THE REPUBLIC OF INDONESIA
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MINISTRY OF PUBLIC WORKS

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

FINAL REPORT

(MAIN REPORT)

NOVEMBER 1993

JAPAN INTERNATIONAL COOPERATION AGENCY

THE REPUBLIC OF INDONESIA
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MINISTRY OF PUBLIC WORKS

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

FINAL REPORT

(MAIN REPORT)

NOVEMBER 1993

JAPAN INTERNATIONAL COOPERATION AGENCY

LIST OF REPORTS

MAIN REPORT

SUPPORTING REPORT

DATA BOOK

The cost estimate was based on July 1992 price level and expressed in Rupiah according to the exchange rate of US$1.00 = Indonesian Rupiah 2,033 and Japanese Yen 1.00 = Indonesian Rupiah 16.20 as of July 1992.

PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct The Master Plan on Water Resources and Feasibility Study for Urgent Flood Control and Urban Drainage in Semarang City and Suburbs and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a study team headed by Mr. TOMIOKA Yoshiyuki of CTI Engineering Co., Ltd. and composed of members from CTI Engineering Co., Ltd. and Pacific Consultants International, four times between April 1992 and September 1993.

The team held discussions with the officials concerned of the Government of Indonesia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Indonesia for their close cooperation extended to the team.

November, 1993

Kensuke Yanagiya

KENSUKE YANAGIYA
President
Japan International Cooperation Agency

JICA STUDY TEAM

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

November, 1993

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

<u>Letter of Transmittal</u>

Dear Sir:

We are pleased to submit herewith the Final Report for the study on THE MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS, which dealt with the formulation of master plan and the feasibility study for priority projects selected in the master plan study as well as the urgent project.

The Final Report consists of the Main Report which contains the details of the project formulation process, conclusion and recommendations; the Supporting Report which includes sector-wise technical details; and the Data Book with site observation records, collected data and calculation output.

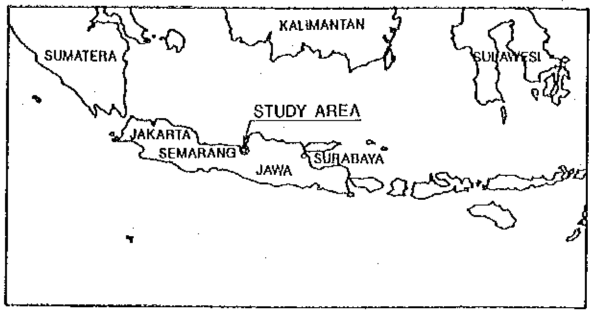
We wish to express our gratefull acknowledgement to the officials of the Japan International Cooperation Agency, the Advisory Committee, the Ministry of Foreign Affairs, the Ministry of Construction, the Embassy of Japan in Indonesia, and the officials concerned of the Government of Indonesia for their assistance and advice extended to the Study Team. We sincerely hope that the study results will contribute much to the socio-economic development of Central Jawa Province.

Very truly yours,

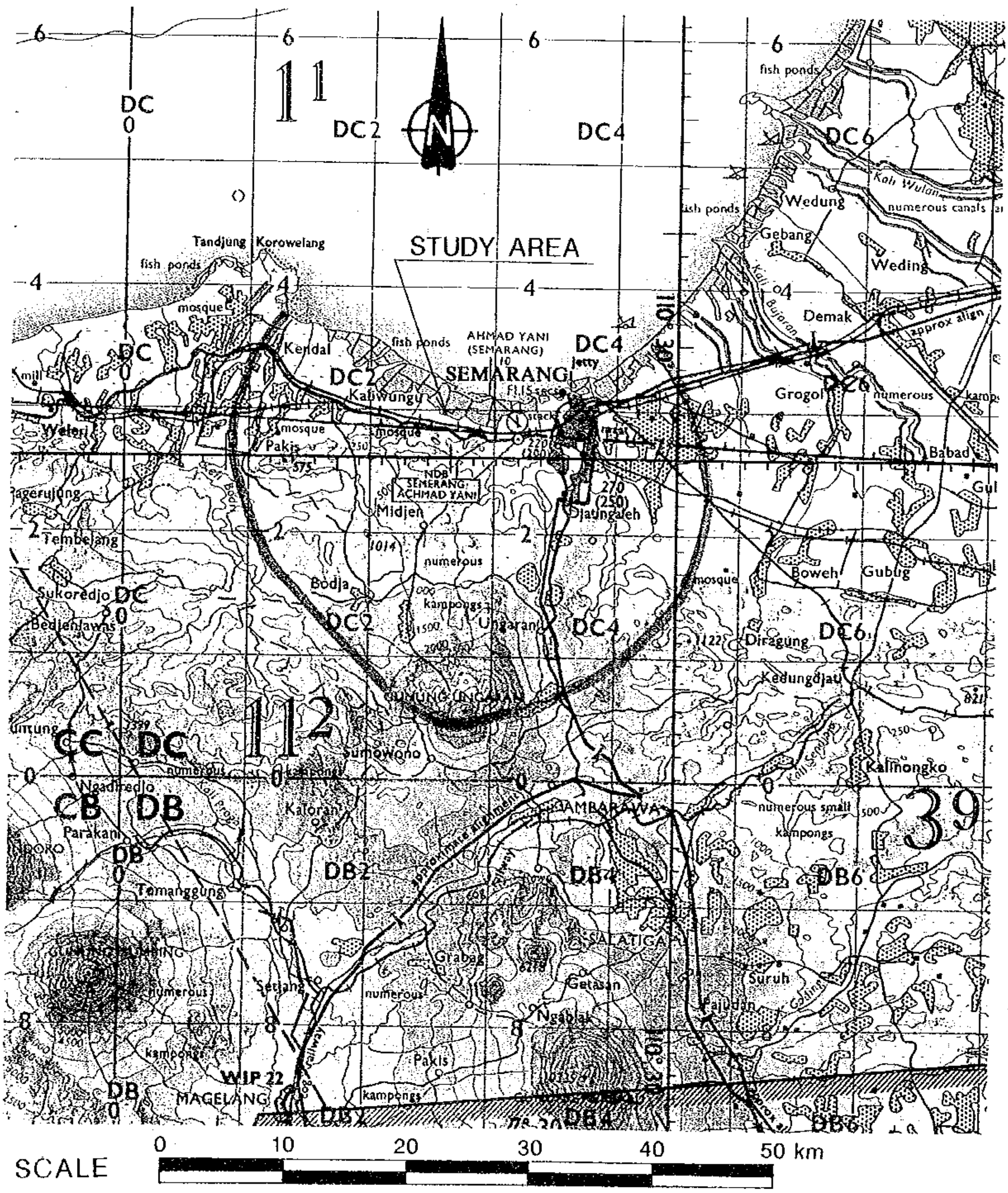
TOMIOKA, Yoshiyuki
Team Leader
JICA Study Team

Encl.: a/s

GENERAL MAP



KALIMANTAN
SUMATERA
SULAWESI
STUDY AREA
JAKARTA
SEMARANG
SURABAYA
JAWA



STUDY AREA
DC
DC2
DC4
DC6
CC
CB
DB
DB2
DB4
DB6
112
39
Tandjung Korowelang
fish ponds
mosque
Kendal
Kaliwungu
SEMARANG
AHMAD YANI (SEMARANG)
Weleri
Pakis
Midjen
Djatingaleh
Tembelang
Sukoredjo
Bodja
Ungaran
numerous
kampongs
GUNUNG UNGARAN
Sumowono
Ngadiredjo
Parakan
Kaloran
AMBARAWA
Temanggung
SALATIGA
Grabag
Getasan
Ngablak
Setjang
MAGELANG
WIP 22
Pakis
Wedung
Gebang
Weding
Demak
Grogol
Babad
Boweh
Gubug
Diragung
Kedungdjati
Kalmongko
Suruh
Kali Wulan
numerous canals
numerous small kampongs
SCALE
0
10
20
30
40
50 km

SUMMARY

SUMMARY

1. INTRODUCTION

1.1 Background of the Study

The recorded recent big flood damage in and around Semarang City occurred in 1973, 1988 and 1990. The flood in January 1990 particularly brought out 47 casualties and damaged 151 houses in the downstream of Garang River. The total damage has been estimated at Rp. 8.5 billion (about US$4.3 million), the largest in the recent 70 years.

Semarang City and suburbs also suffer from the chronic shortage of water supply in dry seasons, particularly, municipal and industrial water supply. The problem on water supply is further aggravated by the concentration of population in the urban area.

Appropriate measures against flood damage and shortage of water supply in Semarang City and suburbs are indispensable for the economic development and stabilization of people's livelihood leading to the further economic development of not only Central Jawa but the whole of Indonesia as well. To this end, the Government of Indonesia had requested the Government of Japan to extend technical cooperation for the Study.

In response to the request of the Government of Indonesia, the Government of Japan had decided to undertake the Study. The Study has been entrusted to the Japan International Cooperation Agency (JICA), the office responsible for implementing the technical cooperation programs of the Government of Japan.

1.2 Objectives of the Study

The Study has the following four objectives:

(1) To formulate a Master Plan of Flood Control, Urban Drainage and Water Resources Development in Semarang City and suburbs.

(2) To carry out a Feasibility Study for the Urgent Project of river improvement works for West Floodway/Garang River.

(3) To carry out a Feasibility Study for the priority projects which are to be selected in the Master Plan Study.

(4) To carry out Transfer of Technical Knowledge to the Indonesian staff concerned.

1.3 Study Area

The study area is within the watershed boundaries of Blorong River, West Floodway/Garang River, East Floodway and Babon River, covering about 1,000 km^2 which include the whole of Semarang City and parts of two regencies (Kabupaten), Kab. Kendal and Kab. Semarang, which lie adjacent to Semarang City.

2. MASTER PLAN

2.1 Target Year

The target year for the Master Plan has been set at the year 2015.

2.2 Objective Area

Flood Control Plan

The study area for the Flood Control Plan has been limited to the basins of the following six (6) rivers:

- Blorong River
- Bringin River
- Silandak River
- West Floodway/Garang River
- East Floodway
- Babon River

Urban Drainage Plan

The Urban Drainage Plan has been formulated within the administrative boundary of Semarang City.

Water Resources Development Plan

The Water Resources Development Plan has been formulated for the water demand of Semarang City.

2.3 Design Scale

Flood Control Plan

The design scale for the objective rivers of the Flood Control Plan has been established as follows:

- Blorong River	:	20-year return period
- Bringin River	:	50-year return period
- Silandak River	:	100-year return period
- West Floodway/Garang River	:	100-year return period
- East Floodway	:	100-year return period
- Babon River	:	50-year return period

Urban Drainage Plan

The design scale for the objective drainage areas of the Urban Drainage Plan has been set at 5- or 10-year return period according to the catchment area of the drainage channel.

Water Resources Development Plan

The water supply plan has been established with a 10-year drought cycle.

2.4 Optimum Plan

A comparative study has been made among alternatives for the Flood Control Plan, the Urban Drainage Plan and the Water Resources Development Plan.

The optimum Flood Control Plan consists of river improvement and the construction of multipurpose dams combined with the Water Resources Development Plan.

The optimum Urban Drainage Plan covers the improvement of nine (9) primary drainage channels and the construction of three (3) pumping stations.

The optimum Water Resources Development Plan consists of the construction of two (2) multipurpose dams combined with the Flood Control Plan and two (2) other single purpose dams.

2.5 Implementation Schedule

The implementation schedule for the Master Plan has been prepared taking priority and economic viability into consideration.

2.6 Project Cost

The project costs of the Master Plan has been estimated at the price level of July 1992 and the currency conversion rates of US$1.00 = Indonesian Rp. 2,033 and Japanese ¥1.00 = Indonesian Rp. 16.2.

Project cost is composed of construction base cost, compensation cost, administration cost, engineering service cost and physical contingency. Price contingency and value added tax have been excluded.

