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

THE STUDY ON
BELAWAN-PADANG
INTEGRATED RIVER BASIN DEVELOPMENT

MAIN REPORT

(SUMMARY)

MARCH 1992

JAPAN INTERNATIONAL COOPERATION
AGENCY

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

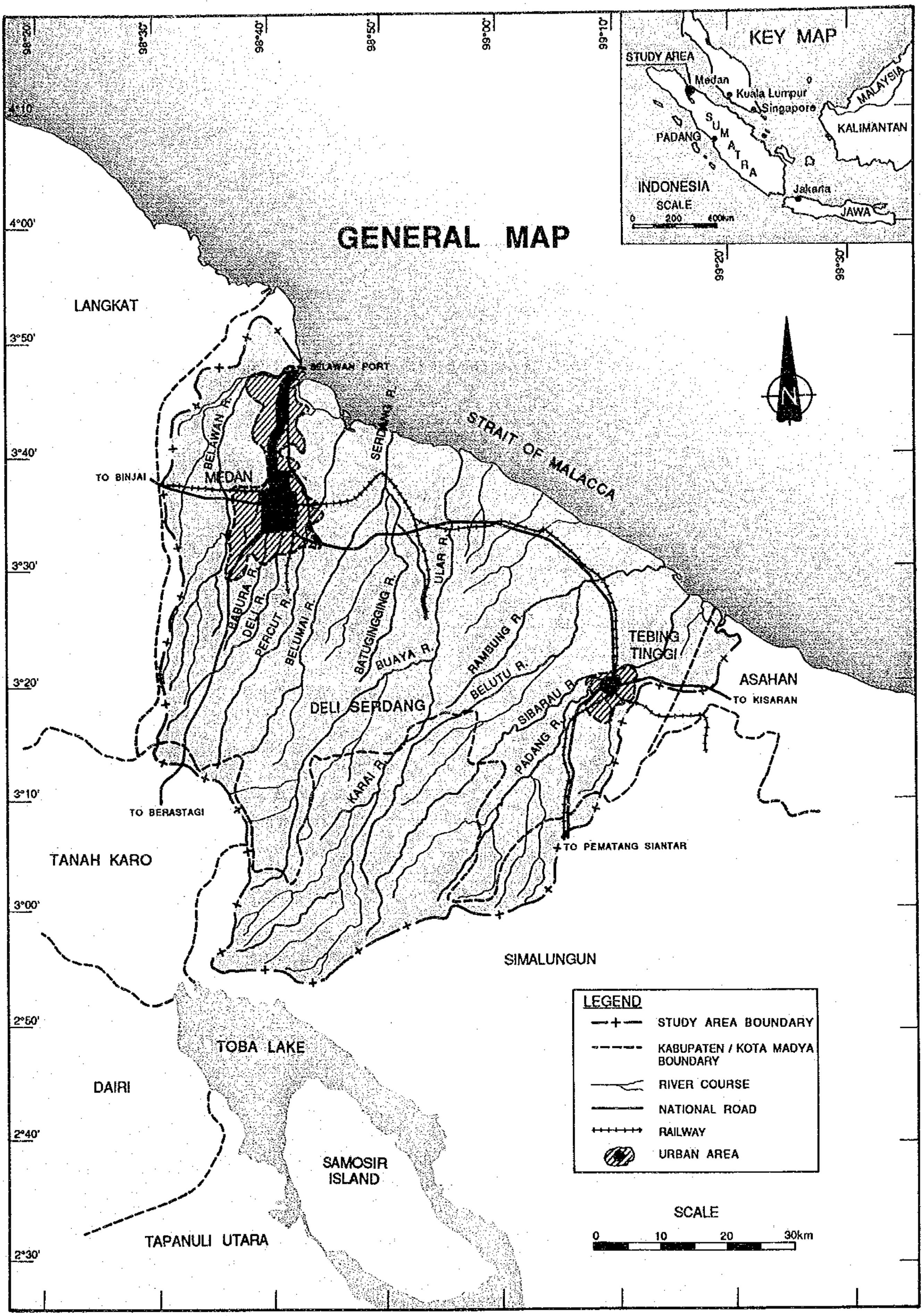
THE STUDY ON
BELAWAN - PADANG
INTEGRATED RIVER BASIN DEVELOPMENT

FINAL REPORT

(SUMMARY)

MARCH 1992

JAPAN INTERNATIONAL COOPERATION
AGENCY



GENERAL MAP
KEY MAP
STUDY AREA
Medan
Kuala Lumpur
Singapore
MALAYSIA
KALIMANTAN
PADANG
SUMATRA
INDONESIA
Jakarta
JAWA
SCALE
0 200 400km
98°20'
98°30'
98°40'
98°50'
99°00'
99°10'
99°20'
99°30'
4°10'
4°00'
3°50'
3°40'
3°30'
3°20'
3°10'
3°00'
2°50'
2°40'
2°30'
LANGKAT
BELAWAN PORT
STRAIT OF MALACCA
TO BINJAI
MEDAN
BELAWAN R.
SERDANG R.
BABURA R.
DELI R.
PERCUT R.
BELUMAI R.
BATUGINGGING R.
ULAR R.
BUAYA R.
RAMBUNG R.
BELUTU R.
TEBING TINGGI
ASAHAN
TO KISARAN
DELI SERDANG
SIBARAU R.
PADANG R.
KARAI R.
TO BERASTAGI
TO PEMATANG SIANTAR
TANAH KARO
SIMALUNGUN
TOBA LAKE
DAIRI
SAMOSIR ISLAND
TAPANULI UTARA
LEGEND
STUDY AREA BOUNDARY
KABUPATEN / KOTA MADYA BOUNDARY
RIVER COURSE
NATIONAL ROAD
RAILWAY
URBAN AREA
SCALE
0 10 20 30km

CONCLUSION

1. Study Objectives

The objectives of the Study as stipulated in the Implementation Arrangement for Technical Cooperation between the Japan International Cooperation Agency (JICA) and the Ministry of Public Works, Indonesia are:

(a) To formulate a Master Plan of integrated river basin development for the integrated river basins from Belawan to Padang, focusing on flood control and water utilization; and

(b) To conduct a Feasibility Study on urgent projects based on ranking of priority.

2. Study Area

The study area of approximately 5,800 km^2, situated in the northern part of North Sumatra Province, is composed of the basins of several small rivers and those of the seven (7) major rivers of Belawan, Deli, Percut, Serdang, Ular, Belutu and Padang. Medan City, the largest city in Sumatra and the third largest city in Indonesia is within the study area.

3. Master Plan

3.1 Flood Control Plan

In the Master Plan Study, optimum combinations of structural measures for flood control are selected from the technical and economical points of view. The optimum flood control plans for the respective rivers are summarized as follows:

Optimum Flood Control Plans

River		Optimum Flood Control Facilities	Remarks
1.	Belawan	River Improvement (21.7 km)	
2.	Deli-Percut	River Improvement (37.4 km), Floodway (3.8 km) and Namobatang Dam	Deli River
		River Improvement (28.0 km) and Lausimeme Dam	Percut River
3.	Serdang	River Improvement (25.4 km)	
4.	Ular	Karai Dam	
5.	Belutu	River Improvement (32.7 km)	
6.	Padang	River Improvement (29.5 km)	

In the above plans, the design flood discharge is taken as a 100-year return period for the Deli-Percut river system project and a 50-year return period for the other river basin projects.

3.2 Water Supply Plan

From the estimated cost efficiency of the structures, the following three (3) structures are proposed to fill the municipal water demand in Medan Area:

(a) Lausimeme Dam
(b) Namobatang Dam
(c) Belumai Aqueduct

With the said three (3) structures, the future municipal water demand for Medan Area in the target year 2010 will be fully met.

3.3 Integrated Scheme

Among the structures considered in both plans, the Namobatang and Lausimeme dams are to have the multiple functions of flood control and water supply to Medan Area. With the multiple functions, the construction costs of the proposed dams will decrease by 8 to 10%.

The proposed target year for completion of the flood control and water supply master plan is the year 2010. The project life of the dams, the floodway and the river improvement works is 50 years, while that of the aqueduct is 40 years after completion.

3.4 Project Evaluation

As a result of comparative studies and analysis, the following conclusions are made.

(1) Flood Control Project

The flood control project is economically feasible. The cost- benefit analysis shows an EIRR of 13.92% at the discount rate of 12%, a B/C ratio of 1.15 and an NPV of Rp. 34,455 million.

(2) Water Supply Project

The proposed water supply projects are economically feasible. As a whole, the EIRR is 10.70%, which is fairly high compared with those of similar domestic water supply projects.

(3) Integrated Projects

As summarized in the table below, the results of analyses show that both the integrated project for the Deli-Percut River System and the integrated project for the whole integrated river basins are economically feasible.

EIRR of Integrated Project

Project	EIRR (%)
Deli-Percut River System	13.55
Integrated River Basins	12.52

4. Urgent Plan

4.1 Project Formulation

In accordance with the implementation schedule of the Master Plan, the urgent project is formulated at the scale of a 30-year return period for the Deli-Percut River and a 10-year return period for the Padang River.

The project scale of the water supply plan is defined by the recurrence probability of drought. Therefore, the design drought of a 10-year return period is adopted for the domestic water supply. In detail, a 5-day mean discharge for 10 years shall not fail to meet the requirement of domestic water demand.

The urgent projects are as follows:

(a)	Deli River Improvement	:	37.4 km long; design discharge = 460 m^3/s at Helvetia
(b)	Percut River Improvement	:	28.0 km long; design discharge = 300 m^3/s at Tembakau
(c)	Floodway (Titi Kuning to Tembakau)	:	3.8 km long; design discharge = 120 m^3/s
(d)	Lausimeme Dam	:	rockfill type, 74.5 m high; gross storage capacity = 34 MCM
(e)	Padang River Improvement	:	29.5 km long; design discharge = 630 m^3/s at Brohol

4.2 Project Evaluation

The results of the cost-benefit analysis for both the urgent projects of flood control and water supply are summarized as follows:

Economic Internal Rate of Return

Projects	EIRR (%)
1. Deli-Percut River System	
1.1 Integrated	14.35
1.2 Flood Control	17.90
1.3 Water Supply	9.90
2. Padang River Flood Control	11.86

The above results show that the flood control project is economically feasible. As for the water supply project, the EIRR is nearly 10%, which is fairly high rate compared with those of similar domestic water supply projects. This shows that the water supply project is feasible from the socioeconomic point of view.

STUDY ON
BELAWAN-PADANG
INTEGRATED RIVER BASIN DEVELOPMENT

SUMMARY

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

TERMS AND ABBREVIATIONS

1. GOVERNMENT AGENCIES AND OTHER ORGANIZATIONS

GOI	:	Government of Indonesia
BAPPENAS	:	Badan Perencanaan Pembangunan National (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, Ministry of Public Works
DGCK	:	Directorate General of Cipta Karya (Housing, Building and Urban Development)
DOR	:	Directorate of Rivers, DGWRD
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 (Centre of Meteorology and Geophysics)
PLN	:	Perusahaan Listrik Negara (State Electricity Corporation)
BPP	:	Balai Penyuluhan Pertanian (Agricultural Extension Centre)
RISPA	:	Research Institute of Sumatra Planter's Association
IHE	:	Institute of Hydraulic Engineering (Bandung)
ADB	:	Asian Development Bank
GOJ	:	Government of Japan
IBRD	:	International Bank for Reconstruction and Development (The World Bank)
IGGI	:	Inter-Governmental Group of Indonesia
JICA	:	Japan International Cooperation Agency
MOC	:	Ministry of Construction, Japan
OECF	:	Overseas Economic Cooperation Fund, Japan
UNDP	:	United Nations Development Programme
WHO	:	World Health Organization

2. UNITS OF MEASURE

Length

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer

Weight

g, gr	:	gramme
kg	:	kilogramme
t, ton	:	metric ton
dwt, DWT	:	dead weight

Area

mm^2	:	square millimeter
cm^2	:	square centimeter
m^2	:	square meter
km^2	:	square kilometer
ha	:	hectare

Time

sec, s	:	second
min	:	minute
h, hr	:	hour
d, dy	:	day
y, yr	:	year

Volume

cm^3	:	cubic centimeter
m^3	:	cubic meter
l, ltr	:	litre

Derived Measures

(Speed/Velocity)

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	:	kilogramme per square centimeter
ton/m^2	:	ton per square meter

(Discharge)

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

3. INDONESIAN TERMS

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
Sawah	:	paddy field
Rawa	:	swamp
Danau	:	lake
Laut	:	sea

CHAPTER 1. INTRODUCTION

1.1 Background of the Study

The study area, situated in the northern part of North Sumatra Province, is composed of the basins of several small rivers and those of the seven (7) major rivers of Belawan, Deli, Percut, Serdang, Ular, Belutu and Padang. Medan City, the largest city in Sumatra and the third largest city in Indonesia is within the study area.

Under the Fourth Five-Year Development Plan, the Government of Indonesia had promoted development policies such as the reduction of the regional discrepancies in labor force and economic potential, water resources development and flood control in developed/developing areas. It was particularly active in promoting the development of outlying areas such as Sumatra in conjunction with the policy to promote transmigration.

The rate of resettlement due to transmigration in North Sumatra Province is high, and the province is one of the areas where development is highly expected. However, the occurrence of floods causing serious damage has been a factor impeding development.

The population of Medan City makes up over a half of the total population of approximately 3.63 million in the study area. The growth of the city population in recent years has resulted in the serious shortage of municipal water.

Under the above circumstances, a request for technical cooperation to work out solutions to the problems of flood and water shortage was made by the Government of Indonesia (GOI) to the Government of Japan (GOJ). In response to the request, the Japan International Cooperation Agency (JICA) was commissioned to conduct the Study on Belawan-Padang Integrated River Basin Development (hereinafter referred to as the Study). The Study was started in March 1990, with completion slated in March 1992.

1.2 Objectives of the Study

The objectives of the Study are as follows:

(a) To formulate a Master Plan of integrated river basin development for the integrated river basins from Belawan to Padang, focusing on flood control and water utilization; and

(b) To conduct a Feasibility Study on urgent projects based on ranking of priority for implementation.

The Study is to be carried out in twenty-four (24) months from March 1990 to March 1992. Divided into two (2) stages, the first stage work from March 1990 to March 1991 is to formulate the Master Plan and the second stage work from April 1991 to March 1992 is to carry out the Feasibility Study for urgent projects selected from the Master Plan.

CHAPTER 2. PRESENT CONDITION

2.1 Natural Condition

Geography

The study area covers the integrated river basins of approximately 5,800 km^2 situated between Belawan River and Padang River. It is located in the northern part of North Sumatra Province in Sumatra Island (2°50' to 3°50'N latitude and 98°30' to 99°20'E longitude), bounded on the northeast by the Strait of Malacca.

A major part of the study area is covered with volcanic soils. These volcanic soils came from the Takur-Takur-Simbolon Centre, the Toba Centre and the Sibayak Centre, and were formed during the Plio- Pleistocene and Pleistocene-Holocene. The major component of the volcanic soils is Toba tuff consisting of pyroclastic flow deposits during the formation of the Toba caldera.

At some places on the western side of the steep mountains, Bruksah Formation is observed. Distributed next to the Bruksah Formation is Mendem Microdiorite, intrusive. The area around Medan City is diluvial upland consisting of the Pleistocene Medan Formation, while the eastern lowlands facing the Strait of Malacca is composed of Holocene alluvium. The formation of these layers is shown in Fig. 2-1.

Seven (7) major rivers originating in the steep slope of the mountains generally flow in north to northeastern direction in the study area. They are, from northwest to southeast, the Belawan, Deli, Percut, Serdang, Ular, Belutu and Padang rivers.

Major Rivers in the Study Area

Name of River	Catchment Area (km^2)	Major Tributary
1. Belawan	647	
2. Deli	358	Babura (99)
3. Percut	186	
4. Serdang	671	Belumai (262) Batugingging (343)
5. Ular	1,081	Buaya (440) Karai (573)
6. Belutu	500	Rambung (166)
7. Padang	919	Sibarau (235)

Note: Figures in parentheses show catchment area (km^2) of tributary.

The climate of Sumatra, unlike that of other Indonesian regions south of the equator, is characterized by a little difference between the wet and dry seasons. Since Sumatra is located near the southern side of the continent across the Strait of Malacca, the study area is not greatly affected by northeasterly monsoons and trade winds.

