. This value is almost similar to 12.12 m^3/s, which was estimated by another JICA Study Team in the Feasibility Study in 1993.

Unit: (m^3/s)

Year	Water Demand modified in 1996				F/S by JICA in 1993
	Eastern	Western	Upper	Total	Total Demand
1995	1.060	1.946	0.304	3.310	5.37
2000	1.924	2.823	0.493	5.240	6.54
2005	3.419	4.419	0.725	8.563	8.58
2010	4.524	5.385	0.893	10.802	9.85
2015	4.953	6.231	1.034	12.218	12.12

<u>Water Supply Program and Ongoing Project</u>

The conveyance channel (net capacity of 2.50 m^3/s) from Kedung Ombo Reservoir through Klambu Barrage is under construction. Kudu Water Treatment Plant, which is proposed at the end of the conveyance channel, is also supposed to be constructed in accordance with the completion of the channel, and the water treatment capacity will be expanded up to 2.25 m^3/s at the final stage.

Dolok Dam Project is still at the stage of review of the feasibility study. The study on economic effect is ongoing, the financial sources are under consideration by the related agencies. As to the Tuntang Jragung Regulation Tunnel Project, the detail design of tunnel was finished, but its implementation is deadlocked because of the opposition by farmers who worry about decrease of river water in the downstream due to the water diversion. Besides, water conveyance from springs in Kendal was planned before, but the project was canceled because the production capacity of this new source is not as much as expected in dry season.

Under these circumstances, the Jatibarang Multipurpose Dam Project is much expected to be put into operation.

4.2 Formulation of Definitive Plan

4.2.1 Required Function of Jatibarang Multipurpose Dam

Jatibarang Multipurpose Dam aims at providing multiple functions of flood control, water supply and hydropower generation. Each function is explained hereinafter.

Flood Control Function

West Floodway/Garang River Improvement is designed on the scale of a 100-year return period with a flood control dam. Jatibarang Multipurpose Dam should have a function to reduce a 100-year probable flood with the peak discharge of 1,010 m^3/s to 790 m^3/s in the downstream from the confluence with Kreo River.

The peak discharge of a 100-year probable flood is 290 m^3/s at the damsite. The design flood discharge at Simongan Weir of 790 m^3/s, which corresponds to a 25-year probable flood discharge, was applied to the river improvement of the river stretches from the river mouth up to the confluence with Kreo River.

Water Supply Function

The discharge secured by Jatibarang Multipurpose Dam consists of the intake water for municipal water supply of 2.04 m^3/s, which includes the present intake amount at PDAM, and the maintenance flow of 0.65 m^3/s.

The municipal water supply of 2.04 m^3/s includes 0.58 m^3/s for present use and 1.46 m^3/s for newly developed. The maintenance flow of 0.65 m^3/s includes 0.5 m^3/s for Semarang River and 0.15 m^3/s for Left Channel of Simongan Weir.

In the future, the deficit in the water supply from Jatibarang Reservoir would be supplemented by the proposed Mundingan Dam and Inter-basin water transfer projects, which were proposed for Kreo River in the Master Plan established by another JICA Study Team in 1993. After the completion of the above two (2) facilities, the maximum outflow will increase to 6.0 m^3/s. The outlet facilities at Jatibarang Multipurpose Dam are designed to include the planed maximum out flow discharge of 6.0 m^3/s.

Hydropower Generation Function

The hydropower generation is carried out subordinately using the released water necessary for water supply to Semarang City.

4.2.2 Jatibarang Multipurpose Dam

Basic Conditions

(1) Design Discharge

Peak discharges of the design floods are summarized in the table below. The control point for calculation of probable rainfall is the damsite itself, which has the catchment area of 53 km^2.

Structure	Design Flood	Peak Discharge
Emergency Spillway	PMF	1,600 m^3/s
Service Spillway	100-year flood	290 m^3/s
Diversion Tunnel	25-year	280 m^3/s

(2) Seismic Coefficient

The design seismic coefficient for the stability analysis should be estimated referring to the treatise "Seismic Zone Map and Guidance for Design of Water Resources Structures against Earthquake", which was brought up by Directorate of Technical Guidance.

Seismic Coefficient	Type of Structure
K = 0.8 * 215.81 * 0.9 / 980 = **0.16**	Concrete Type Dam Large Concrete Structure
K = 0.8 * 215.81 * 1.0 / 980 = **0.18**	Fill Type Dam

Comparative Study on Dam Type

(1) Alternative Dam Types to be Studied

Dams are largely classified into two (2) types, namely, concrete dam and fill type dam based on the materials comprising the dam body. Furthermore, the dam types are break down in detail corresponding to the structural characteristics as follows:

Dam Type		Appropriateness for Condition	
		Dam Height = not lower than 75 m	Foundation = Soft Rock
Concrete Dam	Gravity Dam	OK	OK or No
	Arch Dam	OK	No
	Hollow Gravity Dam	OK	No
	Buttress Dam	No	No
Fill Type Dam	Zoned rockfill Dam	OK	OK
	Facing rockfill Dam	OK	OK
	Homogeneous Fill Dam	No	OK

Notes : OK : Applicable, No : Not Applicable
OK or No : Depending on Strength of Foundation

The two (2) obvious conditions of Jatibarang Dam are pointed out as follows:

- The dam height is assumed to be not lower than 75 m.
- The foundation rocks at the Jatibarang damsite consist of soft rocks with the design shear strength of 50 tf/m^2 belonging to Tertiary to Quaternary.

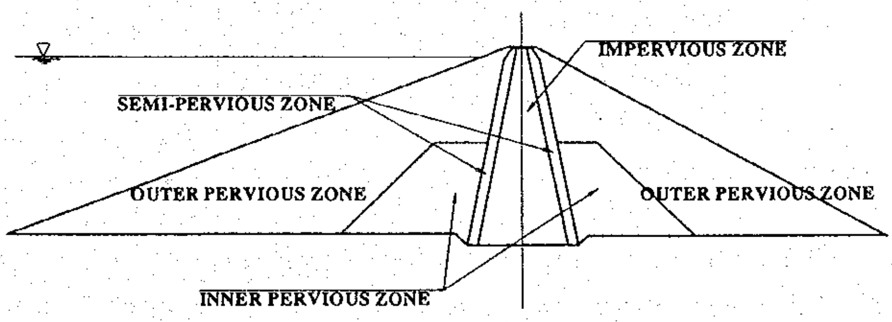
In due consideration of these two (2) conditions, concrete dam and homogeneous fill dam are judged as inappropriate dam types due to their own characteristics.

After exclusion of inappropriate dam types, the following two (2) dam types remain as alternative dam types to be studied.

- Center Core Rockfill Dam
- Concrete Facing Rockfill Dam

(2) Preliminary Design on Center Core Rockfill Dam

Generally this dam type can be divided into three or more zones as shown below, depending on the range of variation in the character and gradation of the available material.