The estimated project costs of the respective plans are as given below:

- Flood Control Plan : Rp. 345,935 million (The costs of two (2) multipurpose dams were allocated to the Flood Control Plan.)
- Urban Drainage Plan : Rp. 165,412 million
- Water Resources Development Plan : Rp. 639,021 million (The costs of two (2) multipurpose dams were allocated to the Water Resources Development Plan.)

2.7 Economic Evaluation

The economic viability of the Master Plan has been assessed in terms of EIRR, B/C and NPV, and the results are as shown in the following table.

Plan	EIRR (%)	B/C	NPV (mill. Rp.)
Flood Control	14.1	1.54	78,016
Urban Drainage	10.4	1.05	4,370
Water Resources Development	11.4	1.15	34,289

2.8 Project Justification

The EIRR of either of the three plans exceed 10%, therefore, the Master Plan is evaluated to be economically viable.

2.9 Selection of Priority Project

Priority projects selected from the Master Plan have been subjected to a feasibility study in due consideration of their economical efficiency and urgency.

3. FEASIBILITY STUDY

3.1 Target Year

The target year for the feasibility study has been set at the year 2005.

3.2 Priority Projects

The priority projects for the feasibility study selected in the master plan study are as follows:

Flood Control Plan

- River improvement of West Floodway/Garang River
- Construction of Jatibarang Dam on Kreo River

Urban Drainage Plan

- Construction of three (3) pumping stations
- Improvement of primary drainage channels
- Reconstruction of a gate structure

Water Resources Development Plan

- Construction of Jatibarang Dam

Hydropower Generation Plan

Since a dam construction project, namely the construction of Jatibarang Dam is selected as the priority project of the Flood Control and Water Resources Development plans, the hydropower generation plan is formulated at the Jatibarang dam site.

3.3 Optimum Plan

A comparative study has been made among alternatives for each plan.

3.4 Implementation Schedule

The implementation schedule for each plan has been prepared taking priority order into consideration so that all priority projects will be completed by the target year 2005.

3.5 Project Cost

The project cost of priority projects has been estimated based on the same price level and currency conversion rates as the master plan. However, price contingency and value added tax which were excluded in the master plan are included in the project cost component in the feasibility study.

The estimated project costs are given below.

- Flood Control Plan	:	Rp. 132,223 million
- Urban Drainage Plan	:	Rp. 64,118 million
- Water Resources Development Plan		Rp. 79,881 million
- Hydropower Generation Plan	:	Rp. 19,019 million
Total	:	Rp. 295,241 million

3.6 Economic Evaluation

The economic evaluation on the priority projects has been conducted by means of EIRR, B/C and NPV, and the results are given below.

Plan	EIRR (%)	B/C	NPV (mill. Rp.)
- Flood Control	16.2	1.90	51,626
- Urban Drainage	15.7	1.81	14,872
- Water Resources Development	28.8	3.81	96,030
- Hydropower Generation	5.9	0.66	-3,140
- Whole Priority Projects	19.8	2.35	160,463

3.7 Project Justification

As shown in the previous section, all plans, except the Hydropower Generation Plan, give a fairly high EIRR of 15% or more. However, the EIRR of the whole project including the Hydropower Generation Plan still show more than 19%. Therefore, the priority projects as a whole have adequate economic viability.

4. URGENT PROJECT

The flood of January 1990 caused overflow along West Floodway/Garang River resulting in the enormous flood damage in Semarang City and suburbs. With this as a turning point, it has been agreed between DGWRD and JICA that the Urgent Project for West Floodway/Garang River should be studied to facilitate the immediate formulation and implementation of river channel improvement works and prevent the recurrence of overflow of the river channel as described in the Minutes of Meeting on Scope of Works on December 14, 1991.

4.1 Target Year

The target year for the Urgent Project has been set at the year 2000.

4.2 Objective River Stretch

The objective river stretch for the Urgent Project is the stretch of about 9.54 km from the river mouth of West Floodway up to the confluence of Garang River and Kreo River.

4.3 Design Scale

The design scale has been set at 25-year return period.

4.4 Optimum Plan

The optimum plan for the Urgent Project has been selected after a comparative study on alternatives. This plan consists of the excavation of the high water channel of West Floodway and the riverbed of Garang River, the reconstruction of the existing Simongan Weir and the construction of groundsills.

4.5 Implementation Schedule

The implementation schedule has been prepared with a period of six (6) years starting from 1994 until the target year 2000.

4.6 Project Cost

The project cost of the Urgent Project has been estimated at Rp. 90,412 million based on the same conditions as the feasibility study.

4.7 Economic Evaluation

The economic evaluation for the Urgent Project has been conducted by means of EIRR, B/C and NPV, and the results are as follows:

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

4.8 Project Justification

The Urgent Project which has been evaluated with the EIRR of 15.9%, is considered to have adequate economic viability.

5. RECOMMENDATIONS

Coordination with Other Government Agencies

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

Reforestation or Regreening of Upper Stream Area

Presently, there are many places devoid of trees in the hilly area, the upper watershed of the objective rivers. These places are vulnerable to slope erosion or collapse caused by intensive rainfall, and the subsequent sedimentation on the downstream stretches of rivers will remarkably reduce the flood discharge capacity of the river channel.

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

Development Control of the Watershed

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

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

DRAFT FINAL REPORT
(MAIN REPORT)

TABLE OF CONTENTS

Page

Page

Page

Page

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

1. INDONESIAN GOVERNMENT AGENCIES

GOI : Government of Indonesia

BAPPENAS : Badan Perencanaan Pembangunan Nasional (National Development Planning Board)

BAPPEDA : Badan Perencanaan Pembangunan Daerah (Provincial Development Planning Board)

DPU : Departemen Pekerjaan Umum (Ministry of Public Works)

DGWRD : Directorate General of Water Resources Development

DGCK : Directorate General of Cipta Karya (Housing, Building and Urban Development)

DOR : Directorate of Rivers

DPUP : Dinas Pekerjaan Umum Propinsi (Provincial Public Works Services)

P3SA : Proyek Pengembangan dan Penyelidikan Sumber-Sumber Air (Water Resources Development and Investigation Planning Project)

PGM : Pusat Meteorologi dan Geofisika (Center of Meteorology and Geophysics)

PLN : Perusahaan Listrik Negara (State Electricity Corporation)

IHE : Institute of Hydraulic Engineering (Bandung)

PDAM : Perusahaan Daerah Air Minum (Water Supply Public Corporation)

2. JAPANESE GOVERNMENT/INTERNATIONAL ORGANIZATIONS

GOJ : Government of Japan

JICA : Japan International Cooperation Agency

MOC : Ministry of Construction, Japan

ADB : Asian Development Bank

IBRD : International Bank for Reconstruction and Development (World Bank)

WMO : World Meteorological Organization

ASTM	:	American Society for Testing and Materials
AWS	:	American Welding Society
ASME	:	American Society of Mechanical Engineer
JEM	:	Japan Electric Machine Industry
USASI	:	United States of America Standards Institute
IEC	:	International Electrotechnical Commission
NEMA	:	National Electrical Manufacturers Association
JEC	:	Japanese Electrotechnical Committee
IPCEA	:	Insulated Power Cable Engineers Association
IEEE	:	Institute of Electrical and Electronic Engineers

3. MEASUREMENT UNITS

(Length)

mm	:	millimeter(s)
cm	:	centimeter(s)
m	:	meter(s)
km	:	kilometer(s)

(Weight)

g, gr	:	gramme(s)
kg	:	kilogram(s)
t, ton	:	tonnage(s)

(Area)

mm^2	:	square millimeter(s)
cm^2	:	square centimeter(s)
m^2	:	square meter(s)
km^2	:	square kilometer(s)
ha(has)	:	hectare(s)

(Time)

s, sec	:	second(s)
min	:	minute(s)
h(hrs)	:	hour(s)
d(dys)	:	day(s)
y, yr(yrs)	:	year(s)

(Volume)

cm^3	:	cubic centimeter(s)
m^3	:	cubic meter(s)

(Others)

l, ltr	:	liter(s)
EL., El.	:	Elevation

(Combined Units)

<u>Speed/Velocity</u>

cm/sec, cm/s	:	centimeter per second
m/sec, m/s	:	meter per second
km/hr, km/h	:	kilometer per hour

Stress

kg/cm^2	:	kilogram per square centimeter
ton/m^2	:	ton per square meter

Discharge

ltr/sec, l/s	:	liter per second
m^3/sec, m^3/s	:	cubic meter per second
m^3/yr, m^3/y	:	cubic meter per year

(Note: Other combined units may be constructed similarly as above.)

Electricity

MW	:	megawatt	GW	:	gegawatt
MWh	:	megawatt hour	GWh	:	gegawatt hour
kv	:	kilovolt			

4. MONETARY TERMS

¥	:	Japanese Yen
US$	:	United States Dollar
Rp.	:	Indonesian Rupiah

5. INDONESIAN TERMS

JKT	:	Jakarta
Jawa	:	Java
Propinsi	:	Province
Kabupaten, Kab.	:	District (Regency)
Kotamadya, Kodya.	:	Municipality
Kecamatan, Kec.	:	Sub-District
Desa	:	Village (Rural Area)
Kampung, Kp.	:	Village (Rural Area)
Kelurahan	:	Village (Urban Area)
Sungai, Sei	:	River
Gunung	:	Mountain
Rawa	:	Swamp
Danau	:	Lake
Laut	:	Sea
PT.	:	Incorporated or Limitted
PIL	:	Preliminary Environmental Analysis
ANDAL	:	Environmental Impact Analysis
AMDAL	:	Institution of Environmental Impact Analysis

6. OTHERS

SWL	:	Surcharge Water Level
DFWL	:	Design Flood Water Level
PMP	:	Probable Maximum Precipitation
PMF	:	Probable Maximum Flood

EIRR	:	Economic Internal Rate of Return
IUIDP	:	Integrated Urban Infrastructures Development Program
SSUDP	:	Semarang and Surakarta Urban Development Program
JIS	:	Japanese Industrial Standard
USASI	:	United States of America Standards
SWR	:	Shadow Wage Rate
CIF	:	Cost, Insurance and Freight
GPS	:	Global Positioning System
VAT	:	Value Added Tax

CHAPTER 1 GENERAL

1.1 Introduction

The Master Plan on Water Resources Development and Feasibility Study for Urgent Flood Control and Urban Drainage in Semarang City and Suburbs, hereinafter referred to as the Study, was conducted from April 1992 to September 1993.

This report contains all the results of the Master Plan Study, the Feasibility Study and the Urgent Project Study.

1.2 Background of the Study

Semarang City and suburbs is located on the plains between the hilly land to the south and the Jawa Sea to the north. Due to the topographic condition and the inadequate flood control facilities, Semarang City and suburbs suffer from habitual inundation in the rainy season.

The recent big flood damages were recorded in 1973, 1988 and 1990. The flood in January 1990 particularly brought out 47 casualties and damaged 151 houses in the downstream of Garang River. Total damage was estimated at 8.5 billion rupiah (about US$4.3 million), the largest in the recent seventy years.

Semarang City and suburbs also suffer from the chronic shortage of water supply in dry seasons, particularly, municipal and industrial water supply. The problem on water supply is further aggravated by the concentration of population in the urban area.

To cope with the water shortage, proposed is the water conveyance from Kedung Ombo Dam Reservoir which was constructed recently. In spite of the water conveyance plan and the other ongoing development plans for new water resources, it may be difficult to meet the water demand of 6,500 l/s estimated for Semarang City at the year 2000.

Appropriate measures against flood damage and shortage of water supply in Semarang City and suburbs are indispensable for the economic development and stabilization of people's livelihood leading to the further economic development of not only Central Jawa but the whole of Indonesia as well. To this end, the Government of Indonesia requested the Government of Japan to extend technical cooperation for the Study.

In response to the request of the Government of Indonesia, the Government of Japan decided to undertake the Study. The Study has been entrusted to the Japan International Cooperation Agency (JICA), the office responsible for implementing the technical cooperation programs of the Government of Japan.

1.3 Objectives of the Study

The Study has the following four objectives:

(1) To formulate a Master Plan at the target year 2015 for flood control, urban drainage and water resources development in Semarang City and suburbs. Priority projects under each field are to be selected in the Master Plan Study.