Temperature ranges between 21°C and 33°C and annual temperature averages 26°C. Humidity range is between 83% and 87% and the average is 85%. The temperature and humidity in this area is very high throughout the year with the annual pan evaporation as high as 1,566 mm. Northerly or northeasterly monsoons blow throughout the year, but the area is located outside of the region affected by tropical depressions or cyclones.

Rainfall in the southern mountainous area and the northern coastal plain are 2,900 mm and 1,700 mm, respectively. Seasonally, rainfall is low in January to March and high in September to December. The isohyetal map of annual rainfall is as shown in Fig. 2-2. The higher elevation the area is located, the more rainfall is observed.

Flood discharges have been recorded only at six (6) stations, and further intermittently. Among the recorded floods, the maximum floods of respective stations are as follows:

Maximum Flood

River	Station	Catchment Area (km^2)	Maximum Flood (m^3/s)
1. Belawan	Asam Kumbang	209	360 (Nov. 1989)
2. Deli	Simeme	158	103 (Dec. 1986)
3. Percut	Tembung	171	178 (Dec. 1986)
4. Serdang	Kp. Serdang	671	288 (Jul. 1987)
5. Belutu	Silau Dunia	72	27 (Dec. 1987)
6. Padang	T. Tinggi	919	173 (May 1981)

Due to the little difference of rainfall between wet and dry seasons, river flows are rather stable except instantaneous floods in the wet season. The ratio of maximum daily discharge to the mean is usually about 5 times, but for Ular River it is only 2.5 times.

Natural Environment

The study area includes areas under legal regulations for nature conservation, namely a Nature Reserve Area (designated by the Protection Nature and Environmental Board) and a Forest Reserve Area. These conservation areas are designated, centering around ranges of mangrove and lowland forest along the seashore.

Compared with Java, Sulawesi and other small islands, Sumatra as a whole has much more abundant and various vegetation. The study area, however, has a small range of vegetation since a large area is cleared for oil palm, rubber and other kinds of plantation.

Generally, Sumatra provides an excellent living environment for wild animals, and is a habitat for a number of species including 196 mammals and 580 different species of birds. In the study area, animals such as monkeys live primarily in the forests.

2.2 Socioeconomic Condition

Population and Land Use

(1) Population

A population census was conducted in 1961, 1971, 1980 and 1990. According to the 1990 population census, the populations of Indonesia and North Sumatra Province were 179,322,000 and 10,256,027, respectively. During the period 1980-1990, the average annual growth rates were 1.97% and 2.06%, respectively.

Population in the study area in 1990 is composed of those of Kab. Deli Serdang, the seven (7) kecamatans of Kab. Simalungun, Kodya. Medan and Kodya. Tebing Tinggi. The population, together with the population density and the number and average size of households are summarized as follows:

Population, Density and Households in 1990

Kab./ Kodya.	Area (km^2)	Population	Population Density (person/km^2)	Number of Household	Household Size (person/hh*)
Deli Serdang	4,398	1,602,749	364	316,875	5.06
Simalungun**	1,553	178,254	115	36,597	4.87
Medan	265	1,730,752	6,532	324,084	5.34
T. Tinggi	38	116,767	3,079	21,896	5.33
Study Area	6,254	3,628,522	580	699,452	5.19

* hh means household; ** 7 kecamatans only.
Source: Hasil Sensus Penduduk 1990, Kab. Deli Serdang, Kab. Simalungun, Kodya. Medan and Kodya. Tebing Tinggi.

The study area has 54 kecamatans as administrative units in 1990. They are the 33 units in Deli Serdang, 7 units in Simalungun, 11 units in Medan City and 3 units in Tebing Tinggi City.

(2) Land Use

Land use in North Sumatra Province has shown a drastic change. More than 40% of the permanent forest area has already been converted into other land utilization such as plantation, paddy and so on.

Land use in the study area is dominated by plantation/estates of rubber, oil palm, coconut, etc., and paddy fields occupy approximately 90,000 ha which correspond to 17% of the study area.

Regional Economy

(1) Gross Regional Domestic Product

At current market prices, the Gross Regional Domestic Product (GRDP) of North Sumatra Province amounted to Rp. 7,592 billion in 1988 at an average annual growth rate of 17.1% (equivalent to the real growth rate of 6.5%) since 1983. This growth rate is fairly high compared with the GDP of the country as a whole, especially the sector of electricity, gas and water supply which indicated the highest average growth rate of 25.1% per annum for the period 1983-1988. The agricultural sector, which had a large share of 36.6% in the GRDP in 1988, also achieved a high growth rate of 19.6% during the same period.

(2) Establishment and Employee

In 1986, North Sumatra Province had 326,839 establishments including the 141,273 establishments in the study area (except Kab. Simalungun), and the number of employees was 675,513 including the 323,932 in the study area. In either case, the study area had nearly half the number in North Sumatra Province.

In the same year, the distribution in the study area was 45,605 (32%) for Kab. Deli Serdang, 88,949 (63%) for Kodya. Medan and 6,719 (5%) for Kodya. Tebing Tinggi in terms of the number of establishments. The percent distribution for the number of employees was 30%, 66% and 4%, respectively.

(3) Budget of Regional Government

Budget expenditure of the North Sumatra Autonomous Government amounted to Rp. 290,356 million in fiscal year 1988/89 at an average annual growth rate of about 16% during the period 1980/81 to 1988/89. This expenditure is composed of Rp. 245,681 million (85%) for routine work and Rp. 44,674 million (15%) for development. Both indicate average growth rates of 18% and 10% per annum, respectively, during the said period. According to the financial information from the Provincial Government of North Sumatra, budget expenditures of both sectors of flood control and water resources development were approximately Rp. 7,100 million and Rp. 120 million, respectively, in fiscal year 1988-89.

Medan Urban Development Project

The study for Medan Urban Development, Housing, Water Supply and Sanitation Project was started in 1978 and completed in October 1980 under the supervision of the Directorate General of Housing, Building, Planning and Urban Development (DGCK), Ministry of Public Works. It was partly financed by the Asian Development Bank (ADB).

Based on the study, the first stage program was implemented starting in 1982. With technical assistance from ADB the second stage of MUDP, namely the Second Medan Urban Development Project (MUDP II), was also started including some overall studies for flood control and water supply covering a wide area from Belawan River to Serdang River which occupies about a half of the area of this present Study.

2.3 Flooding Condition

Flood Control Works

The causes of flood are classified into two (2), river overbanking and inland water drainage. Floods due to river overbanking have been reported in mainly the downstream reaches of the six (6) rivers, except Ular River, while those by inland water drainage have been observed in urban areas such as Kodya. Medan and Tebing Tinggi, and also the coastal lowland areas. Except the Ular River, the flow capacity of all the rivers is very small at less than the flood discharge of a 2-year return period.

Among the flood control works, which were mostly river improvement works, only the Deli River improvement project was carried out with financial assistance from OECF and ADB. The scale of improvement works was set at a 10-year return period mainly due to budgetary restraint. Priority of implementation was then placed on the low-lying areas where flood damage has been serious.

Probable Flood Discharge

Less than twelve (12) hours of runoff concentration time which is governed by the catchment area, river length and topography, is justified for all river basins. Probable daily rainfalls for the respective river basins were estimated, using the Gumbel Method, at 143.0 mm, 206.4 mm and 177.2 mm for a 100-year return period in Deli, Ular and Padang river basins, respectively.

The probable flood discharges of each river basin from 2-year return period to 100-year return period were calculated, applying the probable design storm to the flood runoff model. The probable flood discharges at the reference point of the respective river basins are estimated at 690 m^3/s, 1,070 m^3/s and 940 m^3/s for a 100-year return period at Helvetia (Deli), Pulau Tagor (Ular) and Brohol (Padang), respectively. The distribution in each river system is presented in Fig. 2-3.

Flood Damage

Since the study area is flat with a slight slope towards the sea, overbank flow usually spreads along the river course. Furthermore, flood is somewhat retained in the shoreline area. The flooding in the study area, therefore, shows both of storage and flow/diffusion.

The probable inundation area is estimated at about 500 km^2 in total for six (6) rivers except Ular River. The inundation area is smallest in the Belawan River Basin, while the biggest is in the Serdang River Basin.

The average annual flood damage is generally given using the following formula:

$$d = \int_{Q_1}^{Q_2} D(Q)P(Q)dQ$$

where,

d	:	average annual flood damage
Q	:	flood discharge
D(Q)	:	damage caused by flood discharge (Q)
P(Q)	:	probability of occurrence of flood discharge (Q)
Q_1	:	innocuous discharge
Q_2	:	design flood discharge

The average annual flood damage by return period is summarized as follows:

Average Annual Flood Damage (million Rp.)

Return Period (Year)	Belawan River (1)	Deli River (2)	Percut River (3)	Serdang River (4)	Ular* River (5)	Belutu River (6)	Padang River (7)
10	324	32,363	2,443	10,919	-	2,019	8,961
20	711	35,687	3,059	11,909	460	2,217	9,857
30	869	36,919	3,296	12,248	1,080	2,292	10,193
50	1,001	37,968	3,491	12,527	1,520	2,354	10,469
100	-	38,795	3,647	-	-	-	-

* Source: Overall Ular River Improvement Project, JICA, 1971

2.4 Water Supply

Present Water Source and Water Use

(1) Municipal/Domestic Water

Water sources for the water supply system in Medan are the surface flow of Belawan River and Deli River, springs in the mountain slope and groundwater. Summarizing the current water use in Medan, about 183,000 m^3/day are used for municipal and domestic needs.

Municipal and Domestic Water Source

Water Source	Supply Capacity (m^3/d)
1. Sibolangit Springs	46,000 (530)
2. Sunggal (Belawan River)	90,720 (1,050)
3. Deli Tua (Deli River)	30,240 (350)
4. Deep Well	14,750 (170)
5. Transmission from BPA* (Deep Well)	1,420 (16)
Total	183,130 (2,116)

* Belawan Port Authority
Amounts in parentheses are in l/s.

Under the water supply system operated by PDAM Tirtanadi, the total number of consumers in Medan City is 97,081 and total consumption is 127,177 m^3/day as of May 1990. Since the population is about 1.7 million in 1990, the service ratio is estimated at about 30%.

The water source for the municipal water supply by PDAM Tebing Tinggi is only the surface flow of Padang River. An intake structure and a water treatment plant were constructed at Bulian in 1981, with the intake capacity of 60 l/s and production capacity of about 45 l/s. On the other hand, there exist eight (8) deep wells with a total capacity of 30 l/s for non-domestic water use.

The total number of consumers under PDAM Tebing Tinggi was about 2,400 units, corresponding to about 14,400 persons as of February 1990. Thus, the present water supply service ratio is about 12% since the population is 117 thousand.

Fourteen (14) kecamatans in Kab. Deli Serdang are at present provided with water supply system with water sources from river flow, groundwater and springs. River surface water is utilized at Tanjung Morawa and Sei Rampah from Belumai River (Serdang River) and Belutu River with intake capacities of 10 l/s and 20 l/s, respectively. Other kecamatans are provided by deep wells with the total capacity of about 60 l/s.

On the other hand, there are seven (7) kecamatans currently receiving services under PDAM Tirtanadi. They are Pancur Batu, Namo Rambe, Deli Tua, Sunggal, Labuhan Deli, Percut Sei Tuan and Sibolangit. Data on supply volume, consumers, etc., are not available.

(2) Irrigation Water

The major crops in the study area are wetland rice, upland rice, maize, cassava, soybean, sweet potato, peanut and other beans. Rice is planted generally from October to November and harvested during February to April.

Based on the inventory of existing paddy fields, the present condition is classified into the following four (4) categories of irrigation system.

Category of Irrigation System

Category	Area (ha)	Ratio (%)
1. Technical Irrigation Area	18,824	24.0
2. Semi-technical Irrigation Area	18,890	24.1
3. Simple Irrigation Area	25,592	33.1
4. Rainfed Area	14,700	18.8
T o t a l	78,366	100.0

The technical irrigation area is well provided with irrigation facilities and achieving double cropping, i.e., a crop intensity of 200%. However, the semi-technical and simple irrigation areas may only attain the crop intensity of 120% and 100% on average, respectively.

(3) Institutional, Commercial and Industrial Water

Records of water tariff collection of PDAM Medan in May 1990 show that about 25% of the total use was for non-domestic purposes, and unaccounted loss of water is also estimated at about 25%.

(4) Aquacultural Water

Three (3) types of aquacultural practice in the study area exist; namely, (a) Mina Paddy, (b) Kolam and (c) Tambak. There are about 520 ha of Kolam and 280 ha of Mina Paddy, but the required water is supplied mostly by unused and/or circulated irrigation water. As for Tambak, out of a total of 2,100 ha, about 830 ha is in operation as fresh water is supplied from rainfall.

Present Water Demand

(1) Municipal Water

Referring to Repelita V for per capita consumption and present water use condition in the study area, the municipal water demand in the cities and of the respective river basins is estimated at approximately 372,000 m^3/d, as shown in the following table.

Municipal Water Demand in Cities and River Basins

Name of City/River	Population (person)	Water Demand (m^3/d)
Medan	1,731,000	315,042
Tebing Tinggi	117,000	21,294
Belawan	326,930	6,813
Deli	68,221	1,421
Percut	254,594	5,306
Serdang	293,365	6,114
Ular	381,569	7,951
Belutu	224,470	4,678
Padang	281,428	3,427
Total	3,561,577	372,046

(2) Irrigation Water

Irrigation water requirements are estimated based on the cropping pattern and its corresponding unit diversion requirement (Ular River Improvement Project), as shown in the following table.

Irrigation Water Requirements

River Basin	Irrigation Area (ha)	Irrigation Water Demand (MCM/yr)
1. Belawan	8,242	35.3
2. Deli	4,940	44.1
3. Percut	5,356	30.0
4. Serdang	14,879	84.2
5. Ular	24,296	349.8
6. Belutu	11,398	79.9
7. Padang	9,255	31.8
Total	78,366	655.1

(3) River Maintenance Flow

The low flow of the river shall be maintained so that no serious change from the present condition will arise. However, river maintenance flow has not been determined for rivers in the study area.

Water Balance

(1) Water Supply Potential

Generally, shortage in municipal/domestic water supply is not allowed even in a severe drought; once in 10 years, and irrigation water shall be secured at least in the droughtest year for 5 years.

The water supply capacity of each river basin is evaluated at the possible lowest intake point of river as follows:

Water Supply Capacity of River Basin

River	Intake Point	Catchment Area (km^2)	Drought Mean Discharge (m3/s)			
			20-yr	10-yr	5-yr	Average
Belawan	Kp. Lalang	254	5.84	7.39	7.54	8.59
Deli	Simeme	158	5.07	5.70	6.12	7.13
Percut	Tembung*	171	6.06	6.81	7.31	8.52
Serdang	Tg. Morawa	250	8.18	9.03	10.70	12.19
Ular	Pulau Tagor	1,031	35.67	43.68	45.67	57.82
Belutu	Sei Rampah**	423	12.43	13.02	13.59	15.15
Padang	T. Tinggi	919	32.60	34.13	35.64	39.72

* Specific discharge of Simeme (Deli River) is used with rainfall ratio.
** Specific discharge of T. Tinggi (Padang River) is used with rainfall ratio.

(2) Present Water Balance

Since the water volume of actual consumption could not be obtained, the present water balance is estimated from the present water use for municipal water and the estimated water demand for irrigation water. The simulation is carried out for 20 years from 1969 to 1988. Among the seven (7) rivers, Belawan, Deli, Percut and Belutu have a serious shortage of water. The other rivers of Serdang, Ular and Padang still have a surplus water supply potential.

2.5 Sedimentation

Present Sediment Condition

Neither large-scale landslide nor gully erosion is observed in the upperstream area of rivers. Mountain slopes are usually covered with thick forest and hence stable without producing a big volume of sediment. However, some parts of the upstream areas of Serdang, Ular, Belutu and Padang rivers have suffered from small-scale sheet erosion and surface collapse caused by shifting cultivation and related activities.

The eastern rivers after the Serdang River, namely Belawan, Deli and Percut, are rather free from river bank erosion and sedimentation. The river courses are relatively stable without meandering in the middle stream.

Batugingging River, the right tributary of Serdang River, and Belutu River have high content of silt and sand in their flows. Sandbars have formed at riverbends and riverbeds have aggradated.