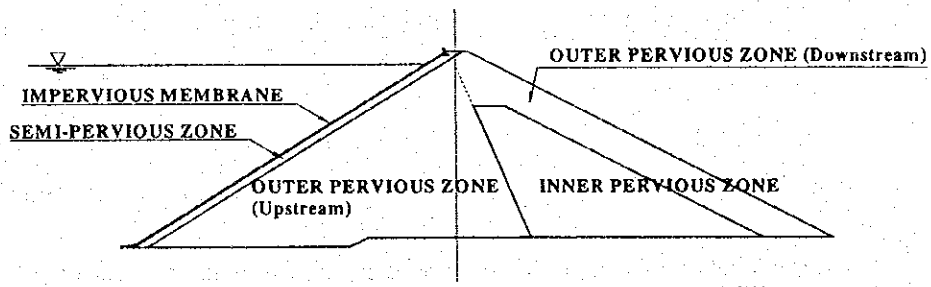
Typical Constitution of Zones in Center Core Rockfill Dam

Preliminary design of center core rockfill dam is executed considering the requirement to suit the conditions of the site and to utilize available construction materials near and around the damsite. The main features are given below:

Crest Level	EL. 157.0 m
Foundation Level	EL. 80.0 m
Dam Height	77.0 m
Crest Length	200.0 m
Upstream Slope	1 : 2.6
Downstream Slope	1 : 1.8
Embankment Volume	790,000 m^3

(3) Preliminary Design on Concrete Face Rockfill Dam

Facing rockfill dam consists of three or more zones as shown below, namely, pervious zone as a major structural element, impervious membrane placed on the upstream slope and semi-pervious zone.



Typical Constitution of Zones in Concrete Face Rockfill Dam

Preliminary design of concrete face rockfill dam is executed considering the requirement to suit the conditions of the site and to use available construction materials. The main features are given below:

Crest Level	EL. 156.5 m
Foundation Level	EL. 80.0 m
Top of Parapet Wall	EL. 157.5 m
Dam Height	76.5 m
Crest Length	200.0 m
Upstream Slope	1 : 1.5
Downstream Slope	1 : 1.8
Embankment Volume	600,000 m^3

(4) Selection of Dam Type

As shown in the foregoing discussion, two dam types are technically feasible at the selected damsite. Center core rockfill and concrete face rockfill dams can be successfully constructed. The selection of the dam type shall be done based on ease of construction, cost and technical considerations reflecting the foundation condition and ease of maintenance.

Item	Center Core Rockfill Dam	Concrete Face Rockfill Dam
Impervious Zone	◎ Relatively easy works	△ Difficult works and costly
Embankment Work	△ Susceptible to weather condition	◎ Less weather dependent
Construction Period	○ 43 months	○ 43 months
Post Construction Settlement under Impervious Zone	◎ Nearly all of the total foundation settlement occurs during construction.	△ It is so great that the face slab can not remain intact.
Repair Against Leakage	○ It is difficult to do anything except control leaks safely.	○ It is only available for inspection and repair of the face slab above EL. 115.0 m.
Construction Cost	◎ 35,740 x 10^6 Rp.	△ 36,320 x 10^6 Rp.
Conclusion	◎ The most suitable alternative	△ Not suitable alternative

Note : ◎ : Advantage, ○ : Even, △ : Disadvantage

From the above discussion, it is concluded that **the center core rockfill type is the most suitable alternative for Jatibarang Dam** due to the following reasons:

① Concrete face rockfill dam is just a little more expensive than center core rockfill dam. Concrete face rockfill dam has a saving of about 25 % less embankment volume than the center core rockfill dam, but the expensive impervious membrane offsets the savings in embankment

② Center core rockfill dam and concrete face rockfill dam are almost equivalent from constructional aspect considering their advantages and disadvantages. The construction periods of both types are also equal.

③ In case of the concrete face rockfill dam, there is a possibility of initial leakage. When the reservoir is filled with water for the first time, the excessive leakage will develop through the face slab because of cracks in concrete. As the foundation of Jatibarang Multipurpose Dam consists of soft rock, the post construction settlement of the foundation may be so great that the face slab can not remain intact. The leaks may require that the reservoir be emptied for repairs. The maintenance cost may increase.

④ Although relatively few concrete face rockfill dams have been built in Indonesia, Cirata Dam adopted concrete face rockfill type. The reasons are shown as below:

- Concrete face rockfill dam has the cost advantage in comparison with center core rockfill type due to a large-scale dam of 126 m in height.
- As the foundation consists of fresh and hard rock, the post construction settlement of the foundation is expected to be so small that cracks in concrete which cause the excessive leakage are not developed and the face slab can be used successfully.

Item	Center Core Rockfill Dam	Concrete Face Rockfill Dam
Impervious Zone	◎ Relatively easy works	△ Difficult works and costly
Embankment Work	△ Susceptible to weather condition	◎ Less weather dependent
Construction Period	○ 43 months	○ 43 months
Post Construction Settlement under Impervious Zone	◎ Nearly all of the total foundation settlement occurs during construction.	△ It is so great that the face slab can not remain intact.
Repair Against Leakage	○ It is difficult to do anything except control leaks safely.	○ It is only available for inspection and repair of the face slab above EL. 115.0 m.
Construction Cost	◎ 35,740 x 10^6 Rp.	△ 36,320 x 10^6 Rp.
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Preliminary Design on Appurtenant Structures

(1) Appurtenant Structures necessary for Dam

Spillway, outlet facilities for water use and diversion tunnel shall be designed as main appurtenant structures for Jatibarang Multipurpose Dam. The functions of these structures are described hereunder.

Spillway

Spillways are provided to release surplus or flood water, which can not be contained in the allotted storage capacity of the reservoir. Since Jatibarang Multipurpose Dam is planned to have a flood control function as one of its purposes, the following two (2) features are considered:

- Function to regulate a 100-year probable flood with peak discharge of 290 m^3/s flows through the reservoir, resulting in the river flow discharge of 790 m^3/s at Simongan, by adding the joining flow from Garang and Kripik rivers.
- Sufficient capacity to accommodate the design flood with peak discharge of 1,600 m^3/s (PMF) after regulating the inflow through the reservoir.

Diversion Tunnel

The objectives of the diversion tunnel are to divert the streamflow around or through the damsite during the construction period. They can minimize serious potential flood damage to the works in progress. The tunnel is designed to be capable of managing a 25-year probable flood that has been worked out as 280 m^3/s.

Outlet Facilities for Water Use

The outlet facilities are to assure the reservoir yield, which is required for municipal water supply to Semarang City and river maintenance flow to the area downstream of the dam. The maximum out flow discharge is 2.69 m^3/s which corresponds to the required flow at the Simongan weir site. In the future with proposed Mundingan Dam and Inter-basin water transfer project, there is possibility to increase the maximum outflow to 6.0 m^3/s. The outlet facilities are designed to consider the planed maximum out flow discharge of 6.0 m^3/s. The intake sill should be high enough to prevent sediment deposits from flowing in it, but low enough to fully intake the filling water in the reservoir.

(2) Layout of Appurtenant Structures

Since there is a very limited space for installation of the appurtenant structures due to the narrow valley, it is unreasonable that each structure selects the optimum location to be installed of its own. After studying the three (3) alternatives to select the optimum combination of the locations for the structures. The following layout was selected.

<u>Spillway</u>

Spillway is located on the left abutment adjacent to the dam body and can be connected with the downstream river channel smoothly. Side channel spillway with the bathtub type overflow weir is adopted, in which the overflow crests can be equipped on the both sides and the end of the side channel.

The service spillway, which corresponds to the flood control plan for 100-year flood, is an ungated overflow weir having ogee shaped crest. It has the length of 15.0 m. The crest level is set at the Normal Water Surface Elevation 148.9 m.

The emergency spillway is not for the flood control but for the dam safety against floods, which exceed the design flood discharge. The emergency spillway is located at the both sides on the side channel. The overflow weir of the emergency spillway has the length of 60.0 m. The crest level is set at the Surcharge Water Surface Elevation 151.8 m.

<u>Diversion Tunnel</u>

A diversion tunnel located along the left abutment is arranged to about 441 m long. The longitudinal gradient is set at 1/30 considering flow velocity and the elevation of the inlet and outlet elevation. The standard horseshoe (2r = 5.6 m) shaped tunnel is adopted.