(2) To carry out a Feasibility Study at the target year 2000 for the Urgent Project of river improvement works for West Floodway/Garang River and its tributaries where the flood of January 1990 caused channel overflow resulting in the recent largest flood damage in Semarang City. The Urgent Project Study is to be done simultaneously with the Master Plan Study so as to attain earlier project implementation.

(3) To carry out a Feasibility Study at the target year 2005 for the priority projects which are to be selected in the Master Plan Study as the objectives requiring urgent solution.

(4) To carry out Transfer of Technical Knowledge to the Indonesian staff concerned through the foregoing series of studies and project formulation in Indonesia and in Japan.

1.4 Scope of the Study

The Study consisted of three stages. The Urgent Project for West Floodway/Garang River was formulated in the first stage from April to October 1992; the Master Plan of flood control, urban drainage and water resources was formulated in the first and second stages from April 1992 to March 1993; and the Feasibility Study for priority projects selected in the Master Plan was carried out in the third stage from May to September 1993. The scope of the Study is summarized as follows.

Urgent Project Study (First Stage)

(1) Field Survey

(a) Field reconnaissance;

(b) Subsoil investigation along West Floodway/Garang River; and

(c) Inundation damage survey.

(2) Data Collection

(3) Study and Analysis

(a) Hydrological analysis;

(b) Inundation damage analysis; and

(c) Projection of future land use.

(4) Formulation of Urgent Project

(a) Establishment of planning criteria;

(b) Establishment of alternative flood control plans;

(c) Selection of optimum plan;

(d) Structural design;

(e) Construction plan;

(f) Cost Estimate;

(g) Economic evaluation; and

(h) Environmental assessment.

Master Plan Study (First and Second Stages)

(1) Field Survey

(a) Field reconnaissance;

(b) Photogrammetric mapping for the coastal plain area;

(c) Ground survey for rivers and drainage channels;

(d) Riverbed material survey;

(e) Inundation damage survey for urban drainage; and

(f) Establishment of automatic rainfall and water level gauging stations.

(2) Data Collection

(3) Study and Analysis

(a) Hydrological and hydraulic analysis;

(b) Inundation damage analysis;

(c) Study on sedimentation;

(d) Projection of future land use and population; and

(e) Projection of future water demand.

(4) Formulation of Master Plan

(a) Establishment of planning criteria and concept;

(b) Establishment of alternative plans;

(c) Selection of optimum plan;

(d) Structural design;

(e) Construction plan;

(f) Cost estimate;

(g) Economic evaluation; and

(h) Environmental assessment.

Feasibility Study for Priority Projects (Third Stage)

(1) Field Survey

(a) Photogrammetric mapping for proposed dam and reservoir sites;

(b) Ground survey for proposed structures of urban drainage;

(c) Geological survey at the proposed dam site; and

(d) Additional inundation damage survey for urban drainage.

(2) Feasibility Study

(a) Establishment of criteria;

(b) Establishment of alternative plans;

(c) Selection of optimum plan;

(d) Preliminary structural design;

(e) Construction plan;

(f) Cost estimate;

(g) Economic evaluation; and

(h) Environmental assessment.

CHAPTER 2 STUDY AREA

2.1 Study Area

The study area is within the watershed boundaries of Blorong River, West Floodway/Garang River, East Floodway and Babon River, covering about 1,000 km^2 which include the whole of Semarang City and parts of two regencies (Kabupaten), Kab. Kendal and Kab. Semarang, which lie adjacent to Semarang City (refer to Fig. 2.1).

The Master Plan Study has been carried out within the study area. The flood control plan was formulated for six major rivers; namely, Blorong River, Bringin River, Silandak River, West Floodway/Garang River, East Floodway, and Babon River. The West Floodway includes its tributaries, i.e., Kreo River, Kripik River and Garang River.

The urban drainage plan was formulated within the administrative boundary of Semarang City and the water resources development plan was formulated for the water demand of Semarang City. Accordingly, all areas related to water demand are included in the study area.

2.2 Geography

2.2.1 Topography

The study area is divided into three regions, (1) mountain region, (2) hilly region, and (3) coastal plain region. The mountain region is on the north slope of Mt. Ungaran (2,050 m), ranging in elevation between 2,050 m and 300 m above mean sea level (MSL). The slope gradient of this region is very steep, and all rivers in the study area originate from this region.

The hilly region lies between the mountain and coastal plain regions at an elevation of 300 to 50 m MSL, and has the width of about 15 km. This region is featured by undulated highland with deep valleys.

The coastal plain region lies between the hilly region and Jawa Sea at elevation below 50 m MSL, and has the width of 4 to 10 km. Rivers in this region flow toward north at a gentle gradient of 1:2,000 to 1:5,000.

2.2.2 Geology

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. Alluvial deposits cover these basement rocks (refer to Fig. 2.2).

2.3 Meteorology and Hydrology

2.3.1 Existing Observatory

There are three (3) meteorological stations in the study area, namely, two stations (Semarang and Ungaran stations) operated by the Center of Meteorology and Geophysics (BMG) and one station at Semarang Ahmad Yani (Semarang Airport) for the observation of temperature, sunshine duration, wind velocity, hourly and daily rainfall, and evaporation.

There are 52 rainfall stations in the study area. Forty-one (41) of these stations are maintained by the Ministry of Public Works (DPU) and they include the four stations for daily rainfall observation in relation to the Jratunseluna Project. Three (3) rainfall stations are maintained by the Institute of Hydraulic Engineering (IHE) for the observation of hourly rainfall, and eight (8) other stations send daily rainfall data to BMG (refer to Fig. 2.3).

2.3.2 Climatic Characteristics

The Semarang station is located in the coastal plain. Temperature at the Semarang station ranges between 21°C and 35°C and average annual temperature is 27.4°C. Average annual humidity is 76% and mean annual wind velocity is 4 knots.

The Ungaran station is located 300 m above mean sea level. Temperature ranges between 18°C and 35°C and average annual temperature is 26.2°C. Average annual humidity is 78%.

In rainy seasons rainfall is generally brought about by northwest wet winds blowing from Jawa Sea. Rainfall continues for approximately 2 to 12 hours, starting in the afternoon until midnight in general. Annual rainfall amounts to 2,460 mm at Semarang Station and 2,065 mm at Ungaran Station. Monthly rainfall recorded at both stations from 1980 to 1989 are given in Table 2.1.

2.3.3 River Discharge

Two (2) water level gauging stations are maintained by the IHE in Garang River and Blorong River. The daily discharge data and annual maximum hydrographies of the two stations were collected from the IHE.

Annual average discharge observed at the Garang River Gauging Station (C.A. = 185 km^2) and the Blorong River Gauging Station (C.A. = 158km^2) are 10.7 m^3/s and 8.0 m^3/s, respectively (refer to Table 2.2).

At Simongan Weir, annual maximum water levels were observed from 1961 to 1990. The annual maximum peak discharges are estimated at 901 m^3/s in 1963 and 1990.

2.4 Socioeconomy and Land Use

2.4.1 Population

A series of population censuses were conducted in 1961, 1971, 1980 and 1990. According to the 1990 census, the population of Indonesia and Central Jawa Province were 179,322,000 and 28,522,000, respectively, and from 1980 to 1990, the average annual growth rates were 1.97% and 1.17%.

The study area include the nine kecamatans of Semarang City (kotamadya), six kecamatans in Kabupaten Kendal and the two kecamatans in Kabupaten Semarang. The population of the study area was 1,724,000 in 1990. The breakdown and population density by kecamatan are given in Table 2.3.

The study area and Semarang City have the area of 1,042 km^2 and 374 km^2, and population density in 1990 were 1,654 persons/km^2 and 3,348 persons/km^2, respectively. The number and size of households in the study area in 1990 are shown in Table 2.4.

The future population in the study area by the year 2015 has been projected for only the purpose of Master Plan formulation based on the above figure, and the results are given in Table 2.5.

2.4.2 Development Policy

National development plans have been formulated in the Fifth Five-Year Development Plan (Repelita V) to promote sustainable socioeconomic growth in Indonesia. The basic concepts for the growth are given as follows.

(1) To uplift the living standard of the people; and

(2) To establish a strong foundation for the next development stage.

Repelita V also aims to provide adequate employment opportunities for the rapidly growing labour force which is expected to expand with 11.9 million new job hunters in the next five years. To this end, environmental aspects are to be taken into consideration in planning the development scheme so as to maintain the balance between ecology and development.

Policies on regional development are to be established to realize the basic concepts and objectives of the national development policy. In Repelita V, development of rural areas and small cities were given priority to achieve a well-balanced development between urban areas and big cities.

2.4.3 Economic Structure

(1) National Economic Structure

(a) Economic Growth

The Gross Domestic Product (GDP) in Indonesia for the period 1985-1990 had grown from Rp. 94,720 billion to Rp. 197,721 billion with the average annual growth rate of 15.9%. Among the sectors, the manufacturing/industry sector was dominant with the average annual growth rate of 24.5% in the same period (refer to Table 2.6)

In Repelita V (fiscal years 1988 - 1993), the target of the average economic growth rate was set at 5.0% per annum.

(b) Government Budget

Budgetary expenditures of the central government amounted to Rp. 46,654 billion in fiscal year 1990/91, consisting of Rp. 29,998 billion for the service sector and Rp. 16,656 billion for the development sector. As shown in Table 2.7, budgetary expenditures indicated a high average annual growth rate of about 20% for the service sector, while there was little growth of 9% for the development sector during the period 1985/86 to 1990/91.

(c) External Trade

In 1980, exports in Indonesia amounted to US$23,950 million against the imports of US$10,834 million, i.e., the balance of trade indicated an export surplus of

US$13,116 million which was the most favorable balance in the past. After that year the amount of exports, on the decrease due to international recession in the oil market, fell to US$14,805 million in 1986, although the trade balance still maintained the export surplus amounting to US$4,087 million. However, the external trade of Indonesia, indicating an upward trend after 1986, amounted to the exports of US$29,620 million and the imports of US$25,906 million in 1991, i.e., an export surplus of US$3,714 million. On the other hand, the external trade balance which excluded petroleum and gas from the exports and imports was in an unfavorable situation every year during the period from 1980 to 1991 (refer to Table 2.8).

(2) Regional Economic Structure

(a) Economic Growth

The Gross Regional Domestic Product (GRDP) in Central Jawa Province for the period 1985 - 1989 had grown from Rp. 10,124 billion to Rp. 18,782 billion at the current market price with the average growth rate of 16.7% per annum (refer to Table 2.9). However, GRDP per capita in the same period showed Rp. 376,615 in 1985 and Rp. 668,030 in 1989 with average growth rate of 15.4% per annum.

(b) Constitution of Gross Regional Domestic Product

By sector, Gross Regional Domestic Product is given annually as follows. The details are shown in Table 2.9.

Sector	Share (%) 1985	1986	1987	1988	1989
Agriculture	30.0	31.0	29.9	32.7	32.0
Industry	20.9	20.8	22.9	22.4	23.8
Trade	18.6	18.5	18.7	17.7	18.3
Others	30.5	29.7	28.4	27.2	25.9
Total	100.0	100.0	100.0	100.0	100.0

(c) Budget of Regional Government

Budgetary expenditures of the Central Jawa Provincial Government amounted to Rp. 516,281 million in fiscal year 1990/91 at an average annual growth rate of about 10% during the period 1982/83 to 1990/91. This expenditure is composed of Rp. 491,614 million (95%) for services and Rp. 84,239 million (5%) for development. Both indicated the average growth rates of 9.3% and 10.3% per annum, respectively, during the said period.

2.4.4 Governmental Organization

(1) Central Government

Based upon the 1945 Constitution, Indonesia established a Republic headed by a President who is elected by the People Deliberative Assembly as the highest state institution. The organization of the central government is shown in Fig. 2.4.

The Ministry of Public Works in the central government was set up under Presidential Decree No. 44/1974. The organizational structure was later modified by Presidential Decree No. 15/1984. The Decree of the Minister

No. 211/1984 covers the basic tasks and functions of the Ministry as a governmental organization to undertake development projects (refer to Fig. 2.5).