In the riverbed of the upper streams of Ular and Padang, downward erosion is dominant and river channels form deep valleys. Deposits of fine sands have formed also at the bend of the river channels.

Sediment Balance

The average sediment yield of the seven (7) river basins is estimated at approx. 430 m^3/km^2/year, which is considered a usual geographical transformation. The results of sediment balance analysis are summarized as follows:

Annual Sediment Balance

River	Catchment Area (km^2)	Annual Sediment Volume (1,000 m^3/year)		
		Yield	Deposit	Discharge*
1. Belawan	618	200.1	59.9	140.2
2. Deli	358	140.8	43.4	97.4
3. Percut	186	61.1	14.2	46.9
4. Serdang	671	383.0	111.4	271.6
5. Ular	1,081	517.9	124.4	393.5
6. Belutu	500	167.6	80.3	87.3
7. Padang	919	413.2	146.5	266.7
Total	4,333	1,883.7	580.1	1,303.6

* Discharge is estimated at the lowest point of river basin.

2.6 Dam Development Potential

Possible Dam Sites

Eight (8) possible dam sites in the study area have been identified through the field reconnaissance and by using the topographic maps on the scale of 1/50,000. Six (6) of them are located in the upper reaches of six (6) rivers, namely Belawan, Deli, Percut, Serdang, Belutu and Padang. The other two (2) are in the middle reaches of the Ular River. The locations are shown in Fig. 2-4.

Comparison of Potential Dams

The topographic features and economic aspect of eight possible dams have been comparatively studied, assuming that a rockfill dam is employed on account of adaptability for various geological conditions of dam foundation, although a concrete gravity type of dam may be more economical when dam height is low and the purpose is exclusively for flood control.

The main features of the dams are summarized as follows:

Technical and Economical Comparison of Potential Dams

River	Damsite	(1) Catchment Area (km²)	(2) Topographically Possible Reservoir Storage Capacity (MCM)	(3) Required Total Reservoir Storage Capacity (MCM)	(4) Required Dam Height For (3) (m)	(5) Quantity of Required Dam Body For (4)* (1000 m³)	(6) Estimated Construction Cost For (5) (Billion Rp)
Belawan	Tembengan	76	25.0	14.8	33	953	76.2
Deli	Namobatang	93	15.0	15.0	41	672	53.8
Percut	Lausimeme	105	60.0	20.6	61	750	60.0
Serdang	Beranti	159	15.0	15.0	38	668	53.4
Ular	Buaya	428	48.0	48.0	19	296	23.8
Ular	Karai	500	85.0	85.0	30	360	28.8
Belutu	Sibakudu	64	45.0	13.7	18	189	15.1
Padang	Sampanan	370	31.0	31.0	34	382	47.4

* Quantity estimated considering the dam type as rockfill.

From the ratio of estimated construction cost per annually secured effective storage capacity, a relatively economical dam construction is expected in the river system of Ular, Belutu and Padang, although these dam sites are located far from Medan. Among the dam sites near Medan, Lausimeme in the Percut River and Namobatang in the Deli River are considered to be promising dam sites from the economical viewpoint of reservoir storage efficiency.

CHAPTER 3. MASTER PLAN

3.1 Flood Control Plan

Project Scale and Target Area

(1) Project Scale

The project scale for flood control is proposed to be a 50-year return period for five (5) rivers, namely Belawan, Serdang, Ular, Belutu and Padang. The project scale is bigger for the Deli and Percut rivers, i.e., 100-year return period, in consideration that the rivers pass through Medan City, and that both Deli and Percut rivers are to be defined as one river system with the construction of a floodway.

(2) Target Area

The target stretch for river improvement is determined based on the inundation area caused by an overbank flow of approximately a 100- year return period flood. The present flow capacity, present land use and future development plan are considered as well. The following table shows the target river improvement stretches.

River Improvement Stretch

River	Improvement Stretch	Length (km)
1. Belawan	15 km upstream of river mouth to crossing with national road	21.7
2. Deli	River mouth to Titi Kuning	37.4
3. Percut	River mouth to Tembakau	28.0
4. Serdang		
(a) Serdang and Belumai	River mouth to Bandar Labuhan	16.5
(b) Batugingging	Confluence with Belumai River to crossing with national road	8.9
5. Ular	River mouth to Pulau Tagor	31.8
6. Belutu	River mouth to Bakaran Batu	32.7
7. Padang	River mouth to confluence with Sibarau River	29.5

Optimum Flood Control Plan

In the Master Plan Study, the optimum combination of structural measures for flood control is selected from the technical and economical aspects. River improvement is examined for all objective rivers and the application of floodway from Deli River to Percut River is investigated. Then, comparison between dam and retarding basin is made and finally, the combination of dam and river improvement is compared.

(1) River Improvement Plan

Alignment of the river course is designed to have less meandering so as to maintain the design high water level which is set at the same level as the ground elevation or the existing dike. The design riverbed longitudinal profile is fixed to the average of the existing one.

A wide and compound cross section with flood channel and low water channel is principally employed. A single cross section is adopted for river stretches in residential/urban areas.

Earth embankment is, in principle, adopted, although revetment of wet masonry is provided for meandering river sections with bank slope steeper than 1:2.

Due to the topographic condition of river basins, namely (1) the lower reaches are rather flat and rivers are shallow; and, (2) the middle and upper reaches are steep and rivers are deep, the river improvement plan is so prepared that the lower section is a wide and compound one and the middle section is a rather narrow and single one.

(2) Construction of Floodway

Construction of a floodway from the Deli River to the Percut River is identified to be possible on account of the topographic condition and land use along and around both rivers. Analysis of construction costs show that river improvement with floodway is economical when the discharge at Helvetia is more than 500 m^3/s.

(3) Construction of Flood Control Dam

For the eight (8) dam sites identified in the upper reaches of the respective rivers, the flood control function is estimated on the basis of a concrete gravity dam type with gated spillway.

The construction costs of river improvement and dam applied singly or in combination with each other are compared. The results of the comparison shows that the river improvement with dam construction is economical for Deli and Percut rivers, while dam construction only is economical for Ular River and river improvement only is economical for the other rivers.

In accordance with the results of the foregoing comparative studies, the optimum flood control plans for the respective rivers are summarized as follows and their design discharges are given in Fig. 3-1.

Optimum Flood Control Plans

River	Optimum Flood Control Facilities	Remarks
1. Belawan	River Improvement (21.7 km)	---
2. Deli-Percut	River Improvement (37.4 km), Floodway (3.8 km) and Namobatang Dam	Deli River
	River Improvement (28.0 km) and Lausimeme Dam	Percut River
3. Serdang	River Improvement (25.4 km)	---
4. Ular	Karai Dam	---
5. Belutu	River Improvement (32.7 km)	---
6. Padang	River Improvement (29.5 km)	---

3.2 Water Supply Plan

Future Water Demand

Population projections are made at intervals of five (5) years for the period from 1995-2010, for each region of Kab. Deli Serdang, Kodya. Medan, Kodya. Tebing Tinggi, Kab. Simalungan (only the seven kecamatans mentioned before) and the study area as a whole, as follows:

Population Forecast in 2010 (thousands)

Region	Projected Population
Study Area	5,681
Kab. Deli Serdang	2,626
Kodya. Medan	2,680
Kodya. Tebing Tinggi	173
Kab. Simalungan*	202

* Seven kecamatans in the study area.

The future municipal/domestic water demand in both Medan and Tebing Tinggi cities and in each river basin in 2010 are computed according to the standards and targets of Cipta Karya in Repelita V, as shown in the following table.

Municipal/Domestic Water Demand in 2010

City/River Basin	Population (person: thousand)	Water Demand (m^3/d)
Medan City	2,679	597,723
Tebing Tinggi City	173	38,639
Belawan River Basin	536	24,811
Deli River Basin	112	5,177
Percut River Basin	417	19,322
Serdang River Basin	481	22,264
Ular River Basin	586	27,117
Belutu River Basin	360	16,675
Padang River Basin	261	12,074
Total	5,605	763,802

Optimum Water Supply Plan

(1) Project Scale and Target Area

The project scale of a water supply plan is, in general, based on the recurrence probability of drought. Compared with the irrigation water supply, the allowable limit of water shortage for domestic water supply is more strict. To simplify the water balance analysis, the design drought of 10-year return period was adopted for both domestic and irrigation water supply.

The target area for the water supply plan with river surface flow is limited to only Medan City and six (6) kecamatans (hereinafter called as Medan Area) under PDAM Medan (except Kec. Sibolangit), and Tebing Tinggi City. Kecamatan capitals where the demand for domestic water is small are excluded from the target area of the water supply plan since groundwater utilization by means of deep well is more economical and easier than river surface flow.

(2) Optimum Combination of Structures

The municipal water demand of 21,300 m^3/d in Tebing Tinggi City in the target year 2010 will be supplied fully by the surface flow of the Padang River. That in Medan Area of approx. 770,000 m^3/d will be assured mostly from new water sources such as reservoirs and aqueduct/transbasin diversion. Since about 60,000 m^3/d will be supplied from groundwater by means of springs and deep wells, 710,000 m^3/d has to come from the new water sources.

To select the appropriate facilities among the alternative water sources, cost efficiency of the facilities was examined, as follows:

Cost Efficiency Analysis

Water Resources Facility	Newly Developed Supply Capacity (MCM/yr)	Construction Cost (mil. Rp)	Cost Efficiency (Rp/m^3/yr)
Tembengan Dam	79	90,000	1,139
Namobatang Dam	52	46,000	885
Lausimeme Dam	117	124,700	1,066
Belumai Aqueduct	82	39,200	478
Ular Aqueduct	192	207,100	1,079

From the estimated cost efficiency of the structures, the following three (3) structures are proposed to fill the municipal water demand in Medan Area:

(a) Lausimeme Dam
(b) Namobatang Dam
(c) Belumai Aqueduct

With the said three (3) structures, the future demand for municipal water in Medan Area in the target year 2010 will be fully met. The water supply program is proposed, as shown in Fig. 3-2.

3.3 Framework of the Master Plan

Overall Scheme

(1) Multipurpose Development

Among the structures considered in both flood control and water supply plans, the Namobatang and Lausimeme dams are to be utilized for flood control and water supply to Medan Area. The capacity and construction cost allotted for the respective purposes are estimated as follows:

Dam Capacity and Construction Cost

Name of Dam	Flood Control		Water Supply		Integrated Plan	
	Capacity (MCM) *1	Const. Cost (mil.Rp)	Capacity (MCM) *2	Const. Cost (mil.Rp)	Capacity (MCM) *2	Const. Cost (mil.Rp)
Namobatang	2.60	23,339	11.00	46,035	14.60	63,554
Lausimeme	2.80	21,182	29.50	124,652	33.40	141,344

Note: *1 Flood control capacity with a gated spillway.
*2 Flood control capacity with a non-gated spillway.

As shown in the above table, the total construction cost if both the flood control and water supply plans are integrated amounts to Rp. 63,554 million for Namobatang Dam and Rp. 141,344 million for Lausimeme Dam. Since the construction cost is reduced by 8 to 10% by integrating the plans, the proposed dams are to have the multiple functions of flood control and water supply.

(2) Target Year

As determined for the flood control and water supply plans, the target year of completion for the master plan is proposed to be the year 2010. The project life of dams, floodway and river improvement works is 50 years and that for the aqueduct is 40 years after completion.

Implementation Schedule

The implementation schedule of the master plan is prepared by placing higher priority on components which can satisfy the following conditions:

(a) Urgency in implementation to mitigate the flood damage and to meet the water demand;

(b) Higher economic efficiency is expected with the implementation; and

(c) The plan will serve to continue and strengthen the existing or ongoing projects of the Indonesian Government.

Among the flood control projects in the six river systems, first priority is to be put on the implementation of the project components in the Deli-Percut River System. The Padang River is to be taken as the second priority, because Tebing Tinggi has been frequently hit by floods. Since rehabilitation of the dike along the Serdang River has already been carried out by DPUP, the river improvement of Serdang River is to be taken as the third priority for implementation.

Following the above three (3) priorities, the Belutu River has to be improved in consideration that the river has only a small flow capacity. The implementation of flood control works on the Belawan and Ular rivers are to have lower priority than the others, because the flow capacity of these rivers corresponds to a 10-year and a 20-year return period, respectively.

The construction of flood control works is scheduled for 20 years from 1991 to 2010, as follows:

Construction Schedule

Project	Construction Period	
	Year	Period
1. Belawan River	3	2008 - 2010
2. Deli-Percut River	10	1995 - 2004
3. Serdang River	5	2003 - 2007
4. Ular River	3	2008 - 2010
5. Belutu River	5	2006 - 2010
6. Padang River	7	1996 - 2002

A water supply project consisting of the construction of Namobatang Dam, Lausimeme Dam and Belumai Aqueduct is planned to meet the demand of municipal water in Medan Area at 2010.

Among the components of the water supply plan, the construction of Lausimeme Dam is the most urgent to meet the present demand of municipal water in Medan Area. Consecutively, the Namobatang Dam will be constructed to meet the future water demand, and the Belumai Aqueduct is to follow.

Construction of the water supply structures is scheduled as follows, where the economic life of each facility is assumed to be 50 years after completion of the construction work.

Schedule of Water Supply Structures

Project	Construction Period	
	Year	Period
1. Namobatang Dam	4	2001 - 2004
2. Lausimeme Dam	4	1995 - 1998
3. Belumai Aqueduct	5	2003 - 2007

Based on the prioritization made above, the implementation program of the master plan is proposed in consideration of the construction periods of the respective project components, as presented in Fig. 3-3.

Cost Estimate

Project cost is estimated under the following conditions:

(a) Price level is as of September 1991.

(b) Annual Price Escalation is only 8% for local currency component.

(c) Physical Contingency is assumed at only 10% for construction cost and engineering service cost

(d) Currency Conversion Rate is assumed at US$1.00 = ¥136 = Rp. 1,950.

(e) Compensation Cost consisting of house evacuation and land acquisition is estimated from the data obtained from Medan City.

(f) Administration Cost is estimated at 7% of the total Construction Cost.

The summary of project cost is shown in the following table.

Summary of Project Cost

Name of River/ Work Item	Const. Base Cost	Adm.	E/S	Comp.	P.Conti.	Total
1. Belawan River						31,261
- RiverImprovement	20,960	1,467	3,144	2,848	2,842	31,261
2. Deli-Percut River						403,130
- Deli Improvement	76,652	5,366	11,498	14,310	10,782	118,608
- Namobatang Dam	42,401	2,968	10,288	2,120	5,777	63,554
- Medan Floodway	21,380	1,497	3,207	3,039	2,912	32,035
- Percut Improvement	29,003	2,030	4,350	7,880	4,326	47,589
- Lausimeme Dam	102,234	7,156	16,861	2,244	12,849	141,344
3. Serdang River						153,850
- River Improvement	68,752	4,813	10,313	20,372	10,425	114,675
- Belumai Aqueduct	28,782	2,015	4,317	499	3,562	39,175
4. Ular River						16,076
- Karai Dam	8,977	628	4,309	700	1,462	16,076
5. Belutu River						56,401
- River Improvement	34,897	2,443	5,235	8,699	5,127	56,401
6. Padang River						100,544
- River Improvement	69,792	4,885	10,469	6,257	9,141	100,544
Total	503,830	35,268	83,991	68,968	69,205	761,262

Adm. : Administration Cost is 7% of construction base cost
E/S : Cost for Engineering Services
Comp. : Compensation Cost
P.Conti. : Physical Contingency

3.4 Project Evaluation

Economic Evaluation

The evaluation is conducted by the usual means of Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and Benefit-Cost Ratio (B/C), using economic cost and benefit of the project.

Project life is economically taken as 50 years after completion of the construction works, and the project benefit together with operating, maintenance and replacement cost (OMR cost) is assumed to occur throughout the project life.

(1) Flood Control Plan

The results of cost-benefit analysis by design flood discharge for each flood control project are given by means of the Economic Internal Rate of Return (EIRR) as follows:

Economic Internal Rate of Return (%)

Return Period (Year)	Belawan River (1)	Deli-Percut River (2)	Serdang River (3)	Ular River (4)	Belutu River (5)	Padang River (6)
10	-	20.03	11.02	-	2.94	11.54
20	0.84	18.49	11.20	8.79	3.14	10.82
30	1.20	18.09	10.96	6.54	3.12	10.36
50	1.33	17.66	10.59	8.92	2.95	9.66
100	-	16.80	-	-	-	-

Of six (6) flood control projects, the three (3) river projects of Deli-Percut, Padang and Serdang are estimated to have the EIRR of over 10% for design flood discharge with return periods from 10 years to 30 years. This shows that the said three flood control projects are economically feasible, and among them the Deli-Percut river system project has the highest economic feasibility.