<u>Outlet Facilities</u>

The Inclined intake for outlet works is located at the right abutment upstream of the toe of the dam body. A tunnel with about 405 m long and the internal diameter of 2.4 m is provided to install an outlet pipe. A hydropower station and a valve house can be located on the right side embankment of the spillway-stilling basin. The diameter of the outlet pipe is determined at D = (4*Q/3.14/V)0.5 = 1.4 m, using the condition of the discharge Q = 6.0 m^3/s and the velocity V = 4.0 m/s.

4.2.3 Hydropower Generation

Location and Layout of Hydropower Station

(1) Location

In consideration of the following advantages, the hydropower station is planned at the immediate downstream of the dam on the right bank of the energy dissipator.

- The access from the existing public road is easy, in respect to the transportation of construction materials and the operation and maintenance after the completion of the hydropower station.
- The short waterway prevents the occurrence of head losses in the waterway and results in an increase in project output.
- Easy access to the dam control building allows power/control cable to be short and inspection to be readily conducted.

(2) Layout

The water to be used for hydropower generation branches off from the outlet pipe for water supply, passes to turbine, and discharges by way of short tailrace into the downstream end of the energy dissipator for flood control. The facilities between intake and branch point of outlet pipe are used both for water supply and hydropower generation.

Hydropower Generation Plan

The results of the definitive plan study of hydropower generation are summarized below:

	Item	Definitive Plan
(1)	Hydropower Generation	
	Maximum plant discharge (m^3/s)	3.00
	Maximum gross head (m)	65.99
	Installed capacity (kW)	1,560
	Number of generator at future stage	no extension
	Annual energy (MWh)	6,020
(2)	Dam and Water Level	
	Dam height (m)	77.0
	Reservoir NWL (EL. m)	148.9
	Reservoir LWL (EL. m) for hydropower generation	138.0
	Tail water level (EL. m)	82.91
(3)	Economic Evaluation	
	NPV (Rp$\times 10^6$)	-1,845
	B/C	0.75
	EIRR (%)	7.0

4.3 Detailed Design

4.3.1 General

Jatibarang Multipurpose Dam planned on Kreo River is located in the southwest of Semarang City at about 13 km upstream from the confluence of Garang River. It will primarily function flood control, public water supply of Semarang City and hydropower generation.

Detailed discussion on selection of dam type has been given in 4.2 Formulation of Definitive Plan. Based on the technical appraisal as well as construction cost, the center core rockfill type was found the most suitable for Jatibarang Multipurpose Dam.

This chapter summarizes the detailed design results of Jatibarang Multipurpose Dam in accordance with the definitive plan and design criteria.

4.3.2 Main Features of Jatibarang Multipurpose Dam

The layout plan, profile along dam axis and typical cross section are shown in Figs. 4.2 to 4.4 and the features are summarized hereinafter.

(1) Dam and Reservoir

Catchment Area	:	53.0 km^2
Reservoir Surface Area	:	1.10 km^2
Maximum Water Surface	:	EL. 155.300 m
Surcharge Water Surface	:	EL. 151.800 m
Normal Water Surface	:	EL. 148.900 m
Low Water Surface	:	EL. 136.000 m
Gross Storage Capacity	:	20,400,000 m^3
Effective Storage Capacity	:	13,600,000 m^3
Flood Control Capacity	:	3,100,000 m^3
Water Use Capacity	:	10,500,000 m^3
Sediment Capacity	:	6,800,000 m^3
Dam Height above Foundation	:	77.0 m
Crest Elevation	:	EL. 157.000 m
Foundation Elevation	:	EL. 80.000 m
Crest Length	:	200.0 m
Crest Width	:	10.0 m
Upstream Slope	:	1 : 2.6
Downstream Slope	:	1 : 1.8

(2) Spillway (refer to Fig. 4.5)

Design Flood		
Probable Maximum Flood	:	1,600 m^3/s (inflow into the reservoir)
100-year Probability	:	290 m^3/s (inflow into the reservoir)
Design Discharge for Energy Dissipater	:	340 m^3/s (100-year probable flood)
Design Discharge for Sidewall Height	:	1,310 m^3/s (PMF outflow from reservoir)
Overflow Crest (Service Spillway)		
Crest Elevation	:	EL. 148.900 m
Crest Length	:	15.0 m
Overflow Crest (Emergency Spillway)		
Crest Elevation	:	EL. 151.800 m
Crest Length	:	30.0 m x 2
Total Length of Spillway	:	307 m
Stilling Basin	:	24.0 m wide x 60.0 m long
Spillway Bridge (PC Girder Type)	:	5.0 m wide x 23.94 m long

(3) Outlet Facilities (refer to Fig. 4.6)

Maximum Design Discharge	:	6.0 m^3/s
Minimum Design Discharge	:	0.26 m^3/s
Intake Structure	:	Inclined Type
Bulkhead Gate	:	Clear Span 2.0 m x Clear Height 1.4 m
Emergency Gate	:	Clear Span 2.0 m x Clear Height 1.4 m
Steel Outlet Pipe	:	393 m long x 1.4 m dia.
Control Gate	:	650 and 250 mm dia.

(4) Diversion Facilities (refer to Fig. 4.7)

Design Discharge	:	280 m^3/s (25-year probable flood)
Tunnel Section	:	Horseshoe with the diameter of 5.6 m
Longitudinal Gradient	:	1/30
Tunnel Length	:	441 m
Tunnel Inlet Elevation	:	EL. 98.500 m
Crest of Main Cofferdam	:	EL. 113.000 m

(5) Hydropower Generation (refer to Fig. 4.8)

Maximum Plant Discharge	:	3.0 m^3/s
Maximum Gross head	:	65.5 m
Installed Capacity	:	1,560 kW
Annual Energy Production	:	6,020 MWh

(6) Access Road

Left Bank Access Road	:	L = 858.0 m, 4.0 m width
Right Bank Access Road	:	L = 1,688.1 m, 4.0 m width
Access Road to Hydropower Station	:	L = 656.5 m, 4.0 m width
Access Road to Intake Structure	:	L = 207.1 m, 4.0 m width
Maintenance Road to Reservoir	:	L = 397.5 m, 4.0 m width

(7) Dam Management Complex

Dam Administration Building	:	594.010 m^2, 3 story
Staff House 1 (Guest House)	:	74.416 m^2, 1 story
Staff House 2	:	49.110 m^2 x 4 units, 1 story
Mushola	:	72.300 m^2, 1 story

(8) Hydropower Station Complex

Hydropower Station Building	:	389.640 m^2, 2 story
Garage	:	183.600 m^2, 1 story
Guard House	:	14.275 m^2, 1 story

(9) Approach Bridge to Goa Kreo

Approach Bridge	:	17.0 m span x 4, 2.0 m width

4.4 Construction Plan

4.4.1 Packaging

The works of Construction of Jatibarang Multipurpose Dam on Kreo River are divided into two (2) packages, namely, Jatibarang Multipurpose Dam including Appurtenant Structures (Package-1) and Operation and Maintenance Buildings and Goa Kreo Bridge (Package-2). (refer to Fig. 4.9)

4.4.2 Jatibarang Multipurpose Dam including Appurtenant Structures (Package-1)

Preparatory Works

Preparatory works such as mobilization of construction equipment, plants and materials, electric power and water supply facilities, lighting facilities, communication facilities, temporary material storage yards, blending areas, a concrete plant, a motor pool, a repair shop and temporary field buildings shall be prepared near the construction site prior to the commencement of the permanent works. An aggregate plant is constructed near the rock quarry where is located at Mt. Mergi, about 17 km southeast of the damsite.