Urban drainage and municipal water supply programs are managed by the Directorate General of CIPTA KARYA (Housing, Building and Urban Development). The Directorate of Environmemtal Sanitation is the agency concerned in the planning, design, implementation, operation and maintenance of urban drainage. Municipal water supply is handled directly by PDAM (Water Supply Public Corporation) under the supervision of the Directorate of Clean Water (refer to Fig. 2.6).

River improvement programs are handled by the Sub-Directorate of Rivers, Directorate General of Water Resources Development (DGWRD). The Directorate of Rivers is directly concerned in river development and its specific tasks are technical planning and design, implementation, and operation and maintenance. It also carries out feasibility studies on river works, especially flood control (refer to Figs. 2.7 and 2.8)

(2) Local Government

There are 27 provinces in Indonesia headed by governors who are appointed by and responsible to the President of the Republic. The organization of the local government is shown in Fig. 2.9.

Public works directly concerning each province are undertaken by the provincial public works office (DINAS PU). Development programs for water resources and river basins in Central Jawa Province are managed by the Provincial Public Works Office for Water Resources (DINAS PU Pengairan).

2.4.5 Land Use

Central Jawa Province which has 32,548 km^2 is divided into 10,010 km^2 (31%) of wet land and 22,538 km^2 (69%) of dry land. Irrigated farmland occupies about 70% of the wet land. Change in land use can be seen at wet lands and farmlands with the tendency of gradual decrease, and at house compound and estate with the tendency of gradual increase in the past decade. Such changes will accelerate in the next decade due to the governmental policy of industrialization.

The study area consists of the entire Semarang City and parts of Kabupaten Kendal and Kabupaten Semarang. Semarang City occupies almost 36% of the study area and about 40% of Semarang City is occupied by house compounds which include residential and commercial areas and 12% by paddy fields and reservoirs called wet land.

The study area includes six of the 15 kecamatans of Kabupaten Kendal. These six kecamatans occupy around 45% of the study area and house compound occupy only 12% of the area of the six kecamatans. However, the paddy fields and reservoir areas, cleared land which is farm land, and government forest each occupy 21% to 24% of the wet land.

The study area includes two of the 14 kecamatans of Kabupaten Semarang. These two kecamatans occupy about 19% of the study area and wet land, government forest and cleared land respectively occupy 24%, 22% and 21% of the area of the two kecamatans. House compound and plantation estate each occupy 15%.

The present land use in the study area is presented in Fig. 2.10. The present and authorized future land use of Semarang City for the year 2000 is presented in Repelita V, 1989-1993. Based on the present and future land use in 2000, the future land use plan for the year 2015 was projected in this study for the purpose of formulating only the master plan. The future land use in the year 2015 projected by the Study Team is presented in Fig. 2.11.

2.5 Development Projects

Regional development projects conducted or ongoing in the study area are summarized below.

<u>Flood Control Project</u>

River	Project	Year	Present Status
Blorong	West Semarang Irrigation Project	1990	Improvement works with design scale of 20-year return period completed.
Silandak	Central Jawa River Improvement and Maintenance Project	1991	Construction of Diversion channel with design scale of 50-year return period completed.
Garang	Central Jawa River Improvement and Maintenance Project	1992 (Target)	Ongoing

River	Project	Year	Present Status
East Floodway	Dolok Penggaron Drainage Design Project	2000 (Target)	Ongoing
Babon	Central Jawa River Improvement and Maintenance Project	1991	Improvement works with design scale of 5-year return period completed.
	Dolok Penggaron Drainage Design Project	2000 (Target)	New diversion channel design scale is 25-year return period.

Urban Drainage Project

(1) Stormwater Drainage Master Plan for Semarang City (1975-76)

This was the first master plan of urban storm drainage for Semarang City with the target year 2000. The study covered the whole Semarang City and recommended the storm drainage program in three phases.

Phase I (up to 1980)

(a) Cleaning of Existing Channels : $V = 178,000\ m^3$

(b) Rehabilitation of Existing Channels : L = 47 km

(c) Improvement of Semarang River : L = 3.6 km

(d) Construction of New Channels : L = 6.2 km

(e) Construction of Tidal Gate : 1 unit

(f) Construction of Side Outlet Weir : 1 unit

The total project cost of Phase I is estimated at about US$6.3 million at 1976 prices.

Phase II (up to 1990)

(a) Improvement of Simpang Lima Drainage System

- Construction of Storage Well : L = 2,000 m

- Construction of Drainage Pump Station : Q = 6 m^3/s; 1 unit

(b) Provision of drainage ditch along roadways.

The total project cost of Phase II is estimated at about US$1.5 million at 1976 prices.

Phase III (up to 2000)

(a) Provision of adequate ditches along new roads

(b) Establishment of flood plain management program

(c) Construction of about 100 km of drainage channels with drains running in cross section from 3 m^2 to 60 m^2.

The total project cost of Phase III is estimated at about US$12 million at 1976 prices. This project was implemented from 1985 to 1990 as the Semarang Drainage Improvement Project (Urban V) with financing from IBRD.

(2) Semarang Drainage Project

Following the master plan mentioned above, the detailed study on Semarang and Banger rivers was conducted in 1982. The project was recommended to be implemented in four phases with the total project cost of 11.3 billion rupiah. The improvement works for Semarang River were undertaken from 1985 to 1990 as Urban V.

(3) Semarang Surakarta Urban Development Project (SSUDP)

This is an ongoing project of the Directorate General of Cipta Karya and the Directorate of Bina Program, Ministry of Public Works, as a medium-term investment program (PJM) for the drainage improvement of Semarang City. The study was carried out from 1990 to 1991 and the objective of the program is to alleviate the frequent flooding in the coastal flood plain by improving the major drainage systems between Silandak River and Babon River. The total project cost was estimated at 57.0 billion rupiah at 1991 prices.

Water Resources Development Project

(1) Jratunseluna River Basin Development Project

This project is ongoing and the Kedung Ombo Dam, one of the main structures planned in the project, has been completed recently. The project has the following implementation schedule to transmit water to Semarang City. The water supply program by Jratunseluna Project is considered as a precondition for the formulation of the Water Resources Development Plan.

Year	Structure to be Constructed	Total Water Supply Capacity at Kudu
1994	Jajar Weir	-
1996	Conveyance Main Canal (Klambu-Kudu)	2,500 l/s
1997	Regulation Tunnel (Tuntang-Jragung)	-
1998	Conveyance Canal (Jragung-Main Canal)	4,250 l/s
1999	Dolok Reservoir	
2000	Conveyance Canal (Barang-Main Canal)	5,000 l/s

(2) Water Supply System for Western Semarang Areas

To meet the future water demand in the Western Semarang Area, Kec. Mijen and Kec. Tugu, PDAM prepared the report which contains the construction of three (3) dams, two (2) water intake facilities and water treatment plants.

CHAPTER 3 PRESENT CONDITION OF STUDY AREA

3.1 River

3.1.1 Blorong River

Blorong River is located on the western study area covering a catchment area of 157.0 km^2 and stretching about 60 km from the river mouth up to Mt. Ungaran (refer to Fig. 3.1). Glaggah River is the major tributary of Blorong River lying in the eastern area of the river basin and meeting the main stream at upstream of the existing irrigation intake structure of Pengilon Weir.

The inundation area of the flood in 1990, the recent biggest flood, spread out in the lower reaches from Pengilon Weir. The total inundation area was about 590 ha with the maximum inundation depth of about 0.5 m and the maximum inundation duration of 24 to 30 hours. Major flood damage came about in the paddy field, and several settlement areas were also flooded.

3.1.2 Bringin River

Bringin River which originates north of Mijen town has the catchment area of about 32.1 km^2 and the river length of about 15.5 km flowing northward into Jawa Sea (refer to Fig. 3.1).

No record of flooding was obtained by the actual damage survey for the January 1990 flood. According to the interview survey, the flood inundation area in 1990 spread out in the lower reaches from the national road, and almost all the existing paddy fields and fishponds were submerged. The flood inundation area is estimated at approximately 860 ha, and the maximum inundation depth and duration are about 0.6 m and 48 hours, respectively.

3.1.3 Silandak River

Silandak River has a catchment area of 8.5 km^2 with a total river length of about 11 km which originates in Mt. Pancang-pancing running toward the southern airport, and, before reaching the airport, branches out into a new floodway and a diversion channel connected to Siangker River (refer to Fig. 3.1).

As in Bringin River, no flooding records remain. According to the interview survey, however, it was clarified that the flood inundation spread out in the lower reaches from the railway bridge and, a part of the airport therein was also inundated. The maximum inundation depth and duration is estimated at about 1.2 m and 14 hours, respectively.

3.1.4 West Floodway/Garang River

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

Simongan Weir, located at about 5.3 km upstream from the river mouth, is the major river structure of West Floodway/Garang River and the downstream from the weir is called West Floodway (Banjir Kanal Barat). The discharge from Garang River flows through the floodway into Jawa Sea.

In January 1990, flood discharge overflow occurred along West Floodway/Garang River leading to the destruction of a considerable part of the river dike. The serious flood overflow occurred particularly along the downstream of Garang River between the confluence of Kripik River and Simongan Weir, and the following flood calamities were confirmed by the Ministry of Public Works:

(a)	Death	:	47
(b)	House Collapsed	:	25
(c)	House Damaged	:	126
(d)	School Building Collapsed	:	1
(e)	Dormitory Collapsed	:	1

The total inundation area for West Floodway and Garang River is about 145 ha with the maximum inundation depth of 2 to 3 m and the maximum inundation duration of 2 to 4.5 hours.

3.1.5 East Floodway

The East Floodway of about 12 km in length was constructed from 1896 to 1903 to lead the flood run-off discharge from the hilly/mountainous areas southeast of Semarang City directly into Jawa Sea. The catchment area of East Floodway covers 29.7 km^2 which is composed of the following three (3) watersheds: 5.8 km^2 of the Candi river basin, 6.8 km^2 of the Bajok river basin and 17.1 km^2 of the Kedungmundu river basin (refer to Fig. 3.1).

In the 1990 flood, the channel overflow occurred along the right bank of East Floodway, particularly at the national road bridge and around the confluence of Kedungmundu River (the major tributary of the floodway). Due to the channel overflow, the flood inundation spread over the densely populated area of Semarang City located north of East Floodway. The major flood damage consists of the houses flooded with the maximum depth of 0.6 m for a duration of 5 to 20 hours. The total area of flood inundation was about 250 ha.

3.1.6 Babon River

Babon River with a catchment area of about 77.0 km^2 and river length of about 30 km (including the length of Penggaron River) originates in Mt. Ungaran and flows northward to Jawa Sea. A major river control structure called Pucang Gading Weir is located on Babon River about 17.6 km upstream from the river mouth and, the upstream from the weir is called Penggaron River which has a river length of about 13 km (refer to Fig. 3.1). Pucang Gadding Weir is now being used as an intake facility for irrigation water and also as flood diversion facility from Penggaron River to East Floodway.

In the 1990 flood, the channel overflow occurred along the river section of about 5 km starting from the river mouth. Due to the channel overflow, the paddy area and a large number of houses were flooded with the maximum depth of 0.3 to 0.6 m and for a duration of 4 to 13 hours. The total flood area was estimated at about 190 ha.

3.2 Urban Drainage

3.2.1 Identification of Objective Drainage Area

Semarang City, consisting of nine (9) districts (kecamatan), is the capital of Central Jawa Province and covers an area of approx. 374 km^2. This area is topographically divided into the following two (2) land features:

(1) The northern coastal flood plain of approx. 123 km^2 lying between the coastline and the 25 m contourline; and

(2) The southern hilly land of approx. 251 km^2 lying above the 25 m contourline.

The northern coastal area of four (4) drainage areas, namely, Eastern Semarang, Central Semarang, Western Semarang, and Kec. Tugu, is identified as the area for the master plan for urban drainage (refer to Fig. 3.2).

