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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
REPUBLIC OF THE PHILIPPINES

STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

FINAL REPORT

VOLUME 1

SUMMARY

FEBRUARY 1995

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

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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LIST OF REPORTS

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THE COST ESTIMATE IS BASED

ON THE PRICE LEVEL OF JUNE 1994

AND EXPRESSED IN PHILIPPINE PESO (₱)

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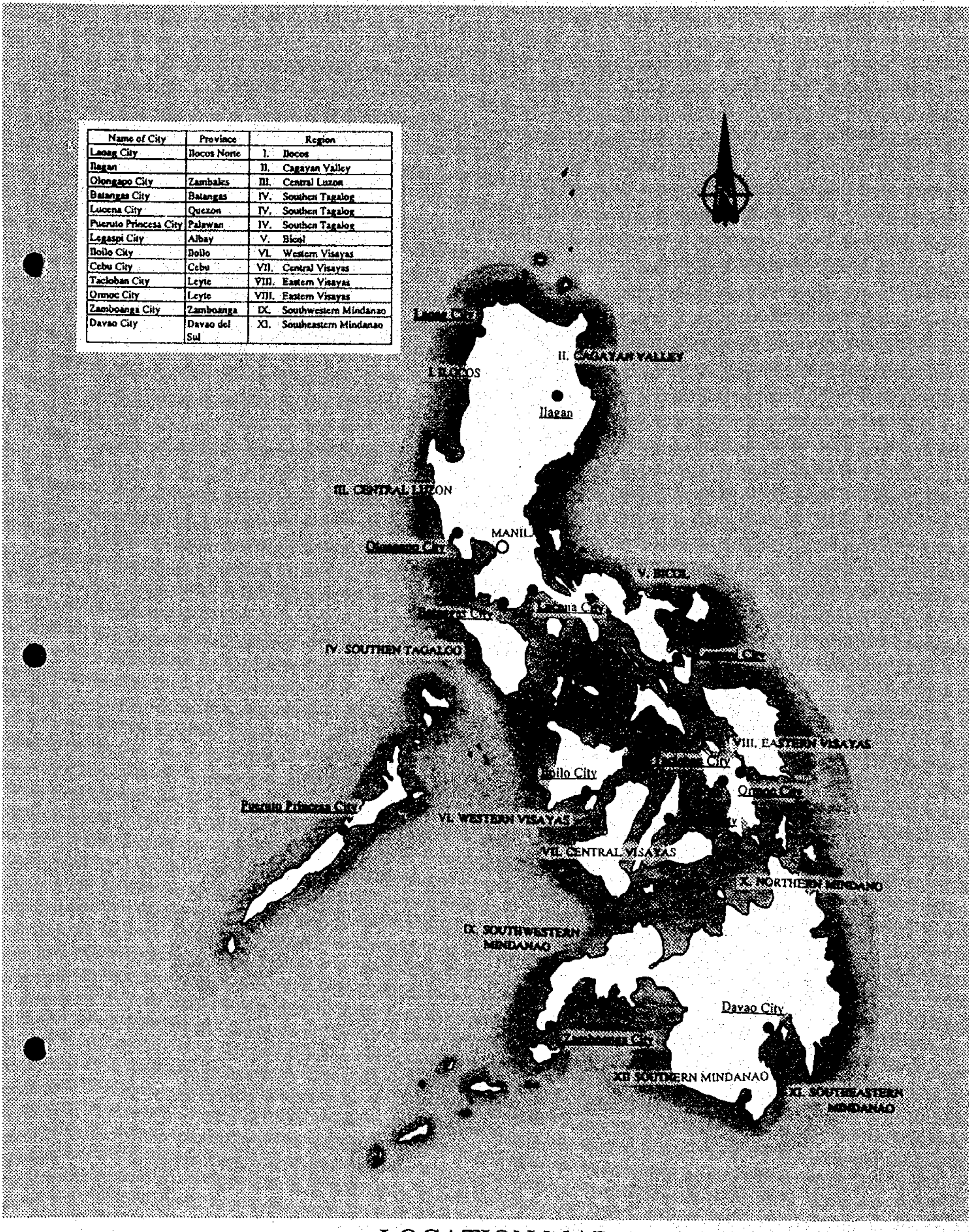
(AS OF JUNE 30, 1994)