Diversion Works

Diversion works consist of the diversion tunnel, inlet facilities and the temporary cofferdam. In consideration of topographical conditions and the construction schedule, the diversion tunnel portion will be commenced first and the inlet portion follows. A river diversion will be carried out by earth fill type cofferdam at the beginning of the second year dry season after completion of the Inlet facilities.

Spillway

The construction schedule of the spillway works should be adjusted to tight relationship works such as the main dam excavation, the concrete placing of the gallery, the main dam embankment, concrete placing of the powerhouse and the main dam embankment schedules.

In working sites, which have enough space for heavy equipment operation, excavation and loading works are carried out by bulldozer and backhoe. The concrete placing works are carried out by concrete pump, direct placing by agitator truck, bucket and chute placing are adopted in accordance with the placing conditions.

Main Dam

The main dam construction works consist of many kinds of works such as excavation, foundation treatment by grouting, gallery construction and embankment. These work schedules are complex and related with each other. The construction works of the dam are basically executed in the order of the followings in the form of series or in parallel.

> Dam and gallery excavation works → Concreting works for gallery
> → Grouting works → Dam embankment works

Excavation works of the main dam, on the critical path as well as gallery excavation, is commenced after the river diversion is completed at the early dry season of the second year.

Embankment materials of the outer pervious zone and the riprap are hauled directly from the rock quarry. Semi-pervious zone materials are hauled from the aggregate plant installed near the quarry site. Since impervious material is required to mix the excavated material from the damsite with fine sand and gravel, a part of the disposal area is used as a blending yard.

Material of the inner pervious zone is accepted by hauling directly from the damsite and rock produced at quarry which meets the specifications.

Spreading and grading for all embankment materials is carried out by bulldozer. Though kinds of equipment of compaction and number of passes are decided by field rolling trials at construction stage, vibrating roller and tamping roller will be selected.

Outlet Facilities

The outlet facilities works consist of the outlet tunnel and the intake. In consideration of locations of each structure, construction method and construction schedule of the outlet tunnel is commenced first and the intake follows.

Powerhouse

The construction schedule of the powerhouse needs the adjustment with the stilling basin concrete placing and the main dam embankment. Excavation for the powerhouse is implemented together with the stilling basin excavation. The left sidewall of the powerhouse becomes walls of the stilling basin, therefore the concrete placing schedule of the powerhouse is required to coordinate with the stilling basin. Heavy equipment like a turbine, a generator and a main transformer are hauled into each floor and installed by a travelling crane installed in the powerhouse superstructure at final procedure in outlet facility works.

Aggregate and Concrete Plants

The crushing and aggregate plants are provided at the quarry site. The location of the concrete plant yard is determined at the right bank in the reservoir area taking into consideration of conditions and the efficient distribution routes of concrete material. According to the quarry operation schedule, the daily rock production required is 2,600 m³/day. The capacity of plant is as follows:

Objectives	Equipment	Description	No.
Production of Aggregate	Aggregate Plant	950 m³/day (180 t/hr)	1
Production of Concrete	Concrete Plant	250 m³/day (40 m³/hr)	1

4.4.3 Operation and Maintenance Buildings and Goa Kreo Bridge (Package-2)

Approach Bridge to Goa Kreo Cave

Foundations of the abutment slabs and piers are excavated down to a sound rock layer by backhoe and if necessary giant breaker is used. Concrete works are executed one by one from the right bank to the left bank side in principal by concrete pump set on the right bank, and placing method by bucket or chute is selected also depending on the site conditions. A truck crane is applied to unloading construction materials and lifting forms and others.

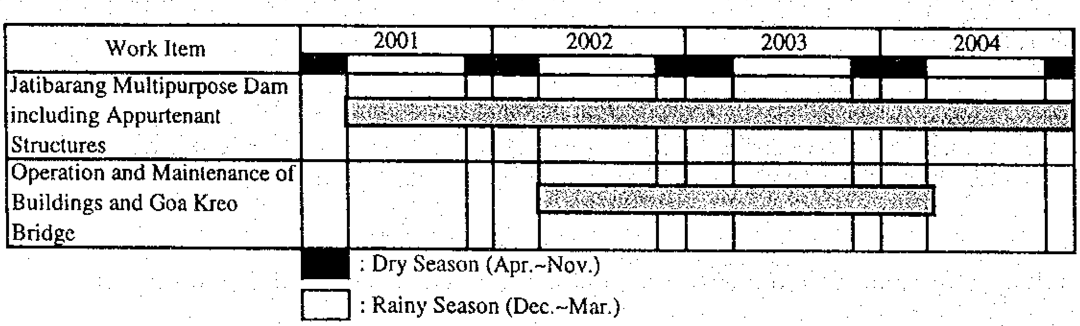
After the completion of the substructure works, a temporary supporting facilities for the first span of the superstructure are installed at the right bank side. The superstructure works are orderly implemented. A truck crane is applied to unloading construction materials and lifting forms and others. Concrete placing is carried out by a concrete pump. The bearing are inserted under the lifted girders by hydraulic jacks after enough curing time for the placed concrete.

Dam Management Complex

The land preparation is commenced in the middle of the first year and completed at the beginning of the dry season of the second year. Considering the whole construction schedule of the Package-1 and specially hydropower station schedule, the dam management complex works are commenced in the latter half of the third year following the approach bridge works to Goa Kreo. The land preparation is executed in Package-1, so equipment in this work is limited for building construction. External works consist of many kind of working items and work schedule is affected by the progress of the building works. Therefore, some kinds of equipment for external works should be kept at the site.

4.4.4 Construction Time schedule

The construction time schedule for two packages are established in consideration of the conditions mentioned preceding items. Tables 4.1 and 4.2 show construction time schedules of Package-1 and Package-2 respectively. The summary of construction schedule established is shown in the table below:



4.5 Operation and Maintenance

4.5.1 Features of Reservoir Operation

A reservoir operation depends on the deficit of discharge at Simongan Weir. To use the stored water effectively, the dam will not release more than this deficit. The secured discharge at the Simongan weir site is 2.69 m^3/s which includes 0.65 m^3/s for river maintenance, 0.58 m^3/s for present use (PDAM) and 1.46 m^3/s for newly developed. The maintenance discharge of 0.26 m^3/s at the damsite means the minimum outflow released from the dam. Therefore, Jatibarang Reservoir will be operated by releasing of discharge from minimum of 0.26 m^3/sec to the deficit discharge at Simongan Weir, and keeping a reservoir water surface between Low Water Surface EL. 136.0 m and Normal Water Surface EL. 148.9 m.

The service spillway, which corresponds to the flood control plan for 100-year probable flood, is an ungated overflow weir having ogee crest without any operation. The crest level is set at EL. 148.9 m. The surcharge water surface is set at EL. 151.8 m, which corresponds to the flood control capacity 3,100,000 m^3. The outflow at the surcharge water surface is estimated at 150 m^3/s.

4.5.2 Operation and Maintenance Works

Operation and maintenance after completion of the construction is indispensable to assure the beneficial function of the project during the expected lifetime. The main points to be considered in operation and maintenance are summarized hereunder.

(1) Operation

<u>Control gates installed at downstream end of outlet pipe</u>

Control gates of 650 mm and 250 mm diameter are operated to release the stored water in the reservoir to the downstream in accordance with the deficit discharge at Simongan Weir.

<u>Bulkhead gate installed at intake structure</u>

Bulkhead gate shall keep fully opened. When the steel outlet pipe is necessary to be drained for inspection, maintenance and repair without lowering the reservoir water surface, the bulkhead gate will be fully closed.