3.2.2 Present Condition of Drainage Area

(1) Eastern Semarang Area

The eastern Semarang area of 47.8km^2 is bounded by the coastline to the north, East Floodway to the west and south, and Babon River to the east. The area is mainly divided into two (2) drainage zones; the Siringin river basin of 14.104 km^2 and the Tenggang river basin of 28.660 km^2. The remaining area of about 5.0km^2 is included in the Babon river basin. Most of the area has been developed as agricultural land; however, it is currently being developed as both industrial and residential areas.

Changes in land use have aggravated flooding conditions due to the increase of peak run-off. The present flooding conditions surveyed were the flood area of 9.76 km^2, flood depth of 0.3 m to 1.2 m, and flood duration of 8 to 21 hours.

This area has never had an urban drainage master plan; however, improvement of two (2) primary channels is proposed to be implemented as a mid-term plan in the SIUIDP (Semarang Integrated Urban Infrastructure Development Program) with financial assistance from IBRD.

(2) Central Semarang Area

The central Semarang area of 27.2 km^2 is situated between East and West Floodway, and covers the central area of Semarang City which is fully urbanized. The area is mainly divided into three (3) drainage areas, the Semarang river basin of 11.225 km^2 including the Asin river basin of 4.252 km^2, the Banger river basin of 6.466 km^2, and the Bulu river basin of 0.578 km^2. The remaining area of about 8.93 km^2 consists of several small independent drainage areas along the northern coastline and West Floodway.

After completion of the Semarang River Drainage Improvement Project undertaken from 1984 to 1990, an area of 5.98 km^2 is still flooded at a depth of 0.2 to 0.7 m and a duration of 1 to 8 hours. The flood conditions of the Banger river basin are more serious; flood area is 2.73 km^2, flood depth is 0.2 to 0.75 m, and duration is 1 to 48 hours.

(3) Western Semarang Area

The western Semarang area of 12.4km^2 situated between Siangker River and West Floodway covers the newly developed area (PRPP and Marina recreation center) and Achmad Yani airport. The area is divided into three drainage zones; the Karangayu-Ronggolawe river basin of 4.533 km^2, the Tawan river basin of 1.403 km^2 and the Silandak drainage basin of 1.426 km^2. The remaining area of about 5.0 km^2 includes Achmad Yani Airport and the fishpond along the seashore.

Improvement of five (5) bottlenecks at the crossings with the national railway and Jl. Siliwangi, which are the main causes of floods (flood area of 0.5 ha, flood depth of 0.2 m, and duration of almost 3 hours), are proposed in SIUIDP.

(4) Kecamatan Tugu Area

The Kecamatan Tugu area of 35.4 km^2 is situated between the west boundary of Semarang City and Silandak Floodway. The area is in the early stage of development. Built-up area is situated along Jl. Siliwangi and the national railway. The predominant land uses are paddy fields and fishponds which are expected to be developed in the future as industrial area. This area includes nine (9) primary drainage channels which drain directly into the Jawa Sea. No master plan has ever been formulated for these channels.

3.3 Water Supply and Use

3.3.1 Public Water Supply and Use

Public water supply for domestic, commercial, industrial and institutional water use in the study area is managed and operated by PDAM. The public water supply system can be divided broadly into three areas, Semarang City, Kabupaten Kendal and Kabupaten Semarang, in accordance with the organization of PDAM.

(1) Semarang City

Water Sources

The water sources are composed of the springs, deep wells at the foot of Mt. Ungaran and the surface water of Garang River (refer to Fig. 3.3). The existing water supply capacity of each source is as follows:

Springs	280 l/s
Garang River Surface Water	580 l/s
Deep Wells	700 l/s

Water Use

The total number of customers served by the water supply system under PDAM Semarang City is estimated at about 60,000 units in 1991. The population supplied water and the service ratio have increased to twice their amount in the last seven years, however, the service ratio of 40% is still considerably low. The remaining inhabitants are relying on dug or drilled private wells and public water taps supplied by water trucks.

On the other hand, the difference between the quantity of water supplied to the system and quantity of water metered in the system, which is called unaccounted for water, ranges from 45 to 55% in the last seven years.

(2) Kabupaten Kendal

Water Sources

In the study area of Kabupaten Kendal, there are two water supply areas established by PDAM Kab. Kendal, namely, Kec. Kendal and Kec. Kaliwungu. The water source for each water supply system is the groundwater from deep wells. The yield capacity of deep wells is 34 l/s for Kec. Kendal and 15 l/s for Kec. Kaliwungu.

Water Use

Under PDAM Kab. Kendal, the total number of customers is 2,935 units in Kec. Kendal and 600 units in Kec. Kaliwungu as of March 1992. Among these water consumptions, domestic consumption accounts for more than 90%, and the water is not supplied for industrial use.

(3) Kabupaten Semarang

Water Sources

In the study area of Kab. Semarang, there are two water supply systems by PDAM Kab. Semarang, namely, Kec. Ungaran and Kec. Klepu. Since Kec. Ungaran and Klepu are located in the hilly area, the main source of water supply is the spring water. The yield capacity is 64 l/s for Ungaran and 5 l/s for Klepu.

Water Use

In accordance with the PDAM Kab. Semarang, the number of customers is 3,028 units in Kec. Ungaran and 245 units in Kec. Klepu. However, detailed data on water consumption are not available.

3.3.2 Irrigation Water

The existing irrigation areas in the study area are concentrated in the Blorong and Babon river basins and presently classified into three categories, technical, semi-technical and simple irrigation areas. The total irrigation area of the three categories is 8,801 ha. The main water source for these irrigation areas is the river surface flow, but spring water is also utilized for supplementary purposes in the hilly area.

3.3.3 Other Water Uses

In the study area, there are eight brackish water aquaculture areas in the low-lying area along the seashore which are used mainly for shrimp and tiger prawn cultivation. A total of 1,525 ha is in operation for brackish water aquaculture.

This type of aquaculture is mainly relying on the rainfall and irrigation water tailing. Furthermore, according to the interview survey, most of these aquaculture also utilize the shallow wells.

3.4 Sedimentation

3.4.1 Present Sediment Condition in the Study Area

The following conditions of sediment have been clarified through the field reconnaissance and data collection.

(1) On the steep slope in the headwaters of the objective river basins, no new sediment yield due to large-scale collapse has been recognized.

(2) In the upper reaches of the respective rivers, deepening is a dominant function of streamflow; however, the riverbeds seem to be stable because of the armor with boulders.

(3) Sediment yield due to bank erosion with small collapse has been observed along the river bank in the middle and down stream, especially at the bending portion. The amount of sediment by bank erosion is, however, small.

(4) A great deal of sediment yield due to sheet erosion on upland cultivation areas has been observed and the sheet erosion seems to be a dominant source of sediment load. On the plantation land, there is only a little amount of sediment yield during heavy rains because of canopy interception and undergrowth cover by forests.

(5) Remarkable amounts of sediment deposit have been observed in the main courses of Silandak River and East Floodway at intersections and mild portions of the riverbed on the alluvial

plains due to erosion in the developed land in the Silandak river basin and the transport of sediment from the upper reaches of Babon River to East Floodway.

(6) River mouth clogging has occurred in Bringin River due to the formation of a coastal sand dune by littoral current.

3.4.2 Present Condition of Riverbed Materials

According to the results of the survey, the characteristics of riverbed materials related to sedimentation are summarized as follows:

(1) In the lower part of rivers, i.e., the alluvial plain portion with a gentle gradient, the riverbed is formed mainly of silt and clay that have been transported as wash load.

(2) In the middle part of rivers on the hilly areas, the riverbed consists mainly of silt and clay; the biggest size seems to be coarse sand.

(3) In the upper reaches of rivers, the riverbed is formed only of gravel and sand.

On the above-mentioned situation, wash load having the particle diameter of less than 0.1 mm, a dominant source of sediment, do not exist in the riverbeds of the upper reaches. This fact shows that once the wash load, which is produced mainly by sheet erosion, flows into the river streams, these small particles are directly drained out into the middle and lower reaches and settle there or are washed out into the coastal areas.

3.5 Environmental Conditions

3.5.1 Environmental Policy in Indonesia

Legislation

The Indonesian Government has established an Environmental Impact Assessment System. In 1982, the principles of Environmental Management, which is prescribed in Act No. 4, Basic Provisions for the Management of the Living Environment, was established.

Then, Environmental Impact Assessment prescribed in the regulation of "The Analysis of Environmental Impact" No. 29, 1986, was established.

Environmental Impact Assessment

According to Indonesian regulation of "The Analysis of Environmental Impact" No. 29, 1986, PIL and ANDAL are defined as follows:

PIL (Preliminary Environmental Information Report) is a brief assessment of the proposed activity, its environmental setting, the possible environmental impacts due to such activities and a plan of action to manage these environmental impacts.

ANDAL (Environmental Impact Analysis) is a detailed and in-depth study of the significant impacts of a proposed activity.

The contents of environmental documents are prescribed by the Decree of the Minister of Population and Environment, "Guideline for the Analysis of Environmental Impact of Proposed Projects" No. KEP 50, 1987."

Required PIL and ANDAL

According to the Decree by the Minister of Public Works No. 531, 1989, AMDAL Study has a screening stage. Basically, new projects are divided into four types of requirement as follows:

(1) The project requires PIL first. If ANDAL is required after finishing the PIL study, ANDAL study is carried out after preparing KA-ANDAL (Terms of Reference of ANDAL).

(2) The project requires only PIL study.

(3) The project requires KA-ANDAL and ANDAL study.

(4) The project does not need environmental study.

3.5.2 Environmental Condition in the Study Area

Natural Environment

The whole of Semarang City and suburbs which comprise the study area has a smaller flora and fauna compared with the other districts of Jawa Island.

Flora in the study area can be divided into two groups, (1) economic and agricultural plants, and (2) forest and other plants. The first group consists of a maximum of 20 species and the second group consists of 29 species.

The fauna consists of birds, mammals, reptiles and insects. There are at least 20 species of birds, and some species of mammals such as rats and monkeys exist.

In any case, there are no specific flora and fauna to be protected.

Social Environment

According to the population census conducted in 1990, population in Central Jawa Province and the study area were about 28.5 million and 1.7 million, respectively. The annual growth rate of population in Central Jawa Province was 1.17% for the period 1980 to 1990.

CHAPTER 4 HYDROLOGICAL ANALYSIS

4.1 Rainfall Analysis

Short and long duration rainfall intensity-duration curves have been developed for the urban drainage and flood control plans using the rainfall intensity at the Semarang Meteorological Station and the Kaligading Automatic Rainfall Gauging Station (refer to Table 4.1).

To express the relationship between rainfall intensity and duration, four equations were compared; namely, the Talbot type equation, the Sherman type equation, the Kuno type equation and the Horner type equation. Among them, the Horner type equation which shows the smallest difference between observed and estimated data was applied (refer to Fig. 4.1), and the model hyetograph of point rainfall was then developed from the Horner type rainfall intensity-duration curve (refer to Table 4.2).

4.2 Flood Run-off Analysis

4.2.1 Procedure of Run-off Analysis

The run-off analysis for the flood control plan was made, focusing on Garang River, by the following procedure:

(1) The run-off model for Garang River was established by the storage function model with actual rainfall and discharge data, and it was applied to the other five (5) rivers.

(2) Probable peak discharge at a reference point of Simongan Weir was estimated from the actual discharge data.

(3) Area reduction factor for the Garang river basin was calculated to convert point rainfall into average rainfall in the river basin. The area reduction factor for Garang River was estimated by the probable peak discharge at Simongan Weir and the model hyetograph. The area reduction factor for the other five (5) river basins was estimated based on their catchment areas (km^2) and the area reduction factor for Garang River.

(4) The probable peak discharge of the other rivers was calculated by the storage function model with the area reduction factor estimated for each river basin.

4.2.2 Probable Peak Discharge at Simongan Weir

The probable peak discharge at Simongan Weir was estimated by the Gumbel Method from the annual maximum discharge data for 1961 to 1990. The estimated amounts of probable peak discharge are as shown in Table 4.3.