In the above plan, the return period of design flood discharge is taken as 100 years for the Deli-Percut river system project and 50 years for other river basin projects.

The result of cost-benefit analysis under the above-mentioned conditions indicates the EIRR of 13.92% at the discount rate of 12%, the B/C of 1.15 and the NPV of Rp. 34,455 million. This shows that the project is economically feasible.

(2) Water Supply

Economic evaluation of the water supply project is generally made by comparing the economic benefit expected by supplying the domestic water with the total economic cost of construction and OMR of facilities required from production to supply of the domestic water. However, the present plan excludes the construction of treatment plants and distribution system. Accordingly, the economic evaluation in the present study is carried out by making a comparison between economic benefit and cost of water production at the water sources.

A cost-benefit analysis is conducted in the same method as that of the flood control project. EIRR is summarized as below:

EIRR of Water Supply Project

Project	EIRR (%)
1. Lausimeme Dam	9.69
2. Namobatang Dam	12.12
3. Belumai Aqueduct	14.77
4. Whole Project of Water Supply	10.70

These results indicate fairly high figures compared with those of similar projects of domestic water supply. This means that these projects are economically feasible.

(3) Integrated Project

An economic analysis for the integrated project of flood control and water supply is made in regard to the design flood discharges with return period of 100-year for the Deli-Percut river system and with the return period of 50-year for other river basins.

EIRR of the Integrated Project

Project	EIRR (%)
1. Deli-Percut River System	13.55
2. Whole River Basins	12.52

The above results show that both the integrated project in the Deli-Percut River System and the integrated project in the whole river basins are economically feasible.

Social and Environmental Impacts

All the proposed facilities and river improvement works will not affect natural conservation areas designated by the national and provincial governments. Reservoir areas of both the Lausimeme and Namobatang dams are not used for productive activities such as paddy, plantation, etc., but covered with bushes. Few residents are found in the areas. The river improvement plan is also proposed minimizing houses to be evacuated and land to be acquired.

Generally, the study area is covered with small range of vegetation and provided with few kinds of wildlife due to the widely developed plantations. Therefore, the realization of the master plan will have a little impact on natural environment in the study area.

On the other hand, the implementation of the project will have the following natural and social advantages which could be evaluated in monetary terms:

(a) Mitigation of flood damage will enhance economic activities and bring about hygienic living conditions;

(b) Piped water supply system will prevent the outbreak of waterborne diseases; and

(c) Assurance of river maintenance flow of the rivers will improve river water quality and the scenic view around the river channels.

CHAPTER 4. URGENT PLAN

4.1 Project Formulation

<u>Project Scale and Target Year</u>

(1) Flood Control

The urgent project is formulated at the scale of a 30-year return period for the Deli-Percut River and a 10-year return period for the Padang River.

The proposed design flood discharge for the urgent project is presented in Fig. 4-1.

(2) Water Supply

The project scale of the water supply plan is defined by the recurrence probability of drought. The design drought of 10-year return period is adopted for domestic water supply. In detail, a 5-day mean discharge for 10 years shall not fail to meet the requirement of domestic water demand.

<u>Project Works</u>

The design flood discharge of Deli and Percut river improvement works in the urgent plan are almost equivalent to those in the master plan. It is economically advantageous to pursue the improvement works with the design flood discharge of the master plan. Accordingly, the project works for urgent projects are determined as follows:

(a) Deli River Improvement	:	37.4 km long; design discharge = 460 m^3/s at Helvetia
(b) Percut River Improvement	:	28.0 km long; design discharge = 300 m^3/s at Tembakau
(c) Floodway (Titi Kuning to Tembakau)	:	3.8 km long; design discharge = 120 m^3/s
(d) Lausimeme Dam	:	rockfill type, 74.5 m high; gross storage capacity = 34 MCM
(e) Padang River Improvement	:	29.5 km long; design discharge = 630 m^3/s at Brohol

4.2 River Improvement

Improvement Plan

(1) Deli River

The proposed alignment with typical cross sections are shown in Fig. 4-2 and the longitudinal profile in Fig. 4-3.

Among six (6) stretches of extreme meandering, a cut-off channel is employed for two (2) stretches after a comparison of cost between cut-off channel and improvement of the existing channel, as follows:

Proposed Cut-off Channel

No.	Stretch	Channel Length (m)	
		Existing	Cut-off
1.	DE.27+350 - DE.27+930	580	220
2.	DE.29+30 - DE.29+70	730	140

The lower reaches (river mouth to Titi Papan) is to be widened to have a new dike. The stretches of Labuhan Deli to Sikambing River (DE.5 to DE.20) should have an alignment within the area acquired by DPUP to avoid further land acquisition.

A single cross section is employed in the center of Medan City. A side slope of 1:2 is adopted for the dike, except along the stretches of DE.12 to DE.30 (H. Juanda Bridge) where a side slope of 1:1.5 is employed due to the restriction of land acquisition. Revetment is made only for this stretch and some meandering portions in the downstream.

(2) Percut River

The proposed alignment with typical cross sections are shown in Fig. 4-4 and the longitudinal profiles in Fig. 4-5.

The alignment for Percut River is planned nearly the same as the existing one which has an 80 m wide compound cross section.

A compound cross section is employed for the stretches from the river mouth to PE.13 (Titi Bobrok Bridge). However, the stretches from Titi Bobrok Bridge to the floodway (PE.28) will have a single cross section with some widening of channel. A side slope of 1:2 is set for the dike in all improvement stretches.

(3) Padang River

The proposed alignment with typical cross sections are shown in Fig. 4-6 and the longitudinal profiles in Fig. 4-7.

A cut-off channel is employed for the confluence stretch with the Sibarau River, where a conspicuous meander is formed.

The improvement is proposed to follow the existing alignment. To avoid a high design flood water level, widening of channel and setting back of dike are applied.

To minimize the construction cost of setting back of dike, the existing dike, mostly the left side dike, is proposed to be strengthened and heightened.

A compound cross section is applied for the stretches from the river mouth to the national road (PA.24) and a single cross section from PA.24 to Sibarau River (PA.29). Side slope of dike is set at 1:2 for all improvement stretches, and revetment is proposed for the stretches in the urban area of Tebing Tinggi City, and some stretches with considerable meanderings.

Related Structures

The relocation and new river structures are summarized as follows:

Relocation and New River Structures

River	Bridge	Weir	Sluice	Drain Pipe
Deli	19 (32)	0 (0)	5 (0)	97 (0)
Percut	13 (15)	1 (1)	5 (0)	56 (0)
Padang	6 (6)	1 (1)	4 (3)	14 (0)
Floodway	7 (1)	0 (0)	0 (0)	0 (0)
Total	45 (54)	2 (2)	14 (3)	167 (0)

Note: Figures in parentheses show the number of existing structures.

4.3 Floodway Construction

Optimum Route

The alignment and longitudinal profile of the economically optimum route are shown in Figs. 4-8 and 4-9, respectively.

Diversion Works

The diversion works is proposed based on the following criteria:

(a) The design discharge of 120 m^3/s, which corresponds to about 40% of a 30-year return period flood (320 m^3/s) in the upstream of Deli River, is diverted into the floodway.

(b) In ordinary time except during flood, the whole discharge of Deli River is diverted into its downstream with no flow discharge to the floodway to maintain the current water uses in the downstream area.

Among three types of diversion structure, Type I is selected with its superiority to the required functions. The wide stretch upstream of the diversion structure is used as impounding area to reduce water velocity and ensure flood diversion as designed. The optimum layout and structure of the diversion works are presented in Fig. 4-10.

4.4 Dam Construction

Dam and Reservoir

The principal features of Lausimeme Dam and its reservoir are summarized as follows:

Purpose	:	Flood Control and Water Supply
Type of Dam	:	Rockfill Dam with Center Core
Height	:	74.5 m
Crest Length	:	195 m
Crest Elevation	:	EL. 256.5 m
Embankment Volume	:	1,750,000 m^3
Catchment Area	:	106 km^2
Impounding Surface Area	:	1.7 km^2 (at Surcharge Water Level)
Sediment Capacity	:	550,000 m^3 (for period of 50 years)
Water Supply Capacity	:	29,500,000 m^3 (Intake Rate, 3.7 m^3/s)
Flood Control Capacity	:	3,900,000 m^3 (incl. 20% allowance)
Total Storage Capacity	:	33,950,000 m^3

Related Structures

The location and features of related structures are shown in Fig. 4-11 together with those of the proposed dam.

(1) Spillway

A spillway will be installed on the left bank at the dam site. The principal features of the overflow part of the spillway are as follows (refer to Fig. 4-12):

Design Discharge	:	360 m^3/s (60 m^3/s for flood control)
Type	:	Non-gated side overflow weir
Dimensions	:	14.4 m wide at NWL, and 30.6 m wide at SWL

(2) Diversion Works

A temporary diversion works during dam construction is planned applying a diversion tunnel below the left abutment of the dam body. The design discharge for the tunnel is 180 m^3/s which corresponds to a flood of a 20-year return period. The principal features are as follows:

Design Discharge	:	180 m^3/s (20-year return period)
Type	:	Horseshoe-shaped Section
Diameter	:	6 m
Length	:	500 m

(3) Intake Facilities

The intake facilities will be designed to allow the intake volume of 3.7 m^3/s at the low water level of the reservoir. For the intake, an intake tower is provided at the mouth of the temporary diversion tunnel running through the abutment of the left bank of the dam.

4.5 Construction Schedule and Cost Estimate

Construction Schedule

The construction schedule of the urgent project is proposed in consideration that the target year is set at 2000. Dividing the urgent project into two (2) areas; namely, the Deli-Percut River System and the Padang River Basin, a higher priority is given to the former area because it includes Medan City where flood damage and water shortage are most serious in the study area.

Among the project components of Deli-Percut River System, the Percut river improvement is to be carried out earlier than the other components since this is the most critical factor to facilitate the efficient functions of the proposed structures in the urgent flood control plan. On the other hand, the construction of Lausimeme Dam shall be completed before or at the same time with Medan Floodway in order to compensate the additional flood discharge to the Percut River through the floodway.

As for the Padang River Basin, the improvement works is divided into two (2) stages; one is the urgent portion and the other is for the master plan. The urgent portion is to be implemented by the target year 2000. In consideration of the required construction periods of all project components, the construction schedule are proposed as follows:

(a) Deli River Improvement : 1995 to 2000 (6 years)
(b) Percut River Improvement : 1995 to 1997 (3 years)
(c) Construction of Floodway : 1995 to 1998 (4 years)
(d) Construction of Lausimeme Dam : 1995 to 1998 (4 years)
(e) Padang River Improvement : 1996 to 2002 (5 years)

Cost Estimate

The summary of project cost is shown in the following table. The breakdown of cost is presented in Table 4-1 and the disbursement schedule is in Table 4-2.

Summary of Urgent Project Cost (Million Rp.)

	Works/Items	F.C.	L.C.	Total
1.	Construction Base Cost			
1.1	Deli River Improvement	43,924	32,915	76,839
1.2	Medan Floodway	13,233	8,118	21,351
1.3	Percut River Improvement	20,348	8,729	29,077
1.4	Lausimeme Dam	67,246	34,988	102,234
1.5	Padang River Improvement	33,503	15,955	49,458
	Sub-Total of 1	178,254	100,705	278,959
2.	Engineering Services	36,966	6,404	43,370
3.	Compensation	0	34,226	34,226
4.	Administration (7% of 1; L.C.)	0	19,527	19,527
	Sub-Total of 2 to 4	36,966	60,157	97,123
5.	Price Escalation (8%; L.C.)	0	92,470	92,470
6.	Physical Contingency (10% of 2 to 5)	21,521	25,333	46,854
7.	Value Added Tax (10% of 2 to 6; L.C.)	0	51,541	51,541
Grand Total		236,741	330,206	566,947

4.6 Evaluation of Urgent Project

Economic Evaluation

The economic evaluation is carried out on the urgent project of the Deli-Percut River System and the Padang River Basin. Objectives of the evaluation are flood control project with 30-year return period and water supply for the Deli-Percut River System, and flood control project with 10-year return period for the Padang river.

The evaluation is conducted by the usual means of Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and Benefit-Cost Ratio (B/C) by using economic cost and benefit of the project.

The project life is economically taken as 50 years after completion of the construction works. The project benefit together with operation, maintenance and replacement costs (OMR cost) is assumed to occur every year throughout the project life, and the partial benefit and OMR cost which will be brought from a partial improvement of river works before completion of the construction works are presumed to accrue in proportion to progress of the construction and to be approximately given in a ratio of the invested construction cost to the total construction cost.

The results of the cost-benefit analysis for both the urgent projects of flood control and water supply are given in Table 4-3, and the EIRR is summarized below:

Economic Internal Rate of Return

Project	EIRR (%)
1. Deli-Percut River System	
1.1 Integrated	14.35
1.2 Flood Control	17.90
1.3 Water Supply	9.90
2. Padang River Flood Control	11.86

The above results show that the flood control projects are economically feasible. As for the water supply project, the EIRR is nearly 10%, which is a fairly high rate compared with those of similar domestic water supply projects. This shows that the water supply project is feasible from the socioeconomic point of view.

Sensitivity Test

Sensitivity tests were made on the EIRRs with 5% and 10% increase in the economic cost and with 5% and 10% decrease in the economic benefit. The results show that the EIRRs of the integrated project and the flood control project are still maintained at more than 10% even if the cost goes up by 10% or the benefit comes down by 10%, which means that the economic feasibility of these projects is justifiable. The water supply project also maintains an EIRR of more than 9% even if the cost or benefit increases to 10% or decreases to 10%, respectively, which means that the project satisfies the condition of socioeconomic feasibility.

Environmental Impact Evaluation

The main subjects concerning the construction of a dam are the biological aspects. There are 37 species of terrestrial flora, 20 kinds of wild animals and 29 kinds of birds observed in the dam project area. Several of them are specifically protected under government regulations, and none of them are endangered by implementation of the project.

The route of the floodway is almost covered by rice paddy and bushes, but the main environmental impact of the floodway will arise after construction. In the dry season, the floodway may be a dumping site of solid waste or garbage of households without proper management.

The main subjects in the environmental impact of river improvement for Deli, Percut and Padang are the aquatic flora and fauna, house evacuation and land acquisition. There are only 11 to 15 kinds of terrestrial flora and 14 types of fishes observed in the Padang, Deli and Percut rivers. No protected species is observed. The required house evacuation is estimated at about 1,500 houses. Results of impact analyses using the matrix method are summarized as follows:

Environmental Impact Analysis

Project	Basic Evaluation on Environment			Change of Environmental Beauty
	Importance of Resources	Environment Condition	Sensitivity of Management	
Lausimeme Dam	very high scale of 5	good scale of 5	medium scale of 3	-1 (-15%)
Medan Floodway	very high scale of 5	good scale of 4	medium scale of 3	-1 (-12%)
Deli River Improvement	high scale of 5	good scale of 4	medium scale of 3	-1 (-19%)
Percut River Improvement	high scale of 5	good scale of 4	medium scale of 3	-1 (-14%)
Padang River Improvement	high scale of 5	good scale of 4	medium scale of 3	-1 (-17%)

4.7 Project Implementation

Implementation Schedule

The urgent plan concerns two (2) areas, the Deli-Percut River System and the Padang River Basin. The former is tentatively named as the Deli-Percut River Flood Control and Water Supply Project and the latter is the Padang River Improvement Project.

The financial project cost is estimated at Rp. 493,373 million for the Deli-Percut and Rp. 73,574 million for the Padang, totaling approx. Rp. 567 billion including price escalation (at 1991 prices). Therefore, the annual average fund required for project implementation is approx. Rp. 95 billion which corresponds to 2.2% of the projected GRDP of Rp. 4,370 billion in the study area in 1991, while the projected budget expenditure of the North Sumatra Provincial Government is about Rp. 450 billion in 1991.

Therefore, it is assumed that project implementation is to be financed by international funding institutions.