<u>Emergency Gate installed at intake structure</u>

The emergency gate equipped at EL. 115.0 m shall keep fully closed. It can be operated and be fully opened if the reservoir water has to be drawn down due to the emergency conditions.

Hydropower Generation Equipment

The hydropower generation is carried out subordinately using the released water necessary for water supply to Semarang City and river maintenance. The maximum power discharge is 3.0 m^3/s with the Low Water Surface EL. 138.0 m until Mundingan Dam is constructed in the future.

Recording reservoir data

Reservoir data including water surface elevation, outflow discharge through outlet facilities, spillway discharge, rainfall and other necessary data shall be recorded and processed appropriately.

Forecasting reservoir inflow

Forecasting reservoir inflow shall be done to estimate the periodical inflow volumes. These estimates provide the basic data for reservoir operation to permit optimization and coordination of water supply and hydropower generation.

Dam discharge warning

The warning to the public in the downstream area shall be issued, when any damage would occur to the downstream target area or the rapid increase of the river water level due to discharge of water from the dam.

(2) Assessment of Safety and Behavior of Structures

To make the assessment of safety and behavior of the structures during reservoir operation, following instruments are equipped for monitoring:

Pore Pressure	Impervious Zone	Piezometer
	Foundation	Standpipe Piezometer
Deformation	Embankment	Movement Marker Probe Extensometer
	Foundation	Foundation Deformation Meter
	Gallery Joint Opening	Joint Meter
Seepage		Seepage Measuring Device
Seismic Events		Strong Motion Accelerograph

The observation of the behavior of dams is important during first reservoir filling and for several years after filling for the safety control, and frequent data collection and analysis of the instruments will be required. The frequency after several years may be reduced when the behavior of the dam has become stable, considering the degree of importance of the measuring items and change of measured values.

(3) Inspection and Maintenance of Structures

The inspection and maintenance of the structures are generally concentrated on deformation, cracks and seepage water. Visual inspection is conducted approximately once every month periodically to monitor the conditions of civil structures, to detect any abnormalities and to check their performance. Emergency inspections are conducted after earthquakes, floods, heavy rain, etc., as deemed necessary. Emergency detailed inspection is conducted when deemed necessary after a patrol, visual inspection, internal inspection, or emergency inspection.

(4) Inspection of Electro-mechanical Facilities

Visual inspection is conducted periodically approximately once every one to three years. The turbine and generator are shutdown during this inspection to check for abnormalities and to check their performance. Internal inspection is conducted periodically approximately once every five to ten years. The turbine and generator are overhauled, thoroughly cleaned and repaired to restore their performance. It is recommended that the inspection cycle be so set as to consider the inspection results and the operation conditions. Emergency inspection is conducted when an abnormality or problem occurs in an electric component.

CHAPTER 5 COMPONENT C: URBAN DRAINAGE SYSTEM IMPROVEMENT

5.1 Present Condition of Study Area

5.1.1 Features of Drainage Channel and Drainage Area

Features of the Study Area

The study area for the D/D Study of the urban drainage system improvement is central Semarang area between Kuala Mas Raya Street and Ronggowarsito Street covering 12.835 km^2. The area is divided into 6.220 km^2 of gravity drainage area and 6.615 km^2 of pump drainage area. (refer to Fig. 5.1)

Fig. 5.2 shows a schematic topography of the area. It is divided into two areas, one of which is "the low land" (lower than EL+1.00 m), which almost correspond to the pump drainage area, and the other is "the high land" of comparatively high elevation (higher than EL+1.00 m), which almost correspond to the gravity drainage area.

As main drainage channels, Semarang, Asin and Baru rivers exist in the study area. According to the catchment areas of the main drainage channels, the area is further divided into Semarang River gravity drainage area, Asin drainage area, Bandarharjo West drainage area and Bandarharjo East drainage area.

Semarang River

Semarang River with its catchment area of 12.835 km^2 including the Asin river basin of 4.430 km^2 is one of the major urban drainage facilities in the Central Semarang situated between East and West Floodway. Semarang River with a total length of approx. 8.25 km is diverted from Garang River at Simongan Weir. It flows to the northeast through an urbanized area and meets Simpang Lima drainage channel near China Town, then flows to the northwest, diverting, Baru River at 2.8 km and meeting with its tributary, Asin River at 1.0 km upstream from the river mouth, respectively.

According to the longitudinal profile of the river bed surveyed in this study, the main channel of total length of 8.25 km is divided into two parts, "the lower reaches" with mild bed slope (1/10,000) and "the upper reaches" with rather steep bed slope (1/800). The boundary between "the lower reaches" and "the upper reaches" is four (4) km upstream from the river mouth, where Agus Salim Street crosses the channel. The topographical map of the area shows that EL. +1.0 m of ground elevation contour line, which is defined as the boundary of gravity and pump drainage areas considering head in secondary and tertiary channels and the high tide level, crosses Semarang River at this boundary. The capacity of the channel is not enough to accommodate the 5-year design discharge, especially in "the lower reaches". The upper reaches of Semarang River belong to the gravity drainage area and drain storm water by gravity.

Asin Drainage Area and Asin River

Asin drainage area covers the Asin river basin of 4.430 km². Almost 80 % of the area is fully urbanized as a residential area. The most serious inundation areas are situated along the left bank of Semarang River and the upper reaches of Asin River, where some low-lying areas have been regularly inundated during high tide even in the dry season. Asin Drainage Area belongs to the pump drainage area and storm rain will be drained through the Asin Pumping Station. The total length of Asin River is about 1.4 km and the longitudinal profile of the river bed is almost flat.

Bandarharjo West Drainage Area

The area of Bandarharjo West drainage area, which belongs to the Baru river basin, is 0.580 km². The southern part of approximately 65 % of the area (0.38 km²) has been fully urbanized including a low income residential area (0.24 km²) and Marabunta warehouse (0.09 km²) along the left bank of Baru River. The rest of 0.20 km² is unused area. Inundation problems in the residential area are very serious. During high tide, some low-lying residential areas are inundated every day by 0.1 to 0.2 m in depth without any rainstorm, due to the backwater of Semarang River. This drainage area also belongs to the pump drainage area and storm rain will be drained to the downstream of Baru River through the Baru Pumping Station.

Bandarharjo East Drainage Area and Baru River

The area (1.605 km²) is divided into two sub-drainage areas, the northern part of approx. 1.00 km² and the southern part of approx. 0.60 km² by Jl. Bangunharjo and Jl. Merak. As an average ground elevation of this area is very low due to the rapid progression of land subsidence, inundation damage is very serious. In recent years, inundation with a depth of 20 - 30 cm along Ronggowarsito Streets is always occuring even during dry season. Storm rain in this drainage area is also drained to the downstream stretch of Baru River through the Baru Pumping Station.

The total length of Baru River is about 1.5 km and the upper stretch of 0.9 km is to be improved. The longitudinal profile of the improvement section is almost flat.

Land Subsidence

The coastal and central areas of Semarang City are suffering from presently progressing land subsidence. It is presumed that the land subsidence is caused by groundwater extraction. The drainage condition of these drainage channels will be deteriorated further by the effect of land subsidence.

5.1.2 Other Related Projects

Semarang Surakarta Urban Development Project (SSUDP)

SSUDP is under execution financed by the World Bank (IBRD = the International Bank for Rehabilitation and Development). The drainage component of SSUDP is targeting mainly secondary and tertiary drainage channel improvement in Semarang City. Regarding the demarcation of the JICA Project and the SSUDP Project, it was concluded that the JICA Project covers the improvement of main drainage facilities and the SSUDP Project covers the improvement of secondary and tertiary drainage channels.