4.2.3 Area Reduction Factor

The area reduction factors for the Garang river basin were calculated from the peak discharges at Simongan Weir by the trial and error method, and the results are shown below.

Probable Peak Discharge at Simongan Weir

Return Period (year)	Probable Peak Discharge (m3/s)	Reduction Factor
5	520	0.44
10	630	0.46
25	770	0.47
50	880	0.47
100	980	0.49

The area reduction factor for the other five rivers was estimated based on the above area reduction factors for Garang River (refer to Fig. 4.2). The area reduction factors for the objective rivers are shown in the following table.

	Garang River	Babon River	East Floodway	Silandak River	Bringin River	Blorong River
Area(km2)	204.0	77.0	29.7	8.5	32.1	157.0
Return Period			Reduction Factor			
5	0.44	0.66	0.78	0.84	0.77	0.50
10	0.46	0.70	0.82	0.89	0.81	0.54
25	0.47	0.70	0.82	0.89	0.81	0.53
50	0.47	0.70	0.83	0.89	0.82	0.53
100	0.49	0.73	0.86	0.93	0.85	0.55

4.2.4 Storage Function Model

The storage function model was applied to establish model hydrographs for the objective rivers. The objective river basins were divided into 23 sub-basins with catchment areas ranging from 1.3 to 70.9 km^2 and with 22 river channels to simulate by the storage function model, as illustrated in Fig. 4.3. The constants for the storage function model were decided as shown in Table 4.4 after some trial calculations. The results of the simulation show almost the same values as the observed data at Garang River Gauging Station as shown in Fig. 4.4.

4.2.5 Model Hydrograph and Peak Discharge

(1) Probable Peak Discharge at Reference Points

The model hydrographs for the other five rivers were established by applying the storage function model and the model hyetograph of point rainfall for the recurrence probabilities of 20- to 100-year return periods (refer to Fig. 4.5). The model hyetographs of point rainfall were converted to the one of areal rainfall multiplying the area reduction factors. The probable peak discharges at the reference points of the rivers are given in the table below.

Return Period (Year)	Probable Peak Discharge (m3/s)*					
	Garang River	Babon River	East Floodway	Silandak River	Bringin River	Blorong River
5	520	407	199(130)	68	195	431
10	630	494	240(157)	84	237	549
20	740	552	267(175)	94	264	628
25	770	578	280(183)	99	277	664
50	880	630	306(201)	110	315	739
100	980	710	342(225)	120	342	845

* Peak discharge at reference point
( ) Peak discharge of East Floodway in front of confluence with Bajak River

(2) Probable Peak Discharge at Proposed Dam Site

The probable peak discharges of 100-year return period at the proposed dam sites for the Master Plan were estimated in the same way as mentioned above. The results are as given in the table below.

Dam	Jatibarang	Mundingan	Kedung Suren	Babon
Area(km2)	53.00	45.70	146.50	51.90
A.R.F.	0.82	0.84	0.58	0.82
P.P.D. (m3/s)	569.00	500.00	864.00	545.00

A.R.F.: Area Reduction Factor at dam site
P.P.D.: Probable Peak Discharge

4.2.6 Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) for Jatibarang Dam

The probable maximum precipitation (PMP) and the corresponding probable maximum flood (PMF) for Jatibarang Dam, which has been selected as the priority project of the flood control master plan, were estimated to determine the design flood water level (DFWL) and the spillway design discharge for the dam.

(1) Probable Maximum Precipitation (PMP)

The PMP was estimated by the simple statistical Hershfield method using the series of annual maximum precipitation observed at Kaligading Rainfall Station. The entire duration of PMP was assumed at one day, in due consideration of past storm durations recorded at the gauging station.

The Hershfield method is recommended by the World Meteorological Organization (WMO) for areas where rainfall record is available but other climatic records are hardly obtained. The estimated area average PMP with time durations of 1, 6 and 24 hours are as shown in

Table 4.5, corresponding to 1.65 to 2.66 times the 100-year point probable rainfall, as follows:

(1) Rainfall Duration	(2) 100-year Rainfall	(3) PMP	(4) Multiplier [(2)/(3)]
1-hour	120 mm	198 mm	1.65
6-hour	197 mm	424 mm	2.15
24-hour	260 mm	691 mm	2.66

(2) Probable Maximum Flood (PMF)

The model hyetograph for PMP was developed based on the rainfall intensity-duration curve and hourly rainfall distribution pattern. The model hydrograph for the PMF was developed from the model hyetograph through the flood run-off calculation. The flood run-off calculation was made by the Storage Function Model.

The model hyetograph and hydrographs for PMF developed as above are shown in Table 4.6 and Fig. 4.6. The probable peak discharge of each return period at the dam site was calculated to provide the design flood discharge, as shown below:

Return Period (year)	2	100	200	5,000	10,000
Discharge (m3/s)	254	569	636	865	911

4.3 Inundation Analysis

4.3.1 Methodology of Analysis

Inundation analysis for the six (6) rivers has been carried out to estimate the flood damage area of flooding conditions of 5-year to 100-year return period. Results of the inundation analysis were used for the estimation of flood damage and the economic evaluation of the improvement plan for the six (6) rivers.

For the inundation analysis, a simulation model was established to simulate the probable inundation area both without- and with-the-project conditions based on the flood mark survey carried out by the JICA Study Team to confirm the inundation area of the flood on January 26, 1990. Since flooding in the inundation area shows both the storage type and the flow/diffusion type, the Two-Dimensional Unsteady Flow Model was employed.

4.3.2 Establishment of Inundation Model

The flood inundation model for each river was established with the following conditions:

(1) The whole inundation area is divided into mesh blocks of 200 m by 200 m, as shown in Figs. 4.7 to 4.12.

(2) The average ground height of each mesh is obtained using the topographic map with a scale of 1/10,000 prepared in this Study.

(3) Structures such as roads and railways which may hamper the smooth flow of inundation water are

taken into consideration assuming them as barriers between mesh blocks.

4.3.3 Simulation by Inundation Model

The maximum inundation depth and inundation area were examined under the probable flood discharge of 5-year, 10-year, 25-year, 50-year, 100-year return period with the initial conditions of the overflow sections marked with arrows in Figs. 4.7 to 4.12, assuming that the surplus discharge exceeding the flow capacity would overflow at the overflow section.

4.3.4 Results of Simulation

Probable inundation areas and water depths corresponding to the probable floods of the six (6) rivers are shown in Figs. 4.7 to 4.12, and the inundation areas occasioned on each return period are shown in the following table. The inundation duration is less than 24 hours in all cases.

Return Period (Year)	Inundation Area (km2)					
	West Floodway	Babon River	East Floodway	Silandak River	Bringin River	Blorong River
	Inundation Area Without Project					
5	-	10.0(1.1)	-	2.3(0.1)	8.6(1.6)	27.2(2.2)
10	1.6(0.0)	12.2(5.8)	3.4(0.2)	2.3(0.1)	8.8(2.0)	29.3(6.0)
25	3.4(0.4)	12.8(6.8)	4.5(0.3)	2.6(0.2)	8.8(3.0)	30.9(8.7)
50	5.0(0.6)	13.9(7.3)	5.0(0.5)	2.6(0.3)	8.9(3.7)	31.4(10.0)
100	7.0(2.1)	15.8(8.0)	18.2(0.8)	2.6(0.6)	9.0(4.5)	32.5(12.6)
	Inundation Area With Project					
25	-	-	-	-	-	30.9(8.7)
50	0.6(0.0)	13.9(7.3)	5.0(0.5)	2.6(0.3)	8.9(3.7)	31.4(10.0)
100	1.3(0.4)	15.8(8.0)	18.2(0.8)	2.6(0.6)	9.0(4.5)	32.5(12.6)

( ) Inundation area of depth more than 50 cm

4.4 Low Flow Analysis

Analyses have been carried out for three rivers, Blorong River, Garang River and Babon River, where dams are proposed for water resources development, as discussed in the following subsections.

4.4.1 Daily Rainfall Analysis

(1) Selection of Rainfall Station

There are 52 rainfall stations in and around the study area as mentioned in CHAPTER 2. These stations have different observation periods and reliability of records. Taking the length of observation period, amount of missing data and areal distribution into account, 12 rainfall stations are selected. The location of the selected stations is shown in Fig. 4.13.

(2) Calculation of Basin Rainfall

All stations selected have plenty of missing data. To interpolate the missing data from among the records, the following procedure was adopted to estimate basin rainfall or average depth over a catchment:

(a) Daily basin rainfall was calculated by the Polygon Method (refer to Fig. 4.13) using the records of 12 rainfall stations in 1980 where whole data are complete;

(b) Representative station was selected for river basins showing the highest correlation between daily point and basin rainfall in 1980;

(c) Missing data of representative station records were interpolated by the linear regression method from simultaneous records at nearby stations; and

(d) Basin rainfall for 33 years is calculated on a daily basis by the linear regression method using the filled-in records of the representative station.

Fig. 4.14 shows the relationship of daily rainfall and regression coefficient between point rainfall at the representative station and basin rainfall based on the records in 1980. Table 4.7 presents calculation results of basin monthly rainfall in the Babon, Garang and Blorong river basins.

4.4.2 Low Flow Analysis

(1) River Flow Condition

Flow regime and balance in the observed records at the three water level stations on Babon River, Garang River and Blorong River are given in Table 4.8, and the flow-duration curves are presented in Fig. 4.15.

(2) Low Flow Model

The Tank Model, which is one of the notable models, is defined as a single basin model encompassing basins covered by existing water level stations. In this case, rainfall data input into this model was the daily basin rainfall as calculated in the rainfall analysis mentioned in Section 4.1. The daily loss was determined from the monthly variation pattern of pan evaporation which was observed at 1,740 mm/year at Semarang Meteorological Station, and all values were scaled down to 60%.

(3) Model Calibration

The parameters of the Tank Model as shown in Fig. 4.16 were determined by the trial and error method until the calculated daily hydrograph shows well fitness to the observed one. The observed and calculated hydrographs were compared as shown in Fig. 4.17.

(4) Synthesis of Streamflow Data

Daily discharge at the three stations for 30 years were estimated by the Tank Model simulation. The calculated flow regime are given in Table 4.9, and the typical flow-duration curves by the respective rivers are presented in Fig. 4.18.

4.5 Tidal Analysis

4.5.1 Observed Tidal Data

Tidal level in the study area has been continuously observed by an automatic water level gauge at Semarang Harbor which is located between the river mouths of West Floodway and East Floodway, and the observation period extends more than ten (10) years.

4.5.2 Annual Mean Tidal Level

Based on the tidal data observed, the annual mean tidal level at Semarang Harbor was estimated in terms of the elevation above MSL of Jakarta Harbor as below (refer to Table 4.10).

(Unit: EL. m)

Item	Before 1985	1989	1990	1991
MHWL	0.54	0.59	0.58	0.60
MSL	0.09	0.05	0.07	0.09
MLWL	-0.33	-0.44	-0.39	-0.37

Recently, tidal inundation has occurred frequently at the low-lying coastal areas leading to serious flood damage, particularly, in Semarang City. The related government agencies had tried to trace the causes of inundation, presuming that one of the possible causes was the recent upward tendency of the tidal level.

As shown above, however, the annual mean tidal levels of the recent three (3) years have the difference of less than 10 cm as compared with those observed before 1985. This proves that no definite long-term transition or upward tendency of the tidal level has occurred.

The MHWL of EL. 0.60 m was used to determine the design high water level for the flood control plan. Therefore, the long-term transition of tidal level was not required to be incorporated into the determination of the design high water level.

CHAPTER 5 MASTER PLAN

5.1 Flood Control Plan

5.1.1 Planning Criteria

Target Completion Year

The target completion year of the Master Plan is the year 2015.

Design Scale, Standard Flood Discharge and Objective River Stretch

The following are the design scales, standard flood discharges and objective river stretches for the Master Plan.