Name of City	Province	Region
Laoag City	Ilocos Norte	I. Ilocos
Ilagan		II. Cagayan Valley
Olongapo City	Zambales	III. Central Luzon
Batangas City	Batangas	IV. Southen Tagalog
Lucena City	Quezon	IV. Southen Tagalog
Pueruto Princesa City	Palawan	IV. Southen Tagalog
Legaspi City	Albay	V. Bicol
Iloilo City	Iloilo	VI. Western Visayas
Cebu City	Cebu	VII. Central Visayas
Tacloban City	Leyte	VIII. Eastern Visayas
Ormoc City	Leyte	VIII. Eastern Visayas
Zamboanga City	Zamboanga	IX. Southwestern Mindanao
Davao City	Davao del Sul	XI. Southeastern Mindanao



LOCATION MAP

Name of City	Province	Region
Laoag City	Ilocos Norte	I. Ilocos
Ilagan		II. Cagayan Valley
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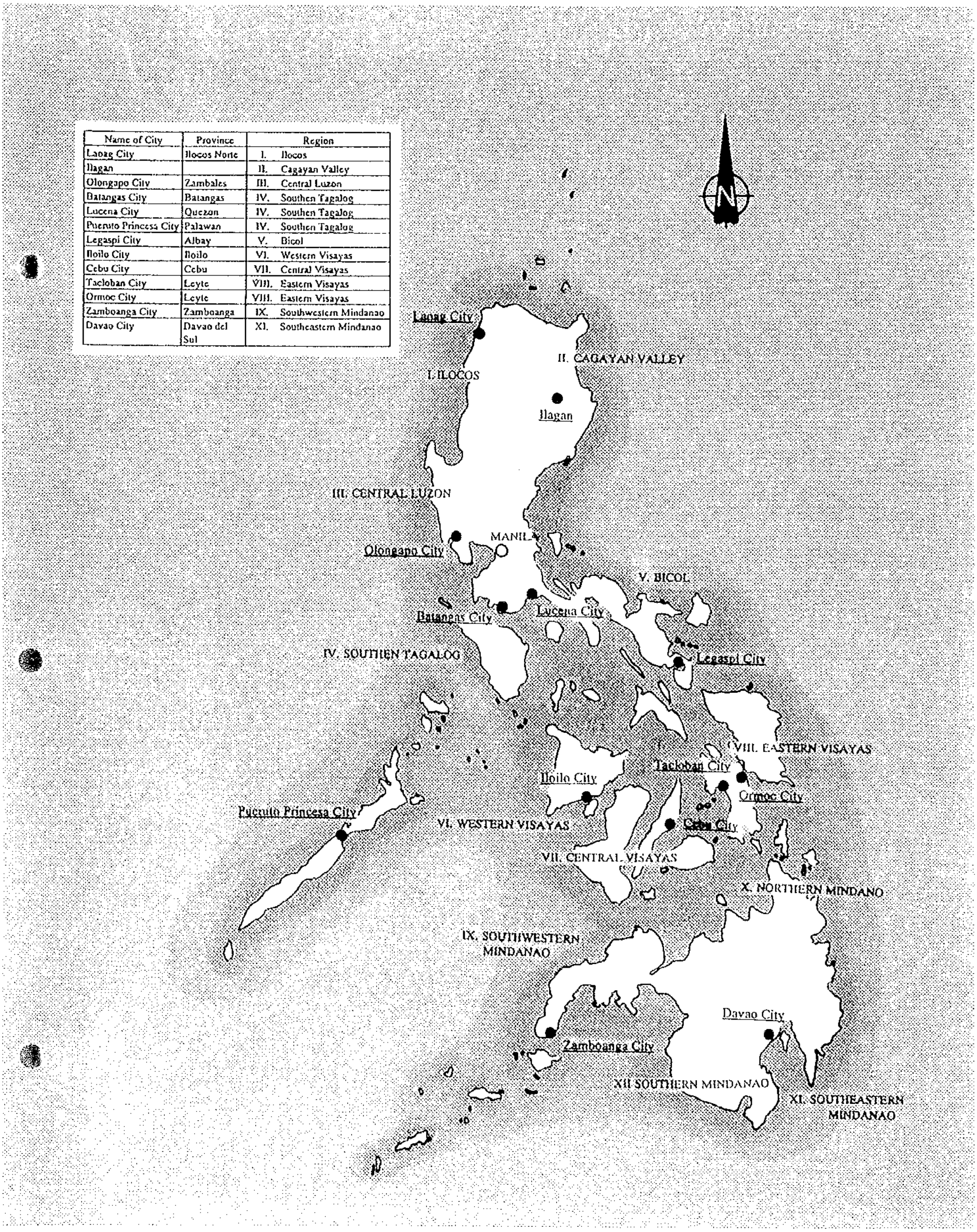