Presently, a new pump drainage system is being planned covering a part of the East Bandarharjo Area by SSUDP. Although the new pump drainage is inside the study area, the facilities are temporary ones as agreed between the Study Team and the JRATUNSELUNA Project Office, which is the executing office of SSUDP, it will not affect the design of the facilities of the study.

Sector Program Loan Projects by JRATUNSELUNA

In 1998, JRATUNSELUNA office initiated several Sector Program Loan (SPL) projects financed by Japanese Government in the area in order to improve the drainage situation of the area urgently. It comprises construction of five small pumping stations, dike raising and dredging. Although these projects are within the study area, as the facilities are temporary ones and they will be removed to other places after the competition of JICA Project, they will not affect the design of the study.

5.2 Formulation of Definitive Plan

5.2.1 Planning Criteria

Target Year

It is necessary to fix a target year for the plan in which social framework for the plan such as land use, population and development stage are defined. In the case of the urban drainage system improvement, the target year of the priority projects is the same as that of the Master Plan (as the target year of 2015) as the area is already fully developed.

Objective Works to be Designed

The objective works to be designed consist of channel improvement and construction of drainage pump stations. The channels of Semarang, Asin and Baru rivers are improved to be able to discharge design flood. Two pumping stations were planned to drain storm rain from the pump drainage areas where gravity drain is not expected.

Scale of Design Flood

The guideline for the level of services for urban drainage proposed in Integrated Urban Infrastructure Development Program (IUIDP) is 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

For the improvement of Semarang River with a catchment area of 12.835 km^2, the design scale shall be 10-year return period from the above table. However, considering the extent of improvement of Semarang River already completed by World Bank finance (Urban V), whose design scale was 5-year, 5-year return period is applied for Semarang River.

Design Rainfall

(1) For Channel Improvement Plan

The rainfall intensity-duration with 2-year and 5-year return periods are employed in accordance with the area of each sub-basin for the hydraulic design of channel improvement.

(2) For Pump Drainage Plan

Consecutive 12 hours rainfall with 5-year return period is applied as the design rainfall for the pump drainage plan.

Design Tidal Level

The design tidal levels are as follows:

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

Freeboard

Following freeboards of the drainage channels are applied for designing channel improvement in accordance with the design discharges of the target channels:

Channel Description	Freeboard (m)
Semarang River	
- from river mouth to railway crossing (3.2 km)	0.60
- upstream stretch from railway crossing (7.2 km)	0.40
Baru River	0.60
Asin River	0.40
Other Secondary Drainage Channel	0.30

Pump Drainage Criteria

In pump drainage plan, the following criteria are applied:

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

(b) 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).

(c) 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.

5.2.2 Channel Improvement Plan

Presently, Baru River is a diversion channel of Semarang River. However, it was proposed to close the Baru River diversion in accordance with the requirement of the Semarang Port Authority and the agreement by Semarang Municipality Office.

According to land reclamation plans, the seashore will be 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.

The design discharges of the target drainage channels to be improved are shown in Fig. 5.3.

5.2.3 Pump Drainage Plan

Two pumping stations, Asin and Baru pumping stations, are planned to drain storm water from the pump drainage areas.

Screw Type Pump was selected for the pumping stations after comparing four (4) types of pump. The main reasons for selection of the pump type are low cost and simplicity of operation and maintenance.

The design pump discharge capacities are decided as follows taking capacity of available retarding ponds into consideration.

- Asin Pumping Station : 8.86 m^3/s
- Baru Pumping Station : 4.37 m^3/s

5.2.4 Definitive Plan

Definitive plan of the urban drainage system improvement are described as follows:

(1) Semarang River Improvement

The new alignment of the channel is followed to the existing one except the portion near the confluence with Asin River. The existing channel course of about 1.7 km is shifted to the right banks to create land for Asin Pumping Station and a retarding pond. The plan of the channel course shifted is shown in Fig. 5.4.

The channel bed is planned to be excavated so that the design discharge can be accommodated. The channel cross sections are followed to have same structure or same slope and freeboards mentioned in 5.2 are employed. Where land acquisition is possible without bringing social problems, inspection roads with 7.0 m wide are provided on both banks.

The longitudinal profile and typical cross sections are shown in Figs. 5.5 and 5.6.

(2) Asin River Improvement

The existing alignment is applied for the design alignment so that any social problems may not be brought about. The existing public roads on both banks are used for the inspection roads. The channel bed is excavated to have a capacity of the design discharge.

The longitudinal profile and a typical cross section are shown in Figs. 5.7 and 5.8.

(3) Baru River Improvement

Since the diversion point of Baru River from Semarang River is to be closed permanently, the existing channel course is planned to have a function of a retarding pond. The lowest part of the objective stretches of Baru River is used for the land of Baru Pumping Station by reclamation of the channel course.

The longitudinal profile and a typical cross section are presented in Figs. 5.9 and 5.10.

5.3 Detailed Design

The results of the detailed design of the component are summarized hereinafter in accordance with contract packages as mentioned in the succeeding sub-clause.

5.3.1 Semarang River Drainage System Improvement (Package 1)

The target area for Semarang River Drainage System Improvement is 6.220 km² of gravity drainage area (refer to Fig. 5.1). The following drainage facilities are designed to discharge the design rainwater from the gravity drainage area safely to the Java Sea. (refer to Fig. 5.11)

(a) Semarang River Improvement

The total channel length for improvement is 7,241 m of which 5,866 m is improved in "Semarang River Drainage System Improvement Work" and the rest of 1,375 m is improved in "Asin River Drainage System Improvement Work".

- Dredging/Excavation of Channel : V=59,000 m^3
- Raising of Existing Dike : L=7,206 m
- Secondary Channel Outlet Closures : 56 places

(b) Renovation of Existing Public Road for Inspection Road : L=11,737 m

5.3.2 Asin River Drainage System Improvement (Package 2)

The target area of Asin Drainage System Improvement is 4.430 km^2 which covers the catchment area of Asin River (refer to Fig. 5.1). The following facilities have been designed in Asin Drainage System Improvement. (refer to Fig. 5.12)

(a) Semarang River Improvement (total river length L=1,375 m)

Work items and work volume for Semarang River Drainage System Improvement are as follows:

Excavation of Channel	V=36,000 m^3
Construction of Revetment	L=719 m
Dike Raising	L=228 m
Construction and Renovation of Inspection Road	L=1,530 m

(b) Asin River Improvement (total river length L=1,165 m)

Work items and work volume for Asin River Improvement are as follows:

Excavation of Channel	V=53,000 m^3
Reconstruction of Revetment	L=2,330 m for both sides
Relocation of Semarang River	L=408 m
Bridges	Span Length =20 m, two bridges
Box Culvert	W=3.5 m, H=2 m, L=194 m
Miscellaneous Works	Reconstruction of water pipe and telephone line conduit
Renovation of Inspection Road	L=2,330 m

(c) Construction of Asin Pumping Station

Work items and work volume for Asin Pumping Station are as follows:

Pumping Station	reinforced concrete, 11.0 m x 35.0 m
Pump	D= 3.0 m x 3 units (3 m^3/s x 3 units)
Gate	W = 4.00 m, H = 3.46 m x 2 gates
Piers and Foundation of Gate	reinforced concrete, 11.6 m x 12.0 m
Maintenance Bridge	Span Length = 20 m
Asin Retarding Pond	A = 1.6 ha, V= 24,000 m^3
Management Office Building	4 Buildings