Name of River	Catchment Area (km2)	Design Scale (Year Return Period)	Standard Flood Discharge (m3/s)*	River Improvement Length (km)
Blorong River	157.0	20	630	15.00
Bringin River	32.1	50	320	5.04
Silandak River	8.5	100	120	5.31
West Floodway/ Garang River	204.0	100	980	9.54
East Floodway	29.7	100	350	12.00
Babon River	77.0	50	630	17.40
Total	508.3			64.29

* Refer to Section 4.2

Planning Criteria for River Improvement

(1) High Water Level

The main criterion is to set the design high water level 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 difficult to set the design high water level lower than the hinterland ground level due to the backwater effect of the tidal level.

(2) Riverbed Profile

The design riverbed profile principally follows the existing riverbed profile to avoid channel erosion or sedimentation and to minimize the relocation and modification of existing river structures.

(3) River Channel Cross Section

A compound cross section with high and low water channels is mostly adopted to minimize embankment height and to assure channel stability. In the compound cross section, the low water channel is to have a design channel flow capacity of 1.01-year return period to assure channel stability. However, the low water channel of West Floodway/Garang River and East Floodway is to have a design channel flow capacity of more than 1.01-year return period due to the difficulty of land acquisition. As an exception to the compound cross section, a single cross section is adopted to the low-lying downstream stretch where the backwater effect of tidal level is predominant. The single cross section is also adopted to the entire river stretch of Silandak Floodway which is subject to a rather small design discharge of 130 m^3/s. The side slope of cross sections is designed at 1:2 in general.

(4) Dike

Earth dike with a side slope of 1:2 is employed for the standard design of all objective rivers, except parts of West Floodway/Garang River and East Floodway where the concrete retaining wall is partly adopted instead of earth dike due to the difficulty of land acquisition. In addition, the following standards are adopted for the freeboard of the dike.

Design Discharge	Freeboard Height
Less than 200 m^3/s	0.6 m
From 200 m^3/s to less than 500 m^3/s	0.8 m
From 500 m^3/s to less than 1,000 m^3/s	1.0 m

The crown width of the dike is set at 4.0 m to serve as inspection road and to prevent seepage at the dike.

Planning Criteria for Flood Control Dam

The following items are adopted as the principal criteria for planning flood control dams.

(1) Flood Regulation Method

The flood discharge will be regulated naturally by a non-gated spillway in due consideration of easy operation and maintenance.

(2) Flood Control Capacity

Since both the flood control capacity and cost of the dam reservoir are increased, the design discharge and cost for river improvement works on the downstream stretch could be reduced. The flood control capacity has been determined in due consideration of the minimum cost among the sums of river improvement costs and dam construction costs.

5.1.2 Alternative Plan

Possible Flood Control Measures

Based on the detailed reconnaissance on the topographic conditions of the study area, the possible flood control measures are proposed including the channel improvement works of the six (6) river stretches of about 64.3 km in total, four (4) flood control dams and two (2) floodways as shown Fig. 5.1.

Alternative Flood Control Plans

The following alternative flood control plans are selected for each objective river stretch in due consideration of the combinations of the aforesaid possible flood control measures:

(1) Blorong River

Alt. A-1: River improvement without any other flood control measure.

Alt. A-2: River improvement with supporting of the flood control by Kedung Suren Dam.

(2) Bringin River

Alt. B-1: River improvement without any other flood control measure.

Alt. B-2: River Improvement with supporting of the flood diversion by a floodway.

(3) Silandak River

Alt. C-1: Improvement of the existing floodway and its upstream existing river channel without any other supporting flood control measure.

Alt. C-2: Improvement of the existing floodway and its upstream existing river channel associated with the river improvement of Siangker River.

(4) West Floodway/Garang River

Alt. D-1: River improvement without any other flood control measure.

Alt. D-2: River improvement with supporting of the flood control by Jatibarang Dam.

Alt. D-3: River improvement with supporting of the flood control by Mundingan Dam.

(5) East Floodway

Alt. E-1: Improvement of the existing Floodway with closure of diversion channel from Babon/Penggaron River as proposed in the plan of "Jratunseluna Project".

(6) Babon River

Alt. F-1: River Improvement on the premises of flood diversion into the Dombo/Sayung River.

Alt. F-2: River Improvement on the premises of flood diversion into Dombo/ Sayung River and the flood control by Babon Dam.

5.1.3 Optimum Plan

The comparative study on the alternative plans mentioned above was made on the basis of project cost, annual operation and maintenance cost and quantity of necessary compensation works. As a result, the optimum plan for each objective river was selected in due consideration of the project cost and number of house evacuation, as shown below and summarized in Table 5.1.

Selection of Optimum Plan

River	Alternative Plan	Project Cost (Mill.Rp.)	House Evacuation (unit)	Optimum Plan
Blorong River	A-1	100,044	452	
	A-2	94,047	32	*
Bringin River	B-1	25,988	57	*
	B-2	41,743	71	
Silandak River	C-1	11,329	0	*
	C-2	-	-	
West Floodway/ Garang River	D-1	128,689	635	
	D-2	85,053	0	*
	D-3	88,390	20	
East Floodway	E-1	30,642	40	*
Babon River	F-1	98,876	414	*
	F-2	145,918	197	

The distribution of the proposed design flood discharge for the optimum plan is as shown in Fig. 5.2. Correspondingly, the typical cross sections and longitudinal profiles for the optimum plan are proposed as shown in Figs. 5.3 and 5.4, respectively.

5.1.4 Implementation Schedule

The implementation schedule of the flood control master plan (refer to Fig. 5.5) is prepared by placing higher priority on projects that can satisfy the following conditions:

(1) Urgency in implementation to mitigate the flood damage;

(2) Higher economic efficiency and less negative social impact to be expected with the implementation; and

(3) Contribution to the existing or other ongoing projects of the Indonesian Government.

5.1.5 Cost Estimate

Project cost, composed of construction base cost, compensation cost, administration cost, engineering service cost and physical contingency, but excluding price escalation and value added tax, is estimated on the basis of design, work plan and the following basic concepts:

(1) Price Level is as of July 1992.

(2) Currency Conversion Rates are assumed at US$1.00 = Rp. 2,033 and ¥1.00 = Rp. 16.20.

(3) Compensation Cost consists of house evacuation and land acquisition costs.

(4) Administration Cost is assumed at 7% of the construction base cost which consists of basic labour wages, materials cost and equipment cost.

(5) Physical Contingency is estimated at 10% of construction base cost, compensation cost and engineering cost.

Project costs of the optimum flood control plans are as tabulated in the following table, and the annual disbursement schedule is as presented in Table 5.2.

Project Cost

(Unit: Mill. Rp.)

Name of River		Cost*
1. Blorong River		94,047
- River Improvement	7,742	
- Kedung Suren Dam	86,305 **	
2. Bringin River		25,988
- River Improvement	25,988	
3. Silandak River		11,329
- River Improvement	11,329	
4. West Floodway/Garang River		85,053
- River Improvement	47,634	
- Floodway Improvement	14,006	
- Jatibarang Dam	23,413 **	
5. East Floodway		30,642
- Floodway Improvement	30,642	
6. Babon River		98,876
- River Improvement	52,854	
- Babon Floodway	46,022	
Total		345,935

* Price contingency and Value Added Tax are excluded.
** Cost allocated for Flood Control Project.

5.1.6 Project Evaluation

<u>Economic Evaluation</u>

(1) Basic Conditions

The Flood Control Master Plan is formulated to protect the flood prone areas from a 20, 50 or 100-year return period flood at the maximum, and its economic viability is assessed on the basis of annual average benefit and economic project cost. Basic conditions for economic evaluation are summarized as follows:

(a) Annual average benefit or potential flood damage is calculated by the mesh unit (200m x 200m) in accordance with the flood inundation analysis, which is carried out in the project areas presented in Figs. 4.7 to 4.12;

(b) Final completion year is assumed at the year 2015, and project life is assumed at 50 years, considering the durable life of facilities to be installed and other similar projects in Indonesia;

(c) Project benefit is estimated on the projected development stage in 2015 in accordance with the final completion year; and

(d) A discount rate of 10% is applied for the calculation of benefit-cost ratio (B/C).

(2) Annual Average Benefit

Flood control benefit is defined as the reduction of potential flood damage attributed to the design works. The reduction is obtained as the difference between the estimated flood damage under the with- and without-the-project situations.

The annual average benefit of the project was estimated as follows:

Project	Annual Average Benefit (mil.Rp.)
Blorong River	14,312
Bringin River	1,768
Silandak River	1,628
West Floodway/ Garang River	27,264
East Floodway	5,239
Babon River	17,453

(3) Economic Project Cost

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

Transfer items such as taxes and duties imposed on construction materials and equipment, including government subsidy and contractor's profit, are excluded from the elements of the financial cost. It is assumed that about 20% of the financial construction cost is involved as transfer items.

The estimated administration and engineering service costs are applied as the economic cost. Economic price of land to be acquired for the project implementation is considered to correspond to the productivity foregone by the project, which is reflected by the estimated compensation cost. Price contingency is not considered in the economic cost while physical contingency is included.

The economic project cost was thus estimated as follows:

Project	Economic Project Cost (mil.Rp.)
Blorong River	86,143
Bringin River	23,791
Silandak River	10,372
West Floodway/ Garang River	78,384
East Floodway	28,107
Babon River	87,152

(4) Cost-Benefit Analysis

The flood control projects are evaluated in terms of Economic Internal Rate of Return (EIRR) and Benefit-Cost Ratio (B/C), as shown in Table 5.3 and summarized in the following table.

Project	EIRR (%)	B/C	NPV (mil.Rp.)
Blorong River	10.5	1.07	2,351
Bringin River	6.1	0.64	-1,337
Silandak River	12.8	1.28	485
West Floodway/ Garang River	16.8	2.02	54,950
East Floodway	14.9	1.54	2,501
Babon River	13.8	1.51	18,547

The Master Plan shows 14.1% of EIRR as the total flood control plan (refer to Table 5.4). The Master Plan is, therefore, evaluated to have an adequate economic viability.

Furthermore, consideration should be given to intangible benefits brought about by the project such as saving of invaluable human lives that may possibly be lost by flooding, protection from possible injuries, and prevention of disease occurrence.

Social and Environmental Impact

The implementation of the Flood Control Plan will not bring any significant impact on the natural environment. However, regarding social impact, land acquisition and house evacuation by river improvement works are necessary as mentioned below.

River	Land Acquisition (ha)	House Evacuation (unit)
Blorong	0	0
Bringin	33.2	57
Silandak	10.0	0
West Floodway/Garang River	0	0
East Floodway	1.1	40
Babon	66.0	289
Total	110.3	386

Note: Land acquisition and house evacuation by dam construction are mentioned in Section 5.3, Water Resources Development Plan.

Except Babon River, land acquisition and house evacuation are not so big.

On the other hand, the implementation of the Plan should reduce flood inundation damage and bring relief to life and assets in the inundation area which would enhance the economic activities in the study area.

5.1.7 Selection of Priority Project

The priority project is selected from among the optimum flood control plans for the six (6) objective rivers in due consideration of economic viability, previous flood damage conditions, and other related development plans.

Economic viability could be evaluated on the basis of the economic internal rate of return (EIRR), and the highest value of EIRR is given to the plan for West Floodway/Garang River.

West Floodway/Garang River is located in the densely populated urban area possessing the highest annual average flood damage among the objective rivers in the year of 2015, as estimated below. In the January 1990 Flood, 47 deaths were recorded as the flood calamity of West Floodway/Garang River.

(1)	Blorong River	:	Rp. 10,314 million
(2)	Bringin River	:	Rp. 1,816 million
(3)	Silandak River	:	Rp. 1,628 million
(4)	West Floodway/ Garang River	:	Rp. 27,264 million
(5)	East Floodway	:	Rp. 5,239 million
(6)	Babon River	:	Rp. 17,753 million

The optimum plan for West Floodway/Garang River requires the flood control capacity of Jatibarang Dam as its project component to upgrade the design scale of 100-year return period. The water supply capacity of Jatibarang Dam is also required as the priority project for the water resources development to meet the incremental water demand of the Study Area (refer to Section 5.3). Therefore, a more detailed study on the flood control effect of Jatibarang Dam is deemed to be urgently necessary.