The invitation for prequalification of construction contractors for the Deli River Improvement Works which has been proposed under the flood control component of MUDP II, was made on November 12, 1991. Channel improvement, lining levee embankment and ancillary works will be undertaken for a total stretch of 25,309 m of the Deli mainstream up to the confluence with Babura River. Construction works started in 1992 and are expected to be completed in 1995.

In view of the implementation of the Deli River Improvement Works mentioned above, implementation of the Deli-Percut River Flood Control and Water Supply Project is divided into two (2) portions. One is the Deli River Improvement Works and the other portion consists of the Percut River Improvement Works, the construction of Medan Floodway and the construction of Lausimeme Dam. The financial project cost for the former is Rp. 226,630 million and the latter is Rp. 266,743 million.

The annual average fund required for the implementation of the Deli- Percut River Flood Control and Water Supply Project excluding the Deli River Improvement Works is, therefore, estimated at approx. Rp. 38 billion. As for the Padang River Improvement Project, it is estimated at Rp. 12 billion.

In compliance with the construction schedule stated in Subsection 5.5.1 of the Main Report, priority of implementation is given to the Deli- Percut River Flood Control and Water Supply Project. On the assumption that the detailed design for the project excluding the Deli River Improvement Works is carried out after this feasibility study, the implementation schedule is prepared based on the priority of project components, with the target year for completion at 2000, as shown in Fig. 4-13.

<u>Recommendation to Pursue the Urgent Project</u>

(1) Development of Tourism and Recreation

Toba Lake is well known as a resort among the people in Medan and its vicinity. However, the location is far and only those who can financially afford visit the lake for leisurely activities.

The proposed Lausimeme Dam is only 32 km away from the center of Medan. The surrounding area is gifted with natural vegetation, flora and fauna, and topographically superior scenery. Construction of the dam will create an artificial lake which has many possibilities for recreational activities such as fishery, camping, swimming, boat rowing and other water-related amusements. With its easy accessibility and the abundant natural resources, the Lausimeme Dam could be a promising resort for tourism development.

In this connection, it is recommended that land resources development be studied and implemented simultaneously with the implementation of the urgent project.

(2) Participation of Private Sector

In accordance with the procedure for a large-scale water supply development project in Indonesia, water sources are developed by the central government, i.e., the DGWRD, Ministry of Public Works, as part of multipurpose water resources development. Water for municipal/domestic uses is allocated to the DGCK and to local governments which are responsible for water supply projects at the producer's price.

Then, a kind of state enterprise (PDAM) manages the water supply system after the construction of main structures and the transfer of operation/administration from the BPAM. As a private sector organization, the state enterprise has to gain some profits for cost of operation/maintenance of the system and for cost of future improvement and expansion of services. The storage capacity of the proposed reservoir is allocated mostly for water supply, which is estimated at 29,500,000 m^3 or 90% of the effective storage capacity.

The proposed Lausimeme Dam, as stated in the foregoing, is expected to have secondary benefits by promoting tourism development and increasing opportunities for leisure and recreation of people in Medan and its vicinity. Although Lausimeme Dam will have an important effect on flood control of the Deli-Percut River System, the dam and reservoir as well as the impounded water will contribute much to the area of Medan and its vicinity for the betterment of people's living standard. Therefore, it is recommended that the participation of the private sector is not only on operation/maintenance but also on project implementation.

(3) Further Study

(a) Survey

The optimum floodway route is selected in this study using the topographic map with a scale of 1:5,000. Therefore, detailed river survey or topographical survey is recommended to be conducted in the detailed design stage. Furthermore, detailed topographic survey with a scale of 1:500 is required for the proposed Lausimeme dam site and additional aerophoto mapping with a scale of 1:5,000 is necessary for possible quarry sites around the reservoir.

(b) Geological Investigation

In this present study, a total of 150 m of drilling, in-situ permeability test and some uniaxial compression of drilling core were undertaken for the proposed Lausimeme Dam. Detailed geological investigation of additional drilling for the dam site and saddle portion of the reservoir are necessary for the detailed design. Investigation of core and rock materials and other soil mechanics tests shall be carried out before the detailed design.

(c) Environmental Impact Analysis

During the feasibility study, environmental impact study (ANDAL) was conducted for the urgent project. Although the study shows only small negative impacts to occur during the construction of the urgent project as stated in Section 5.7 of the Main Report, a more detailed environmental impact assessment has to be conducted by the authorized commission before the detailed design with simultaneous preparation of the environmental management plan and the environmental monitoring plan.

TABLES

Table 4-1 PROJECT COST OF URGENT PROJECT

Item	Unit	Quantity	Cost (million Rp.) F.C.	L.C.	Total
1. Construction Base Cost					
1.1 Deli River Improvement (L = 37.4 km)			43,924	32,915	76,839
Preparatory Works	L/S		7,320	5,486	12,806
Excavation	1000 m3	2,352	9,351	4,201	13,552
Embankment	1000 m3	492	3,901	2,009	5,910
Revetment	1000 m2	545	12,157	17,487	29,644
Parapet Wall	m	2,500	2,220	740	2,960
Sluiceway	site	5	487	162	649
Drain	site	97	856	286	1,142
Bridge	site	19	7,632	2,544	10,176
1.2 Medan Floodway (L = 3.8 km)			13,233	8,118	21,351
Preparatory Works	L/S		1,203	738	1,941
Excavation	1000 m3	1,166	4,665	2,096	6,761
Embankment	1000 m3	16	124	64	188
Revetment	1000 m2	97	2,035	2,811	4,846
Weir (Floodway Side)	site	1	1,061	701	1,762
Weir (Deli River Side)	site	1	1,139	706	1,845
Bridge	site	7	3,006	1,002	4,008
1.3 Percut River Improvement (L = 28.0 km)			20,348	8,729	29,077
Preparatory Works	L/S		1,850	794	2,644
Excavation	1000 m3	1,433	5,734	2,576	8,310
Embankment	1000 m3	370	3,798	1,799	5,597
Revetment	1000 m2	6	131	182	313
Weir	site	1	2,136	1,145	3,281
Sluiceway and Water Gate	site	5	1,571	524	2,095
Drain	site	56	495	165	660
Bridge	site	13	4,633	1,544	6,177
1.4 Lausimeme Dam			67,246	34,988	102,234
Preparatory Works	L/S		11,208	5,831	17,039
Excavation	1000 m3	150	654	329	983
Foundation Treatment (Grouting)	1000 m	6	678	222	900
Embankment	1000 m3	1,750	44,800	25,200	70,000
Concrete Works	1000 m3	20	6,000	2,000	8,000
Diversion Tunnel (Dia. 6 m)	m	500	3,063	1,313	4,376
Relocation Road	m	2,500	844	94	938
1.5 Padang River Improvement (L = 29.5 km)			33,503	15,955	49,458
Preparatory Works	L/S		3,046	1,450	4,496
Excavation	1000 m3	3,422	13,695	6,153	19,848
Embankment	1000 m3	848	6,716	3,460	10,176
Revetment	1000 m2	23	499	882	1,381
Weir	site	1	3,616	2,033	5,649
Parapet Wall (Bahilang River)	m	600	540	180	720
Sluiceway	site	4	653	218	871
Drain	site	14	124	41	165
Bridge	site	6	4,614	1,538	6,152
Sub-total of 1.			178,254	100,705	278,959
2. Engineering Services Cost			36,966	6,404	43,370
3. Compensation Cost			0	34,226	34,226
4. Administration Cost *1)			0	19,527	19,527
Sub-total of 2 to 4			36,966	60,157	97,123
5. Price Escalation *2)			0	92,470	92,470
6. Physical Contingency *3)			21,521	25,333	46,854
7. Value Added Tax *4)			0	51,541	51,541
Grand Total			236,741	330,206	566,947

Notes :
1) 7 % of 1. Construction Base Cost
2) Foreign Currency : 0 %, Local Currency 8 %
3) 10 % of 1 to 5
4) 10 % of 1 to 6

Table 4-2 ANNUAL DISBURSEMENT SCHEDULE FOR URGENT PROJECT

(Unit : Million Rp)

Description	Total			1993		1994		1995		1996		1997		1998		1999		2000	
	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. CONSTRUCTION BASE COST	351,161	178,254	172,907	0	0	0	21,712	33,702	24,107	40,403	30,461	44,248	36,800	37,466	35,038	13,141	14,281	9,295	10,508
1.1 Deli River Improvement	76,839	43,924	32,915	0	0	0	0	6,800	5,086	6,800	5,086	10,645	7,691	10,645	7,691	6,440	4,983	2,595	2,378
1.2 Medan Floodway	21,351	13,233	8,118	0	0	0	0	3,308	2,030	3,308	2,030	3,308	2,030	3,308	2,030	0	0	0	0
1.3 Percut River Improvement	29,077	20,348	8,729	0	0	0	0	6,783	2,910	6,783	2,910	6,783	2,910	0	0	0	0	0	0
1.4 Lausimeme Dam	102,234	67,246	34,988	0	0	0	0	16,812	8,747	16,812	8,747	16,812	8,747	16,812	8,747	0	0	0	0
1.5 Padang River Improvement	49,458	33,503	15,955	0	0	0	0	0	0	6,701	3,191	6,701	3,191	6,701	3,191	6,701	3,191	6,701	3,191
1.6 Price Escalation; F.C. 0% & L.C. 8%	72,202	0	72,202	0	0	0	21,712	0	5,335	0	8,498	0	12,232	0	13,379	0	6,107	0	4,939
2. ENGINEERING SERVICES COST	45,503	36,966	8,537	9,309	1,625	11,090	2,284	3,849	993	2,544	620	2,544	669	2,544	723	2,544	781	2,544	843
2.1 Detailed Design	26,022	22,180	3,842	9,309	1,476	11,090	1,921	1,781	445	0	0	0	0	0	0	0	0	0	0
2.2 Construction Supervision	17,348	14,786	2,562	0	0	0	0	2,069	328	2,544	447	2,544	447	2,544	447	2,544	447	2,544	447
2.3 Price Escalation; F.C. 0% & L.C. 8%	2,133	0	2,133	0	149	0	363	0	220	0	173	0	222	0	276	0	334	0	396
3. COMPENSATION COST	42,636	0	42,636	0	0	0	16,456	0	26,181	0	0	0	0	0	0	0	0	0	0
3.1 House Evacuation & Land Acquisition	34,226	0	34,226	0	0	0	13,840	0	20,387	0	0	0	0	0	0	0	0	0	0
3.2 Price Escalation; F.C. 0% & L.C. 8%	8,410	0	8,410	0	0	0	2,616	0	5,794	0	0	0	0	0	0	0	0	0	0
4. ADMINISTRATION COST	29,252	0	29,252	0	0	0	0	0	4,717	0	6,055	0	7,215	0	6,695	0	2,607	0	1,963
4.1 Administration (7% of 1.1+1.2+1.3+1.4+1.5)	19,527	0	19,527	0	0	0	0	0	3,673	0	4,366	0	4,817	0	4,139	0	1,492	0	1,040
4.2 Price Escalation; F.C. 0% & L.C. 8%	9,725	0	9,725	0	0	0	0	0	1,044	0	1,689	0	2,398	0	2,556	0	1,115	0	923
5. TOTAL (1+2+3+4)	468,552	215,220	253,332	9,309	1,625	11,090	40,452	37,551	55,998	42,946	37,136	46,792	44,684	40,009	42,455	15,684	17,668	11,839	13,314
6. PHYSICAL CONTINGENCY	46,854	21,521	25,333	931	163	1,109	4,045	3,755	5,600	4,294	3,713	4,679	4,469	4,001	4,245	1,568	1,767	1,184	1,331
6.1 Physical Contingency: 10% of 1.	35,117	17,826	17,291	0	0	0	2,171	3,370	2,411	4,040	3,046	4,425	3,680	3,747	3,504	1,314	1,428	930	1,051
6.2 Physical Contingency: 10% of 2.	4,548	3,695	853	931	163	1,109	228	385	99	254	62	254	67	254	72	254	78	254	84
6.3 Physical Contingency: 10% of 3.	4,264	0	4,264	0	0	0	1,646	0	2,618	0	0	0	0	0	0	0	0	0	0
6.4 Physical Contingency: 10% of 4.	2,925	0	2,925	0	0	0	0	0	472	0	605	0	722	0	669	0	261	0	196
7. TOTAL (5+6)	515,406	236,741	278,665	10,240	1,788	12,199	44,497	41,306	61,598	47,240	40,849	51,471	49,153	44,010	46,700	17,252	19,435	13,023	14,645
8. VAT: 10% of 7.	51,541	0	51,541	0	1,203	0	5,670	0	10,290	0	8,809	0	10,062	0	9,071	0	3,669	0	2,767
9. GRAND TOTAL (7+8)	566,947	236,741	330,206	10,240	2,991	12,199	50,167	41,306	71,888	47,240	49,658	51,471	59,215	44,010	55,771	17,252	23,104	13,023	17,412

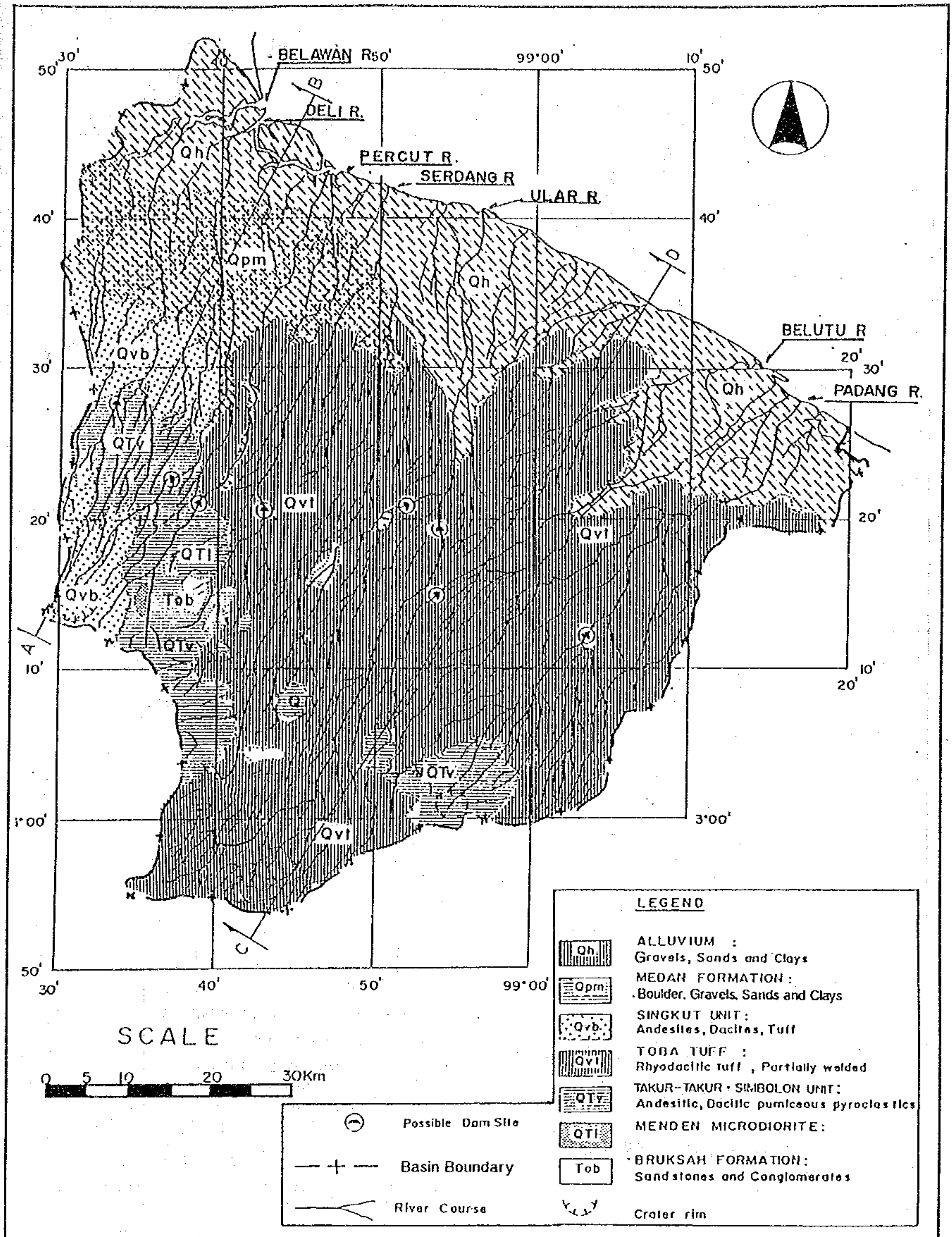
Price Level : September 1991
Conversion Rate : US$1.00 = Rp.1,950 = Yen136