5.3.3 Bandarharjo Drainage System Improvement (Package 3)

The target area of Bandarharjo Drainage System Improvement is 2.185 km². The following facilities have been designed in Bandarharjo Drainage System Improvement. (refer to Fig. 5.13)

(a) Baru River Improvement (total river length: L=1,071 m)

Work items and work volume for Baru River Improvement are as follows:

Excavation of Channel	V= 25,000 m³
Reconstruction of Revetment	L= 1,806 m
Closing of existing diversion gate from Semarang River	1 L.S.
Renovation of Inspection Road	L=1,640 m

(b) Construction of Baru Pumping Station

Work items and work volume for Baru Pumping Station are as follows:

Pumping Station	reinforced concrete, 11.0 m× 35.0 m
Pump	D=2.6 m x 2 units (2.3 m³/s x 2 units)
Gate	W = 4 m, H = 3.25 m x 1 gate
Piers and Foundation of Gate	reinforced concrete, 6.0 m x 12.0 m
Baru Retarding Pond	A=0.9 ha, V = 9,000 m³
Baru Conveyance Channel	box culvert, W=2.0 m, H=2.0 m, L=692 m
Management Office Building	4 Buildings

(c) Renovation of Existing Inspection Road : L=3,000 m

(d) Other Structures

There are two secondary channels to be newly constructed. An additional dike for boundary is included in the construction package, although the design of it is excluded from this study.

5.3.4 Treatment Method of Dredged Material

Since river bed deposit of Semarang, Asin and Baru rivers contain significant amount of alkyl mercury and other heavy metals, when the deposit is excavated or dredged, it should be treated before disposal in a spoil bank to avoid contamination of groundwater at the spoil bank. In this study period, leaching tests of heavy metals in the deposit have been performed in order to decide the treatment method more precisely and alkyl mercury was detected to be leached out.

Based on the result of leaching tests, the treatment method is designed and will be clearly stated in the technical specifications of the construction work as follows:

(a) The material to be treated is all river bed deposit excavated or dredged from the existing channels of Semarang, Asin and Baru rivers,

(b) The dredged material shall be deposited in a certain designated area for treatment,

(c) The dredged material shall be mixed with cement at a rate of 7% based on the dry density of the dredged material.

If the unit weight of the wet material is assumed as 1.5 t/m³ and water content of the wet material is assumed to be 70%, 7 % of the weight of the dry material becomes 70 kg/m³ of the wet material.

5.4 Construction Planning

5.4.1 General

Packaging of the Component

The component of the Urban Drainage System Improvement consists of three (3) packages, the Semarang River Drainage System Improvement (package 1), the Asin River Drainage System Improvement (Package 2) and the Bandarharjo Drainage System Improvement (Package 3). (refer to Fig. 5.14)

Outline of the Project Works

The outline of the project works of the component is summarized in the table below.

Works	Unit	Package 1	Package 2	Package 3	Total
Channel Improvement	km	5.9	2.3	1.1	9.3
Dredging/Excavation	m³	59,000	53,000	25,000	137,000
Construction of Pumping Station	Station	0	1 Q=9.0 m³/s	1 Q=4.6 m³/s	2
Construction of Gate Structure	Unit	0	2 W=4.00m H=3.46m	1 W=4.00m H=3.25m	3
Construction of Retarding Pond	Unit	0	1 V=24,000 m³	1 V=9,000 m³	2
Reconstruction of Bridge	Bridge	0	3 Span Length = 20.0m	-	3
Management Office Compound	L.S.	0	1	1	2

Treatment of Dredged and Excavated Material from Drainage Channels

It has been revealed that the sediment in the main drainage channels contains much heavy metals which should be harmful for human health and some heavy metals was found to be leached out by the leaching test conducted by JICA Study Team. The sediment which is dredged or excavated and hauled thereafter to a spoil bank shall be treated not to contaminate the groundwater before damping to a spoil bank. The treatment method was decided in accordance with the result of the leaching test that the dredged material shall be mixed with at least seven (7) % of cement. This treatment is planned to be executed at a treatment area which will be located near a spoil bank.

Spoil Bank

The total volume of dredged/excavated material in the channel improvement works amounts to about 137,000 m^3. A spoil bank area to dump the dredged/excavated material in this component is proposed at a land reclamation area which is planned by a private developer at the coast of Semarang City. The location of the proposed spoil bank is shown in Fig. 5.15.

5.4.2 Semarang River Drainage System Improvement (Package 1)

(1) Objective Stretches

As shown in Fig. 5.11, the objective stretches of Package 1 extends from No. 45 to No. 241+13 with total length of 5.9 km.

(2) Main Construction Works

The main construction works of Package 1 consist of dredging of Semarang River, raising of the existing dike, closure of existing drainage outlets and rehabilitation of the existing inspection roads (refer to Fig. 5.11).

(3) Method of Dredging of Semarang River

Dredging works will be conducted by a combination of a long arm backhoe and dump trucks or an ordinal backhoe and dump trucks in accordance with the channel width of Semarang River. The dredged material will be hauled to a treatment yard by dump trucks. Dredging under bridges will be done by mini backhoe and manpower by closing the area with temporary coffering of sandbags.

(4) Dredging Works in Dry Season

Since the dredged material shall be treated so that the material dumped at a spoil bank do not contaminate groundwater, the material will be mixed with cement at the treatment yard. The material shall be dried by sunshine before mixing with cement to reduce moisture contents of the dredged material. Therefore, dredging works are planned to be conducted in dry season only from April to November.

5.4.3 Asin River Drainage System Improvement (Package 2)

(1) Objective Stretches

As shown in Fig. 5.12, the objective stretches of 2.24 km for Package 2 consist of whole stretches of Asin River from No. 3 to No. 57 with the length of about 1.2 km, a box culvert at the upstream end of Asin River with the length of 194 m and the lower reaches of Semarang River from the river mouth (No. 0) to No. 45 with the length of about 850 m which include the shift of Semarang River.

(2) Main Construction Works

The main construction works of Package 2 consist of the improvement of Asin River and the lower reaches of Semarang River, construction of Asin pumping station with the three units of screw pumps with the installed capacity of 9.0 m^3/s, together with Asin retarding pond with the storage capacity of 24,000 m^3, gate structure, a box culvert which is connected to the uppermost end of Asin River with the length of 194 m, reconstruction of two existing bridges, renovation of the existing inspection roads on both sides of Asin River, construction of inspection roads anew on both sides of the lower reaches of Semarang River and a management office compound (refer to Fig. 5.12).

(3) Method of Dredging and Excavation

Dredging of the lower reaches of Semarang River from the river mouth (No. 0) to No. 29 will be done by the combination of clamshell grabbing and a barge with tugboat. Dredged material will be hauled by barge and tug boat to the treatment yard near the spoil bank. Excavation of the relocation of Semarang River for the stretch between No. 29 and No. 45 will be executed by the combination of backhoe and dump trucks. Excavation of Asin River will be done by the combination of backhoe and dump trucks. The excavated material will be hauled to a spoil bank.

(4) Dredging and Excavation in Dry Season

Same as Package 1, the dredged and excavated material from Semarang and Asin rivers shall be mixed with cement after reduction of the moisture contents of the materials under the sunshine at the treatment area. Therefore, dredging and excavation works shall be executed in dry season.

(5) Construction Procedure of Asin Pumping Station and Gate Structure

The construction of Asin Pumping Station and Gate Structure are conducted in accordance with the following procedures :

(a) Excavation and pile driving,
(b) Concrete placing,
(c) Installation of pumps and gates together with their apparatus,
(d) Construction of operation buildings and other related buildings, and
(e) Test operation.