Based on the evaluation of the circumstances mentioned above, the optimum flood control plan for West Floodway/Garang River has been recommended as the priority project and was the objective of the feasibility study. The required works for the optimum plan is composed of river improvement and the allocation of flood control capacity to Jatibarang Dam.

5.2 Urban Drainage Plan

5.2.1 Objective Primary Drainage Channels

The drainage channels studied for river improvement under the urban drainage plan are the primary channels that are directly connected to Jawa Sea or major rivers flowing into Jawa Sea such as East Floodway and West Floodway. The objective primary channels in the objective drainage areas defined in Section 3.2 are given in the following table. Details and location of the objective primary channels are shown in Fig. 5.6.

Name of Drainage Area	Objective Primary Channel		
	Number	Total Catchment Area (km^2)	Total Channel Length (km)
Eastern Semarang	2	42.764	18.42
Central Semarang	4	18.269	16.61
Western Semarang	4	7.362	7.98
Kec. Tugu	9	35.376	30.10
Total	19	103.771	73.11

5.2.2 Planning Criteria

Target Year

The target completion year of the Urban Drainage Master Plan is set at 2015 on the premise that the project implementation period is 20 years.

Scope of Measures

The proposed measures will consist of structural and non-structural measures to limit the project cost and to facilitate smooth implementation of the project.

Structural measures proposed for the present and future built-up areas are:

(1) Improvement of primary channel sections having poor flow capacity for the future requirement including improvement of bottlenecks such as bridges, box culverts and pipe culverts;

(2) Construction of tidal protection facilities such as raising of the existing embankment or revetment, and construction of tidal gate; and

(3) Construction of pumping station with retarding basin for low-lying areas to economize on pump drainage cost by reducing the pump requirements.

Main non-structural measures proposed for future development areas are:

(1) Proper land use arrangement or regulation for the area requirement of the proposed structural measures mentioned above; and

(2) Recommendation of lowest ground elevation by filling up in the future land development for low-lying areas (fishpond or paddy field) along the seashore.

Design Scale

Design scale for the Urban Drainage Master Plan is proposed to meet the guideline on the level of services for urban drainage system proposed in IUIDP (Integrated Urban Infrastructure Development Program). The proposed design scale is as follows:

Catchment Area (km^2)	Design Flood Return Period (year)
Less than 0.1	1
0.1 to 1.0	2
1.0 to 5.0	5
More than 5.0	10

Design Flood Level

The high tide level (MHWL) of +0.6 m above MSL at Semarang Harbor is used as the starting water level for the calculation of the design high water level of the objective drainage channels.

Run-off Formula

The Modified Rational Formula is applied for the calculation of design discharges for the channel improvement. The proposed run-off coefficients (c) by land use are shown in the table below.

Land Use	Run-off Coefficient (c)
Business and Surrounding Area	0.8
Residential Area; High Density	0.7
Medium density	0.6
Low Density	0.5
Industrial and Harbor Area	0.8
Green Zone and Others	0.3

Demarcation Criteria of Gravity/Pump Drainage System

Some downstream areas of Semarang River and Banger River are to adopt the pump drainage system taking the low elevation of the area into account as shown in Fig. 5.7.

Freeboard and Roughness Coefficient

Freeboard and Manning's roughness coefficient for channel improvement are applied as follows:

Channel Type	Freeboard (m)	Manning's Roughness Coefficient
Unlined Channel (embankment)	0.60	0.031
Lined Channel (both banks)	0.40	0.024
Lined Channel (bed and both banks)	0.40	0.015

5.2.3 Alternative Plans

Alternative plans for objective primary channels are established for Tenggang River in East Semarang Area, Semarang River, Banger River and Bulu River in Central Semarang Area in consideration of the present channel condition, land use, related projects, and so on. Other primary channels do not have any alternative plans except channel improvement works.

(1) Tenggang River

Two (2) cases of diversion alternatives by new channel construction are prepared as shown in Fig. 5.8(2/7).

Alternative 1A: Large scale channel improvement of Tenggang River under the present drainage system.

Alternative 1B: Channel improvement of Tenggang River and construction of a new diversion channel of 2.25 km for the industrial area of 6.4 km^2 between Jl. Raden Patah and the national railway.

Alternative 1C: Partial channel improvement of Tenggang River and construction of a new diversion channel of 4.15 km for the eastern area of about 18.2 km^2.

(2) Semarang River

The following tidal protection and pump drainage alternatives are prepared as shown in Fig. 5.8(3/7).

Alternative 2A: Proposal in the previous Master Plan and SIUIDP

Alternative 2B: Raising the embankment of Semarang River between the North Ring Road and the national railway for tidal protection, and construction of two (2) small pumping stations with a gate and retarding basin at the mouth of Asin River and the low-lying area of Bandar Harjo West Area, where the right bank of Semarang River crosses the Ring Road.

(3) Banger River

Two (2) channel improvement alternatives are prepared as shown in Fig. 5.8(4/7).

Alternative 3A: Construction of two (2) connection channels (box culvert) with a total length of 0.9 km along Jl. Kartini and Jl. Bugangan.

Alternative 3B: Karangturi River improvement of 2.58 km by widening and deepening of channels.

(4) Bulu River

The following alternatives are prepared as shown in Fig. 5.8(5/7).

Alternative 4A: Bulu River improvement in original drainage system

Alternative 4B: Bulu River improvement and construction of new covered connection channel of 200 m along Jl. Indraprasta.

5.2.4 Optimum Plans

The results of the comparative study on alternative plans for the primary channels are given below.

Channel	Alternative Plan	Project Cost (Mill.Rp.)	House Evacuation (unit)	Optimum Plan
Tenggang	1A	19,404	248	
	1B	20,806	214	
	1C	20,523	144	*
Semarang	2A	23,713	-	
	2B	16,863	150	*
Banger	3A	4,607	130	*
	3B	6,228	215	
Bulu	4A	1,004	36	
	4B	685	30	*

Channel improvement plans including those for other channels without alternative plans have been prepared, as follows:

Proposed Channel Improvement Plan

(1) Design Discharge

Each objective drainage area has been divided into several sub-drainage areas based on the existing topographic conditions, roads and channel networks as shown in Fig. 5.8. The design discharges for channel improvement were estimated by the Modified Rational Formula according to the short duration design rainfall of a 5-year or 10-year return period and the projected land use in 2015. The proposed design discharges for each channel improvement are shown in Fig. 5.9.

(2) Proposed Channel Improvement

The objective primary channels require channel improvement by widening and dredging in order to increase their conveyance capacity. The proposed longitudinal profile and cross sections of primary channels are shown in Fig. 5.10.

Proposed Pump Drainage Plan

(1) Pump Drainage Area

As mentioned in Subsection 5.2.2, Demarcation Criteria of Gravity/Pump Drainage System, the low-lying areas of the Semarang river basin between the North Ring Road and the national railway are defined to adopt the pump drainage system. The low-lying areas are divided into the following three (3) pump drainage areas (refer to Fig. 5.8):

Name of Pump Drainage Area	Area (km2)
Bandar Harjo West (BW)	0.580
Asin River Basin (AS)	4.252
Bandar Harjo East (BE)	1.490
Total	6.322

(2) Requirement of Pumping Station and Retarding Basin

The capacities of drainage pumps and retarding basins are calculated as below in accordance with the design criteria.

Item	Pump Drainage Area		
	BW	AS	BE
Drainage Area (km^2)	0.580	4.252	1.490
Specific Pump Capacity ($m^3/s/km^2$)	1.340	1.340	1.340
Specific Storage Requirement ($\times 10^3$ m^3/km^2)	69.2	69.2	69.2
Required Pump Capacity (m^3/s)	0.8	5.7	2.0
Required Total Storage Volume ($\times 10^3$ m^3)	40.1	294.2	103.1
- Storage Volume by Channels ($\times 10^3$ m^3)	6.0	44.1	15.5
- Storage Volume by Temporary Inundation in the area ($\times 10^3$ m^3)	17.4	170.1	59.6
- Storage Volume by Retarding Basin ($\times 10^3$ m^3)	16.7	80.0	28.0

Note: 1. Storage volume by channel is assumed to be almost 15% of required total storage volume.

2. Almost 15% of pump drainage area allows temporary inundation at depths lower than 0.20 m, under non-flood damage.

Proposed Non-structural Measures

Eastern Semarang and Kec. Tugu areas are being rapidly urbanized or expected to be fully urbanized by the target year 2015. To cope with the change of land use in these areas, non-structural measures as well as structural measures are to be adopted. The following non-structural measures are recommended.

(1) Preservation of Low-lying Area

For land development, low-lying areas with storage potential are recommended to be preserved by the local government as much as possible under the guidance of appropriate land use regulations.

(2) Preservation of Future Land Requirement of Channel Improvement

The objective primary channels in Eastern Semarang and Kec. Tugu areas will require a large scale channel improvement by widening and dredging. Therefore, it is recommended that land acquisition shall be pursued before the areas are fully developed. The total area to be preserved in both areas is estimated at $1,774.5 \times 10^3$ m^2.

(3) Required Ground Elevation of Future Development

For land development, most low-lying areas along the seashore in Eastern Semarang and Kec. Tugu areas are expected to be developed by filling up to at least 1.1 m above MSL. Moreover, extra-filling for not only settlement due to consolidation but also land subsidence due to ground water development shall be considered.

5.2.5 Implementation Schedule

The implementation schedule for urban drainage was prepared under the same concept as in Section 5.1, Flood Control Plan, and presented in Fig. 5.11.

5.2.6 Cost Estimate

Project cost was estimated under the same conditions as in Section 5.1, Flood Control Plan, and summarized as below.

Summary of Project Cost
for Urban Drainage Plan

(Unit: Mill. Rp.)

Drainage Channel		Cost
1. Eastern Semarang		58,600
- Siringin River	18,571	
- Tenggang River	40,029	
2. Central Semarang		85,600
- Semarang River	60,671	
- Banger River	21,449	
- Bulu River	3,480	
3. Western Semarang		21,212
- Ronggolawe River	8,771	
- Karangayu River	8,449	
- Tawang River	2,116	
- Silandak Channel	1,876	
Total		165,412

Note: Price Contingency and Value Added Tax are excluded.

The annual disbursement schedule is given in Table 5.5.

5.2.7 Project Evaluation

Economic Evaluation

(1) Basic Conditions

The basic conditions for the economic evaluation of urban drainage are the same as in Section 5.1, Flood Control Plan.

(2) Annual Average Benefit

The same conditions and methodology for the calculation of economic benefit in Section 5.1, Flood Control Plan, were adopted.

The annual average benefit was calculated as the probable reduction of damage rate by the drainage plan under the corresponding design scales, as given in the following table:

	Project	Design Scale (Year Return Period)	Annual Average Benefit (mil.Rp.)
(a)	Western Semarang	5	2,255
(b)	Central Semarang	5	2,392
		10	14,248
(c)	Eastern Semarang	10	17,847

(3) Economic Project Cost

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

Project	Economic Project Cost (mil.Rp.)
Western Semarang	19,433
Central Semarang	89,795
Eastern Semarang	173,814

(4) Cost-Benefit Analysis

The urban drainage projects were evaluated in terms of Economic Internal Rate of Return (EIRR) and Benefit-Cost Ratio (B/C) as shown in Table 5.6 and summarized below.

Drainage Area	EIRR (%)	B/C	NPV (mil.Rp.)
Western Semarang	10.8	1.08	223
Central Semarang	15.1	1.57	10,179
Eastern Semarang	9.5	0.95	-4,797

The Urban Drainage Master Plan shows 10.4% of EIRR as the total Urban Drainage Plan (refer to Table 5.7). If consideration is given to the exclusion of indirect and intangible benefit in this calculation, this EIRR of over 10% is relatively high, compared to other similar projects.

Social and Environmental Impact

The implementation of the Urban Drainage Master Plan will not bring about any significant impact on the natural environment. However, regarding social impact, land acquisition and house evacuation are necessary as given in the following table.