Table 4-3 RESULTS OF ECONOMIC ANALYSIS FOR URGENT PROJECT

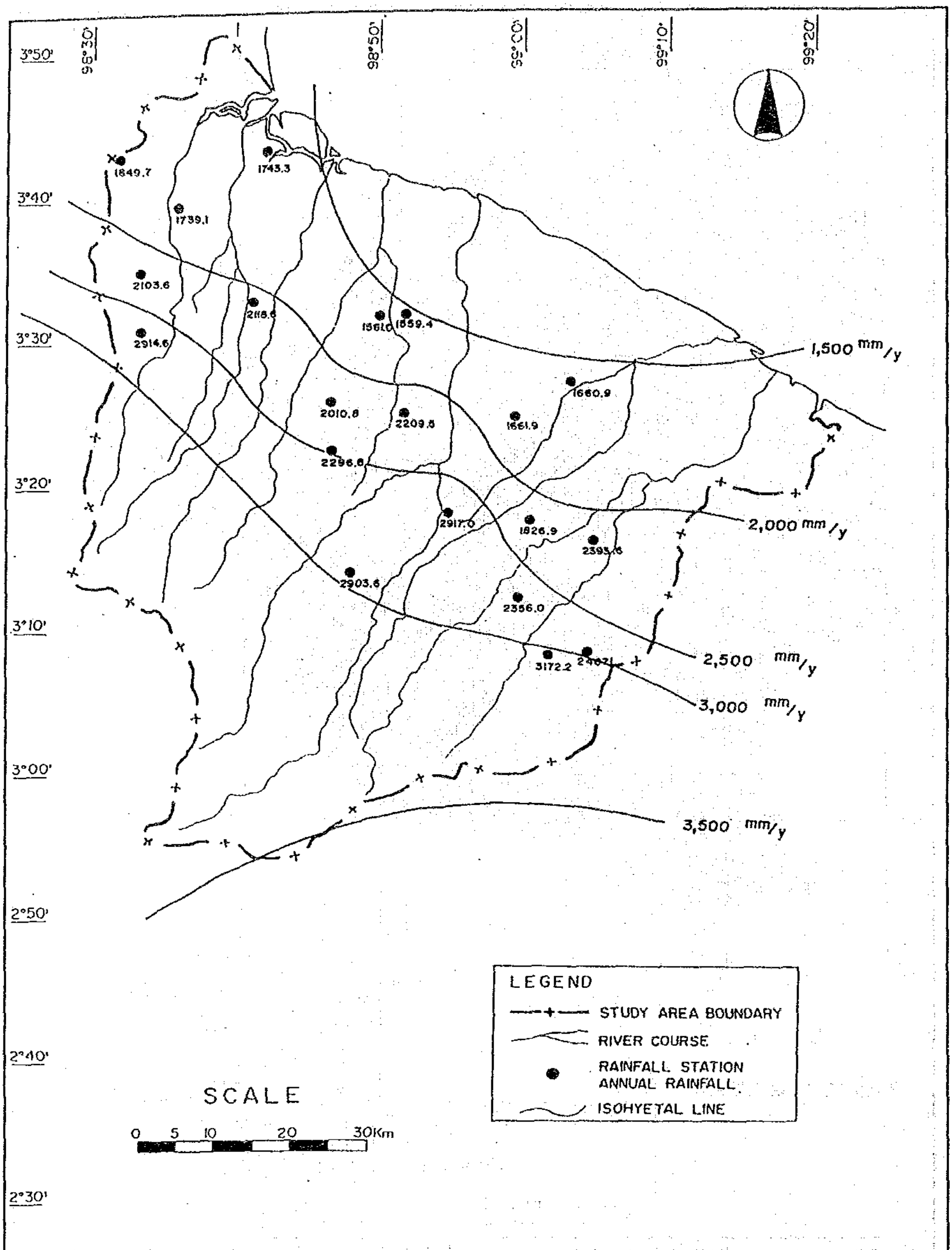
Evaluation Items		1. Deli-Percut River System: Integrated 30-year	1. Deli-Percut River System: Flood Control 30-year	1. Deli-Percut River System: Water Supply	2. Padang River: Flood Control 10-Year
IRR (%)		14.35	17.90	9.90	11.86
NPV (Million Rp)					
Discount	12 %	46,596	66,530	(20,315)	(404)
Rate	10 %	113,286	114,227	(1,295)	6,923
	8 %	226,082	189,914	35,859	19,825
	5 %	588,307	412,244	175,899	61,695
	1 %	2,311,513	1,343,415	968,821	253,095
B/C					
Discount	12 %	1.23	1.51	0.73	0.99
Rate	10 %	1.51	1.80	0.98	1.18
	8 %	1.93	2.22	1.40	1.45
	5 %	3.08	3.29	2.70	2.12
	1 %	7.21	6.71	8.11	4.18

Note: ( ) shows a minus sign.

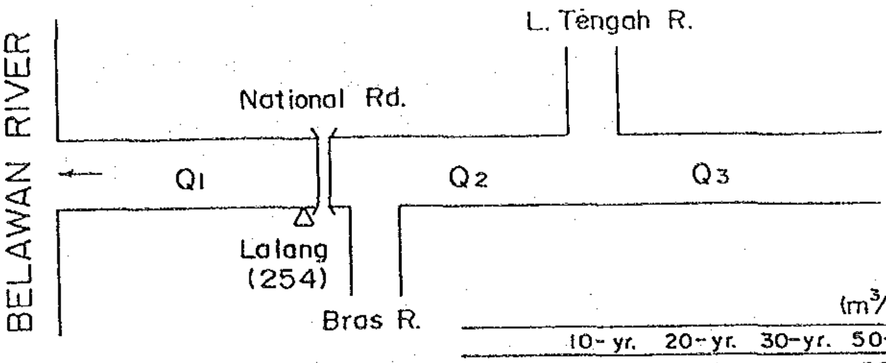
FIGURES



THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA	GEOLOGICAL MAP OF STUDY AREA
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.2-1

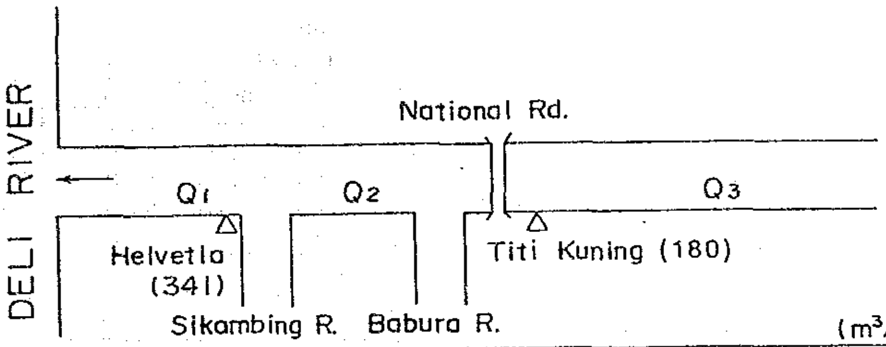


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA	ISOHYETAL MAP OF ANNUAL RAINFALL
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.2-2



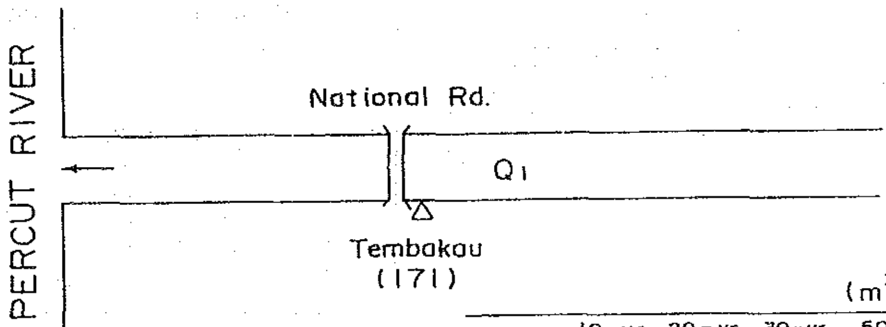
(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr.
Q1	410	470	510	550
Q2	390	440	480	510
Q3	250	290	310	340



(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr.	100-yr.
Q1	460	530	570	620	690
Q2	420	490	520	570	640
Q3	260	300	320	340	380



(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr.	100-yr.
Q1	230	260	280	300	340

LEGEND

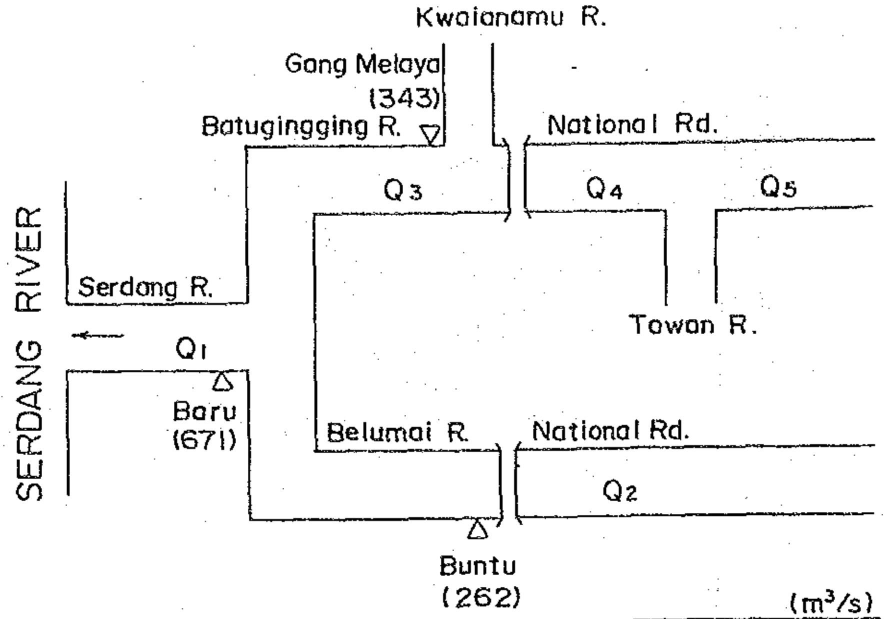
- ⅃ L River Course
- △ Reference Point
- (000) Catchment Area (km²)

THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

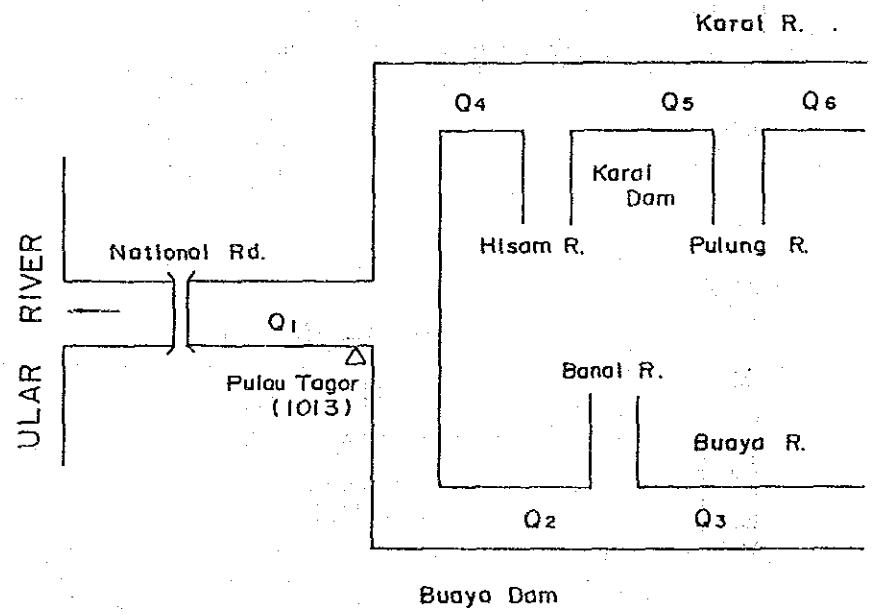
PROBABLE FLOOD DISCHARGE DISTRIBUTION

Fig.2-3(1/3)



(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr.
Q1	680	750	800	850
Q2	270	290	310	330
Q3	390	420	450	480
Q4	310	340	360	380
Q5	100	110	120	130



(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr.
Q1	710	820	890	970
Q2	310	360	390	420
Q3	210	240	260	290
Q4	410	470	510	550
Q5	370	420	450	500
Q6	230	260	280	310

LEGEND

River Course

△ Reference Point

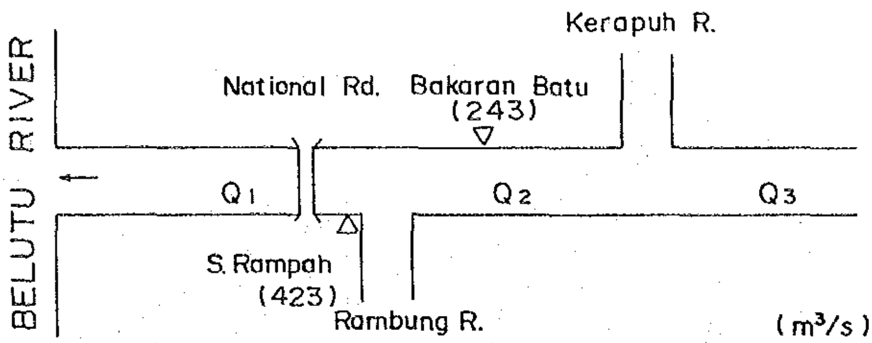
(000) Catchment Area (km²)

THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

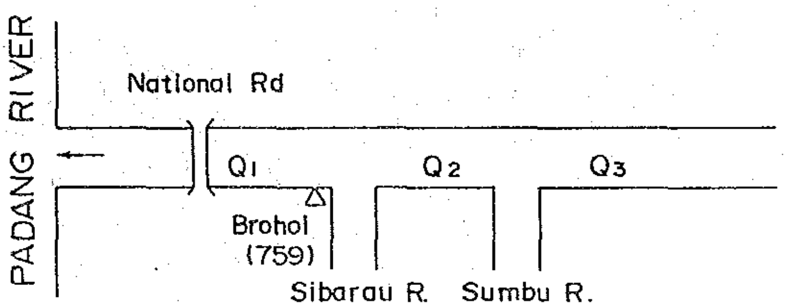
PROBABLE FLOOD DISCHARGE DISTRIBUTION

Fig.2-3(2/3)



(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr
Q1	260	290	310	340
Q2	160	180	190	210
Q3	80	90	95	100



(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr.
Q1	620	720	770	840
Q2	480	550	580	630
Q3	380	440	470	510