(6) Construction of Asin Retarding Pond

The construction works of Asin Retarding Pond consist of earth works and revetment works. A part of the retarding pond is to be constructed at the original river course of Semarang River and the rest of the part is constructed on the right bank of Semarang River.

The retarding pond will be constructed at the area of the original Semarang river course before shifting and the right bank of the course. The area at the original Semarang river course shall be reclaimed by filling earth material and the area on the right bank shall be excavated. The earth works will be done by the combination of bulldozer, backhoe and dump trucks.

(7) Reconstruction of Existing Bridges

There are two (2) bridges spanned across Asin River whose free boards above the High Water Level are not enough presently. These bridges are to be reconstructed so that they have free boards of 60 cm each as specified.

At the time of excavation of Asin River, Asin River is separated in three (3) sections by temporary coffer dams and the excavation and the reconstruction works will be executed in a same section after dewatering.

5.4.4 Bandarharjo Drainage System Improvement (Package 3)

(1) Objective Areas

As shown in Fig. 5.13, the objective area of Package 3 is Baru River with the stretches of about 1.1 km long from No.21 to No. 70+13 and Bandarharjo West area where the Baru Retarding Pond is to be constructed.

(2) Main Construction Works

The main construction works of Package 3 consist of the improvement of Baru River for the stretches mentioned above, construction of Baru Pumping Station with two (2) units of screw pumps and the installed capacity of 4.6 m^3/s and Gate Structure together with Baru Retarding Pond with the storage capacity of about 9,000 m^3, closure of a diversion gate, management office compound, a box culvert which connects Asin Retarding Pond and Baru River and secondary drainage channels (refer to Fig. 5.13).

(3) Method of Dredging and Excavation

The lower reaches of the objective stretches of Baru River will be dredged by the combination of a long armed backhoe and dump trucks from the both banks, while the upper reaches of the objective stretches will be excavated in the channel by the combination of a regular backhoe and dump trucks by separating the target stretches into three (3) sections with temporary coffer dams and dewatering the closed areas.

(4) Dredging and Excavation in Dry Season

Same as Package 1, the dredged and excavated material from Baru River shall be mixed with cement after reduction of the moisture contents of the material under the sunshine at the treatment area. Therefore, dredging and excavation works shall be executed in dry season.

(5) Construction Procedure of Baru Pumping Station and Gate Structure

The construction of Baru Pumping Station and Gate Structure are conducted in accordance with the following procedures :

(a) Excavation and pile driving,

(b) Concrete placing,

(c) Installation of pumps and gates together with their apparatus,

(d) Construction of operation buildings and other related buildings, and

(e) Test operation.

(6) Construction of Baru Retarding Pond

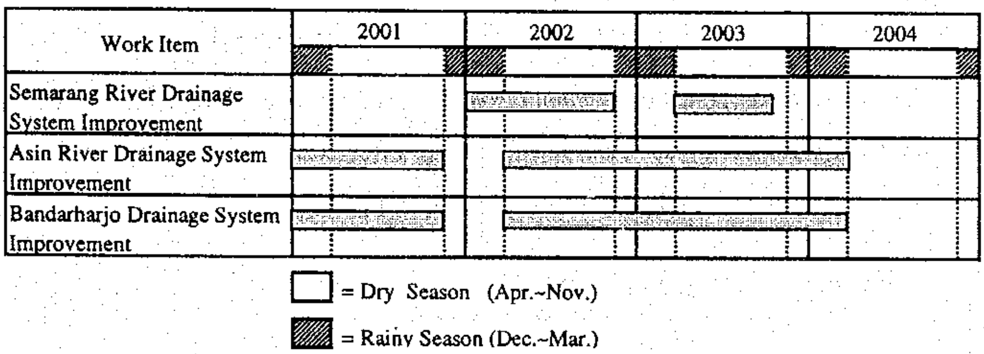
After clearing and stripping the pond area, the area is excavated by the combination of backhoe, bulldozer and dump trucks. Revetment of wet masonry is constructed at the pond bank to protect the bank slope mainly by manpower.

(7) Baru Conveyance Channel

Baru Conveyance Channel which connects the Baru Retarding Pond and Baru River is designed as a box culvert with the length of 692 m and the internal dimensions of 2.0 m wide and 2.0 m high. Temporary sheet pile wall shall be employed for the whole length for the excavation works because of the limited width of the work site. After the excavation is completed concrete works is carried out and backfill will follows on both sides and top of the culvert.

5.4.5 Construction Time Schedule

The construction time schedule for three packages are established in consideration of the conditions mentioned preceding items. Tables 5.1 to 5.3 show construction time schedules. The summary of construction schedule established is shown in the table below:



5.5 Operation and Maintenance of Facilities

5.5.1 Operation Concept of Pump and Gate Facilities

The drainage pump system will function in both dry and rainy seasons. The operation concept of pump and gate facilities is described below.

<u>Dry Season(April to October)</u>

(1) The water level of the retarding pond is to be maintained by auxiliary pump to keep the design low water level, in order to maintain a good drainage condition in the area. The auxiliary pump will discharge only waste water from households.

(2) The gate is closed to protect the area from high tide.

<u>Rainy Season (November to March)</u>

(1) Before a storm comes, the water level of the retarding pond is to be maintained by both auxiliary pump and main pump at the design low water level in order to maintain enough storage volume in the pond.

(2) When a storm comes and it starts to rain, the water level of the retarding pond is to be maintained by both auxiliary pump and main pump at the design low water level as long as possible.

(3) When inflow discharge of rainfall exceeds the pump capacity and the water level get rising, the pump shall be operated in full capacity

(4) The operation of pump shall be continued until the storm is over, inflow decreases and the water level in the pond returns to the design low water level.

(5) The gate is to be opened only when the water level in the retarding pond is higher than the water level on the sea side and it is more effective to discharge storm water. On such an occasion all pump operation shall be stopped.

5.5.2 Maintenance Concept of Facilities

<u>Maintenance of Mechanical Facilities</u>

The mechanical facilities in the project are the essence of the pump drainage system, without which the whole urban drainage system will lose its main function. Because of the low elevation of the whole drainage area, the area relies on artificial pump drainage system.

Therefore, it is absolutely necessary with all effort to maintain the function of the mechanical facilities without interruption.

Maintenance activities of the facilities are composed of four components, namely "Observation", "Inspection", "Repair" and "Record". These activities are all equally important to attain proper maintenance of the facilities.

Proposed frequency for each activity is shown below.

Facilities	Observation	Inspection	Repair
Civil Structures	Monthly	Annually	Required Time
Main Pump	Daily during wet season	Weekly during wet season Monthly during dry season Annual Inspection by Manufacturer	Annually (painting once in five years)
Auxiliary Pump	Daily	Weekly Annual Inspection by Manufacturer	Annually
Gate	Monthly	Annually Annual Inspection by Manufacturer	Annually (painting once in five years)
Electrical Equipment	Daily	Monthly Annual Inspection by Manufacturer	Annually

<u>Maintenance of Civil Facilities</u>

Pump and gate foundations are important civil facilities to maintain the function of mechanical facilities and are to be maintained properly. Retarding pond storage volume should be maintained regularly to fulfill the function of storm water retarding. River channel facilities such as channel itself, dike and revetment are to be maintained to attain the function of safe discharge of storm water through the channel.

Land subsidence is one of the important factors affecting the function of the civil facilities. The progress of land subsidence should be monitored carefully and to be reflected in effective countermeasures in maintenance works.