LEGEND

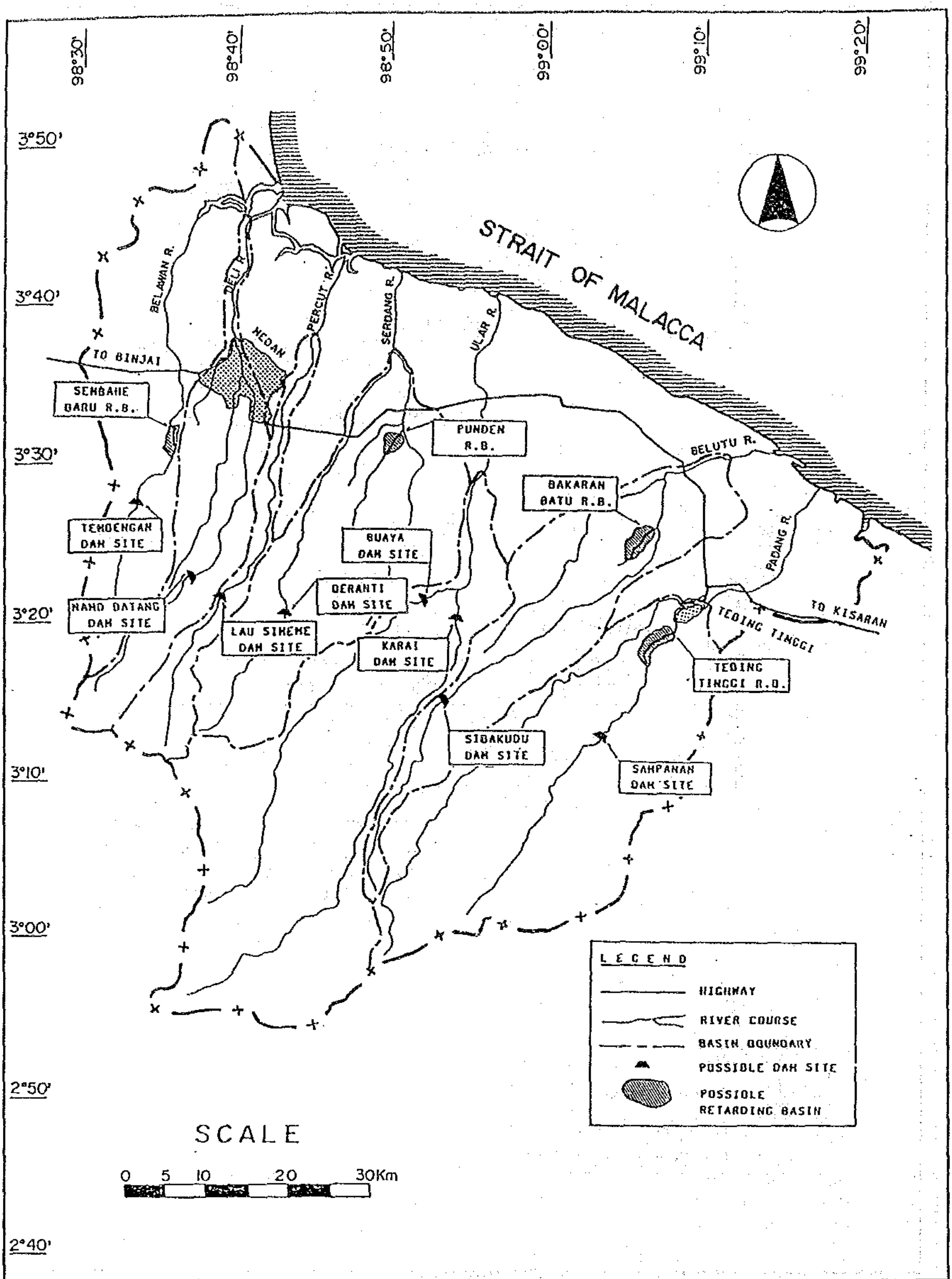
- ┘└ River Course
- △ Reference Point
- (000) Catchment Area (km²)

THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

PROBABLE FLOOD DISCHARGE DISTRIBUTION

Fig.2-3(3/3)

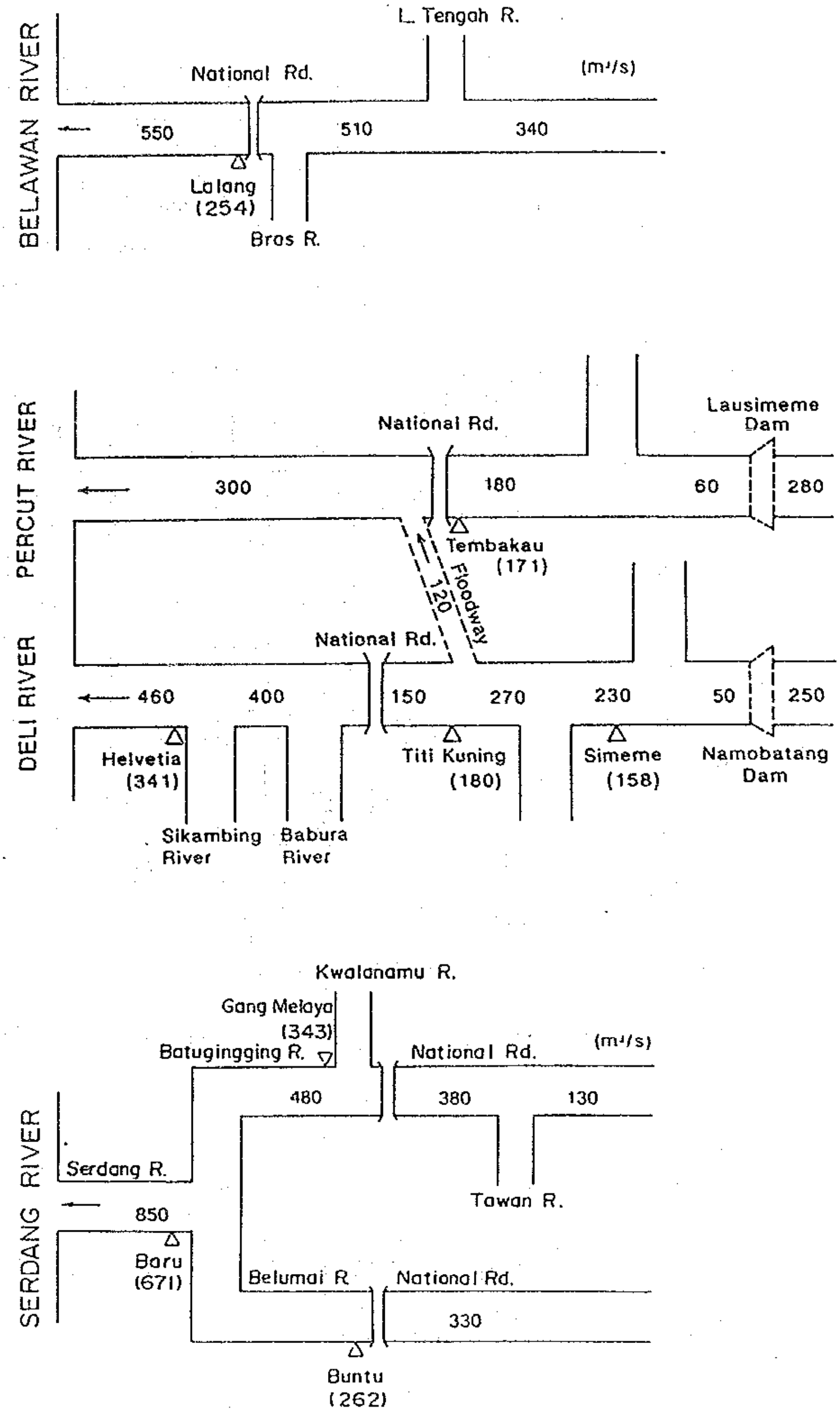


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

LOCATION OF POSSIBLE DAM SITES

Fig.2-4

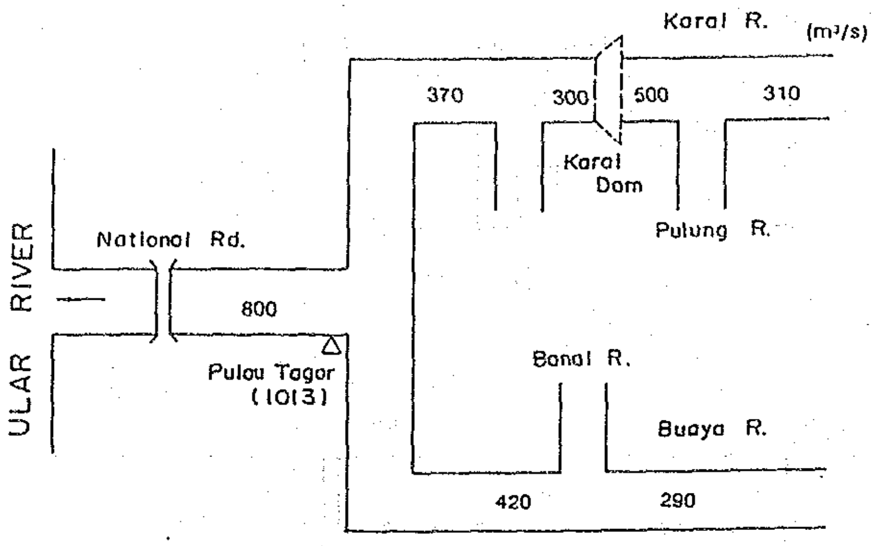


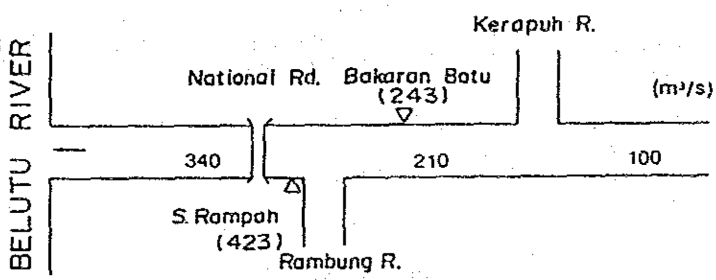
THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

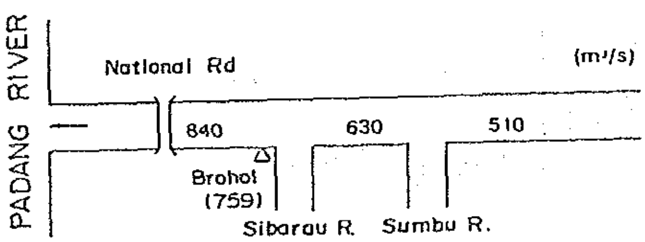
JAPAN INTERNATIONAL COOPERATION AGENCY

DESIGN FLOOD DISCHARGE OF OPTIMUM FLOOD CONTROL PLAN

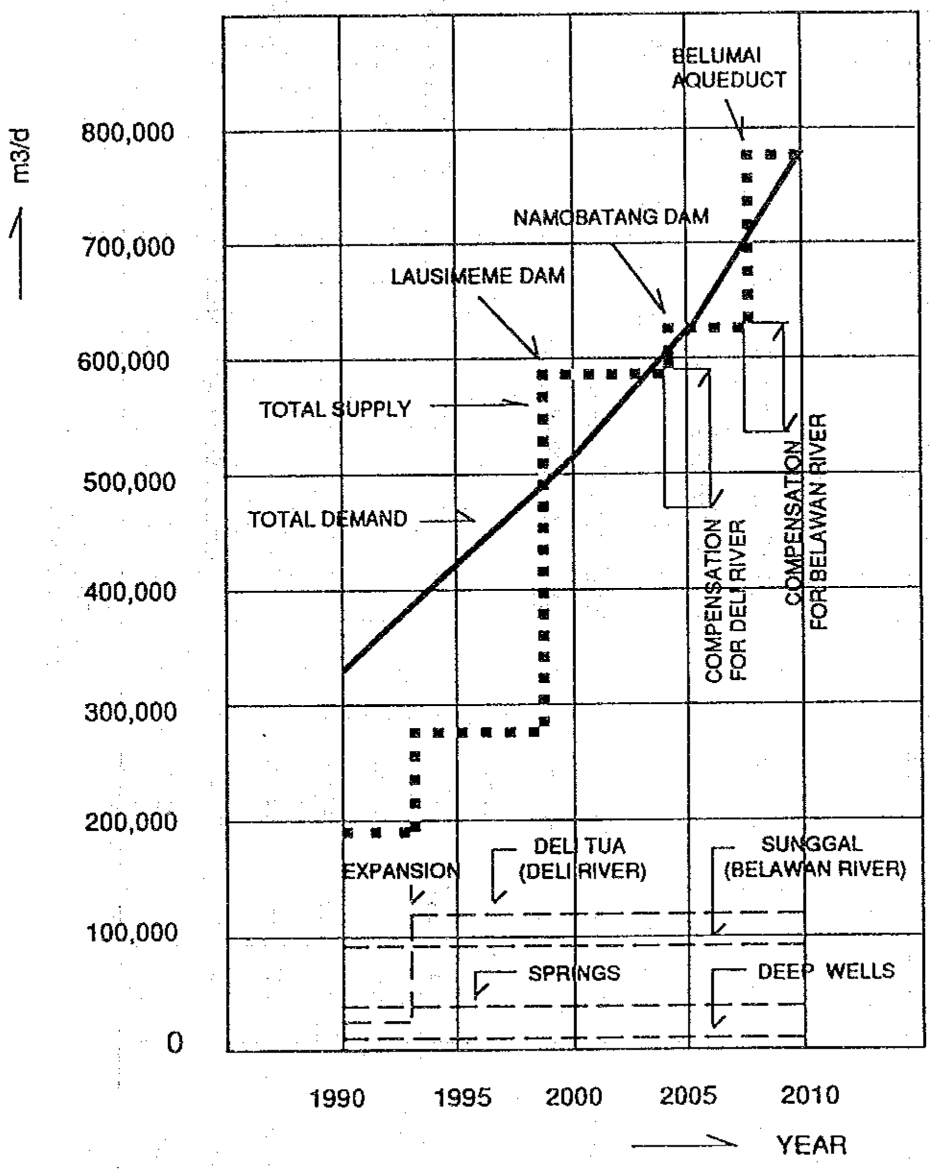
Fig.3-1(1/2)







THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA	DESIGN FLOOD DISCHARGE OF OPTIMUM FLOOD CONTROL PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.3-1(2/2)



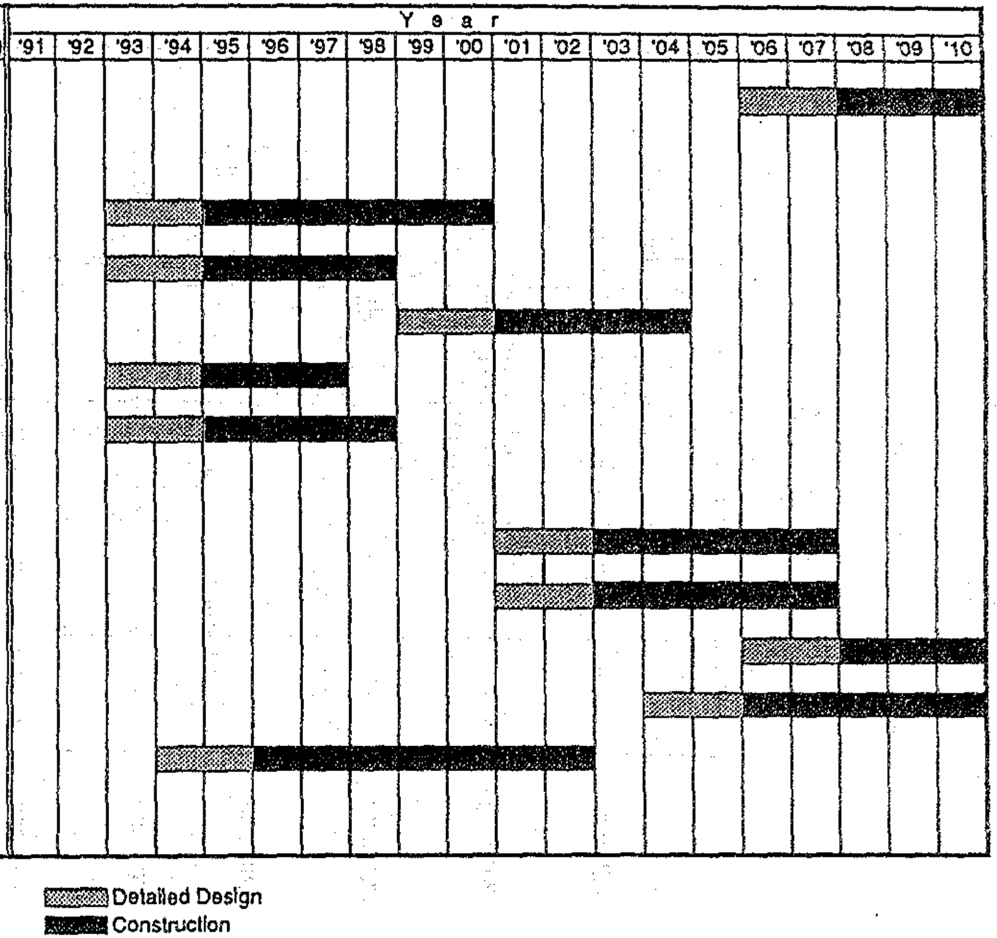
THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

WATER SUPPLY VS. DEMAND

Fig.3-2

Project	Quantity	Unit	Construction Cost (In Mill. Rp.)
1 Belawan River, River Improvement	21.7	km	31,300
2 Deli-Percut River System			403,100
(a) Deli River Improvement	37.4	km	118,600
(b) Medan Floodway	3.8	km	32,000
(c) Namobatang Dam	1	site	63,600
(d) Percut River Improvement	28.0	km	47,600
(e) Lausimeme Dam	1	site	141,300
3 Serdang River			153,900
(a) River Improvement	25.4	km	114,700
(b) Belumai Aqueduct	5.5	km	39,200
4 Ular River, Karai Dam	1	site	16,100
5 Belutu River, River Improvement	32.7	km	56,400
6 Padang River, River Improvement	29.5	km	100,500
Total Construction Cost			761,300

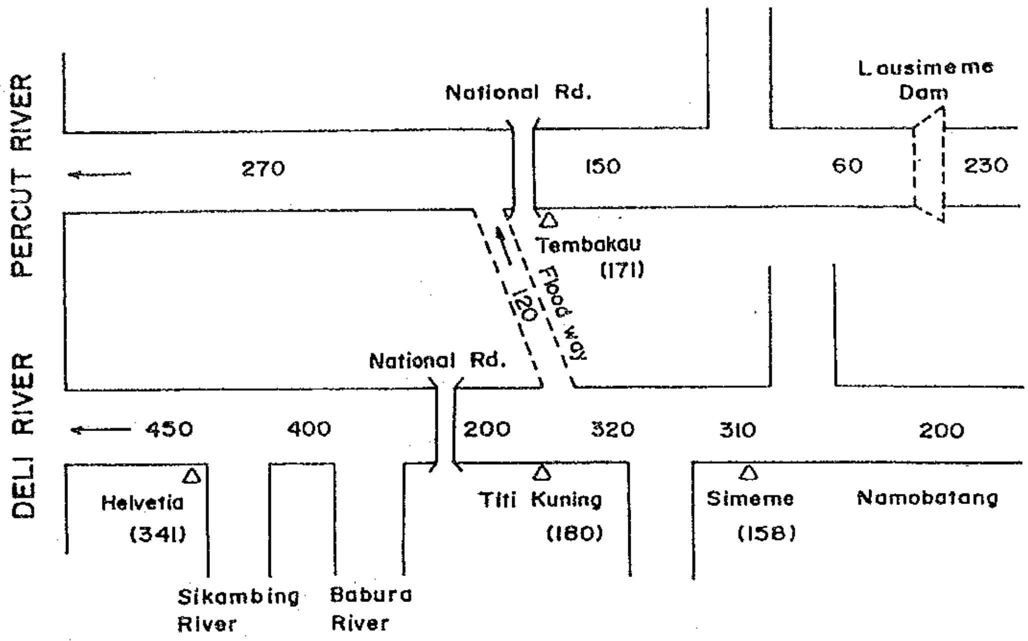


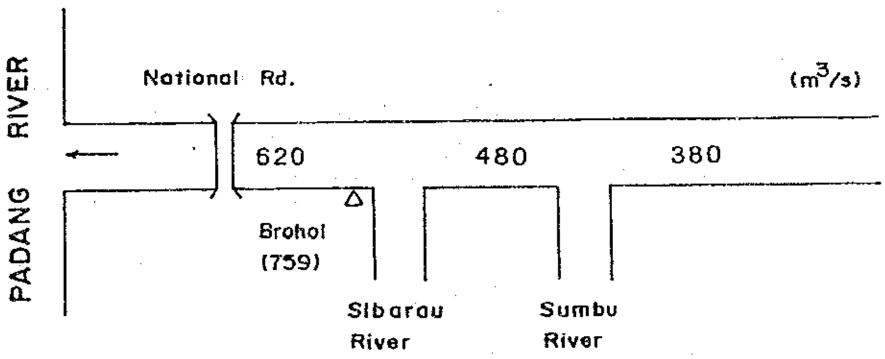
THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

IMPLEMENTATION SCHEDULE OF MASTER PLAN

Fig.3-3



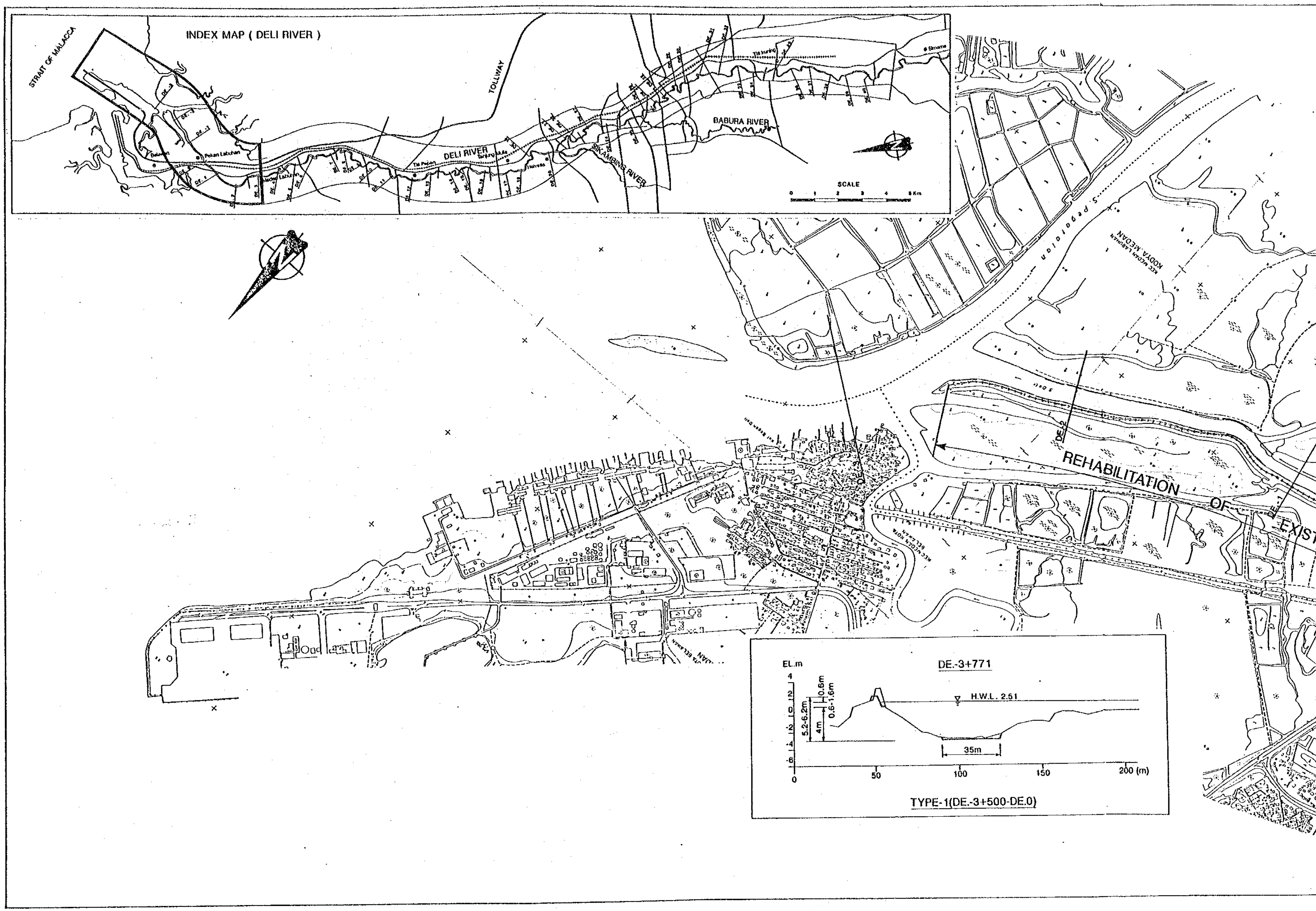


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

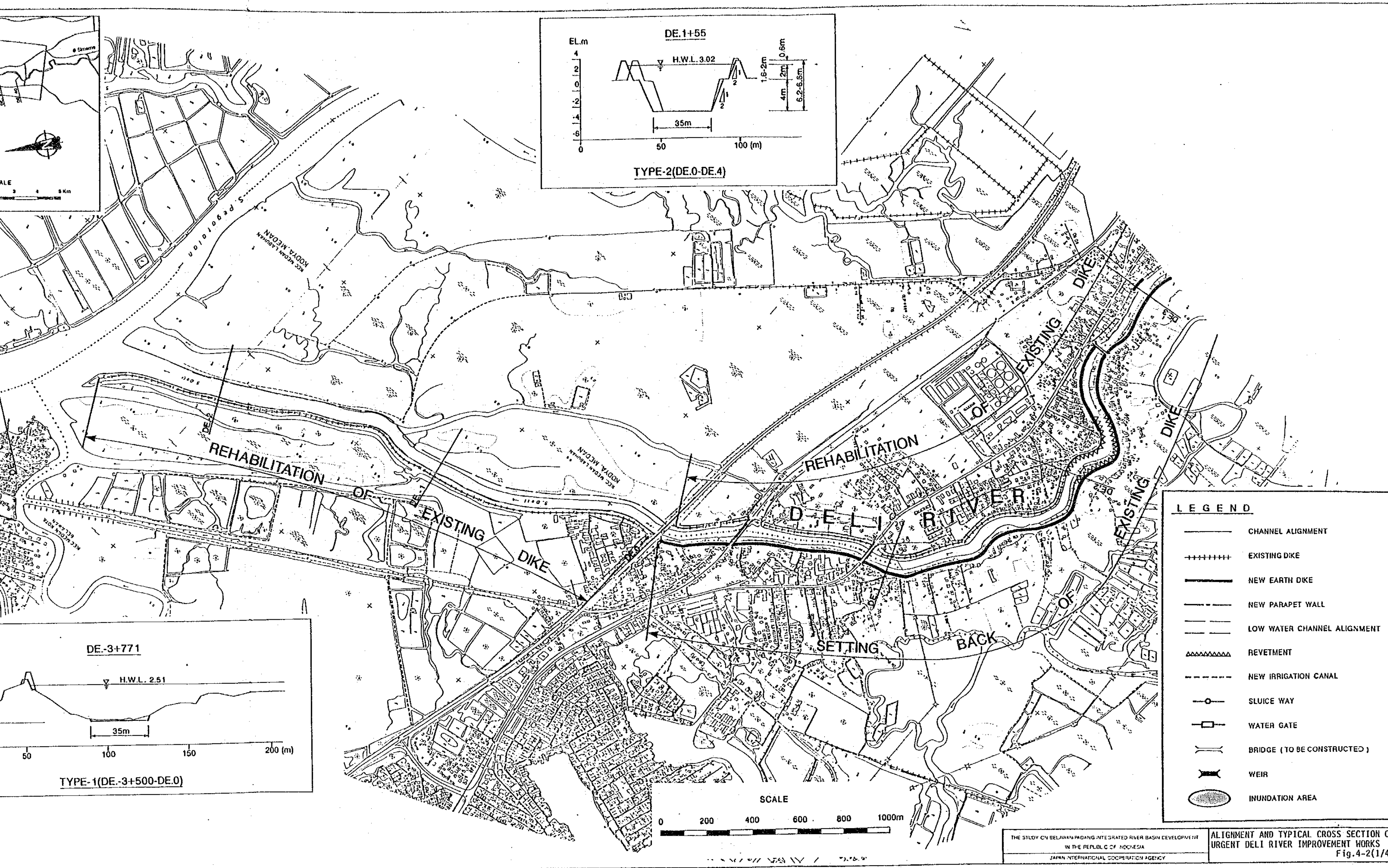
JAPAN INTERNATIONAL COOPERATION AGENCY

DESIGN FLOOD DISCHARGE OF URGENT PROJECT

Fig.4-1

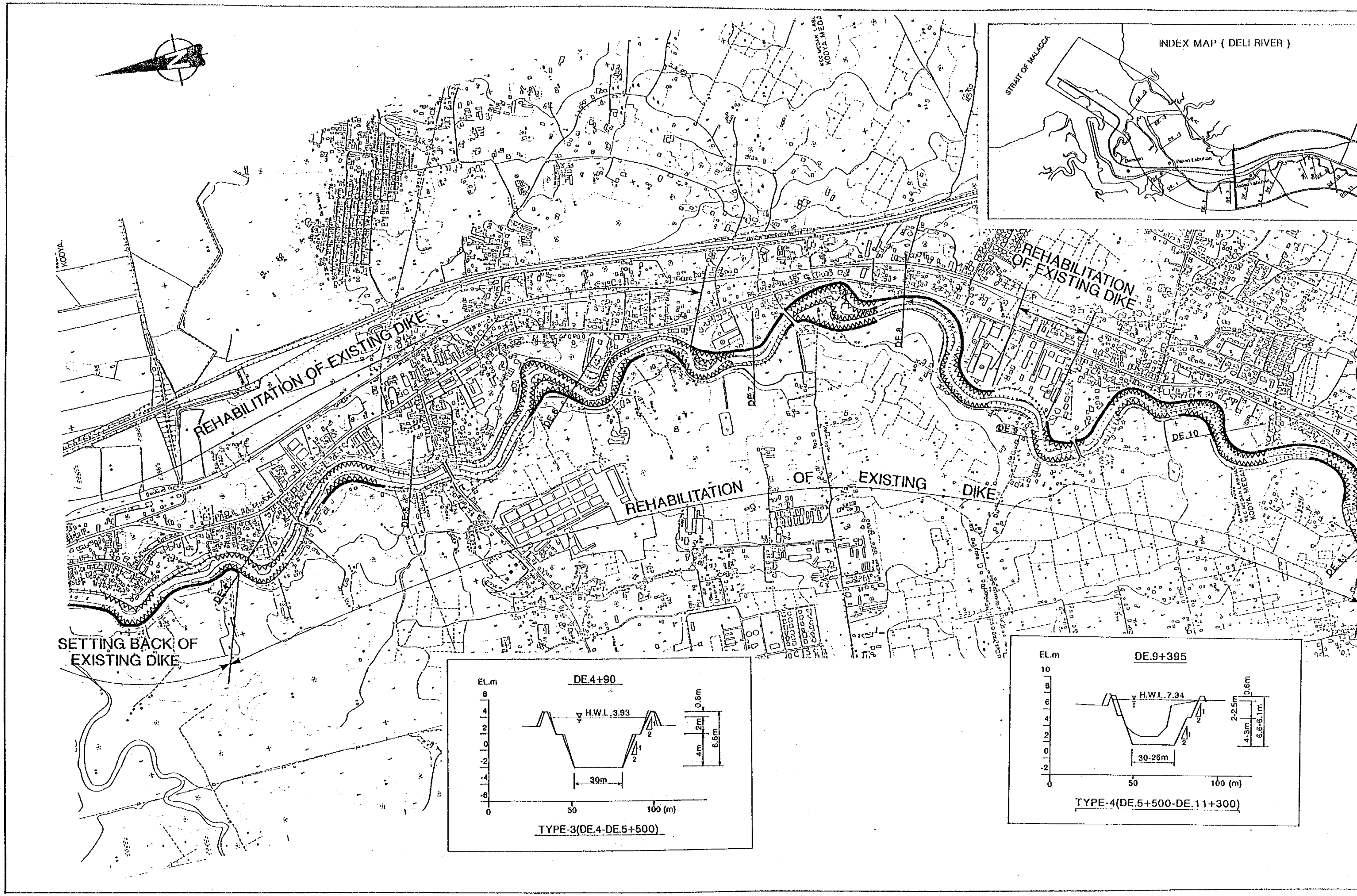


INDEX MAP (DELI RIVER)
STRAIT OF MALACCA
TOLLWAY
DELI RIVER
BABURA RIVER
SIKAMBING RIVER
SCALE
0 1 2 3 4 5 Km
DE.-2
REHABILITATION OF EXIST
DE.-3+771
EL.m
H.W.L. 2.51
0.6m
0.6-1.6m
5.2-6.2m
4m
35m
0 50 100 150 200 (m)
TYPE-1(DE.-3+500-DE.0)



ALIGNMENT AND TYPICAL CROSS SECTION OF URGENT DELI RIVER IMPROVEMENT WORKS

Fig.4-2(1/4)


INDEX MAP (DELI RIVER)
STRAIT OF MALACCA
REHABILITATION OF EXISTING DIKE
REHABILITATION OF EXISTING DIKE
REHABILITATION OF EXISTING DIKE
SETTING BACK OF EXISTING DIKE
KODYA.
DE.6
DE.7
DE.8
DE.10
DE.4+90
EL.m
H.W.L. 3.93
0.6m
2m
4m
6.6m
30m
100 (m)
TYPE-3(DE.4-DE.5+500)
DE.9+395
EL.m
H.W.L. 7.34
30-26m
100 (m)
TYPE-4(DE.5+500-DE.11+300)