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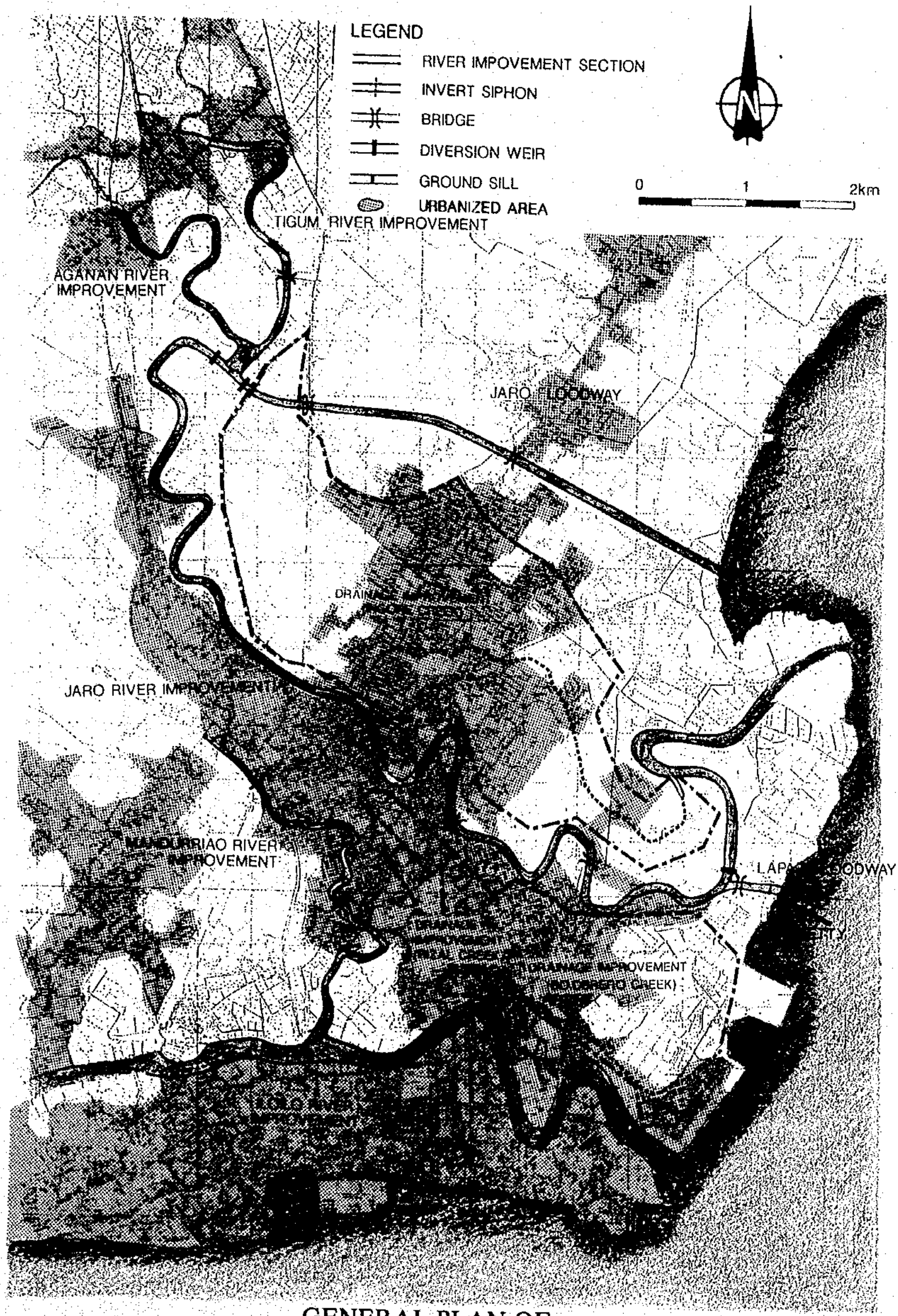
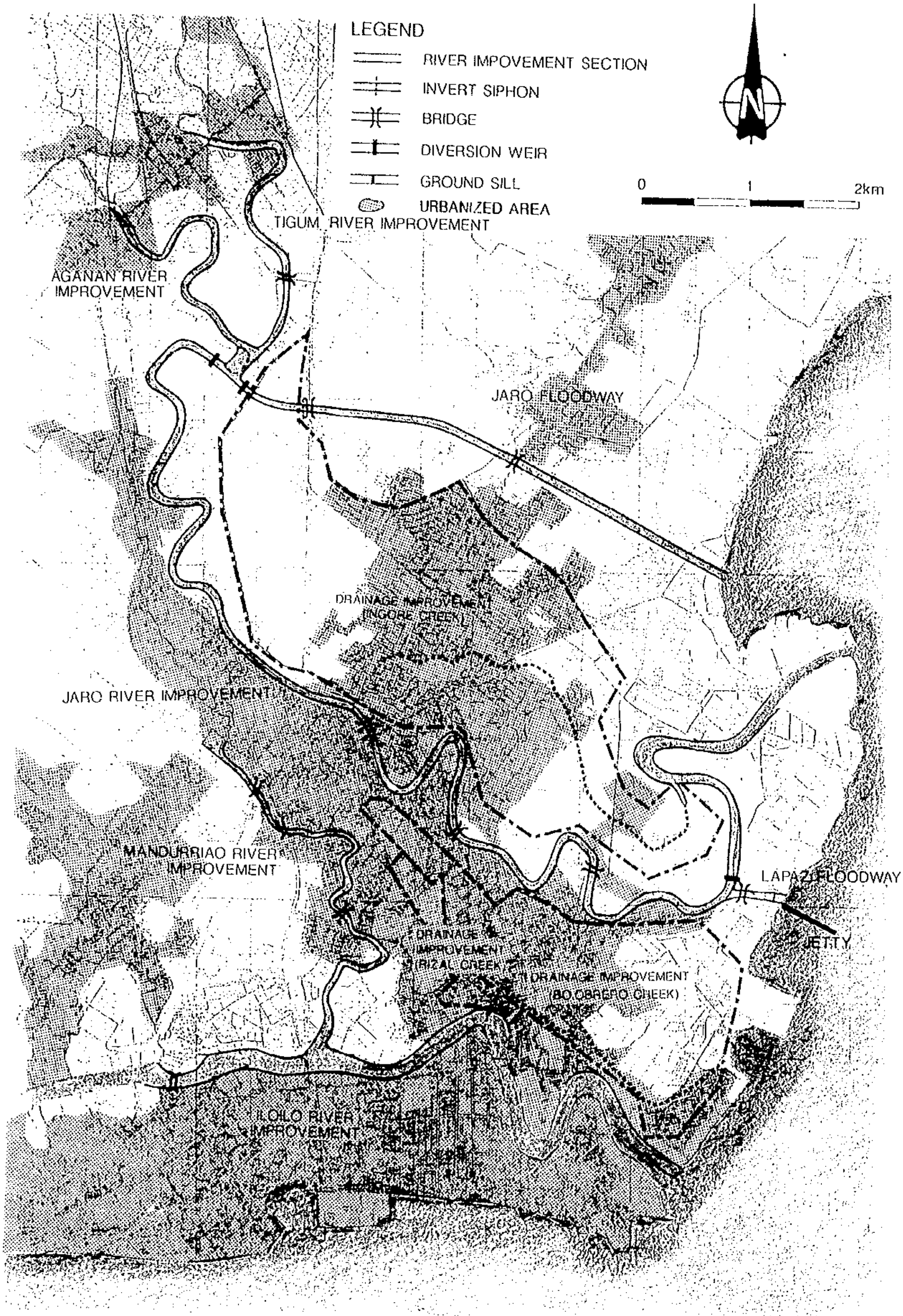


GENERAL PLAN OF
FLOOD CONTROL PROJECT IN ILOILO CITY



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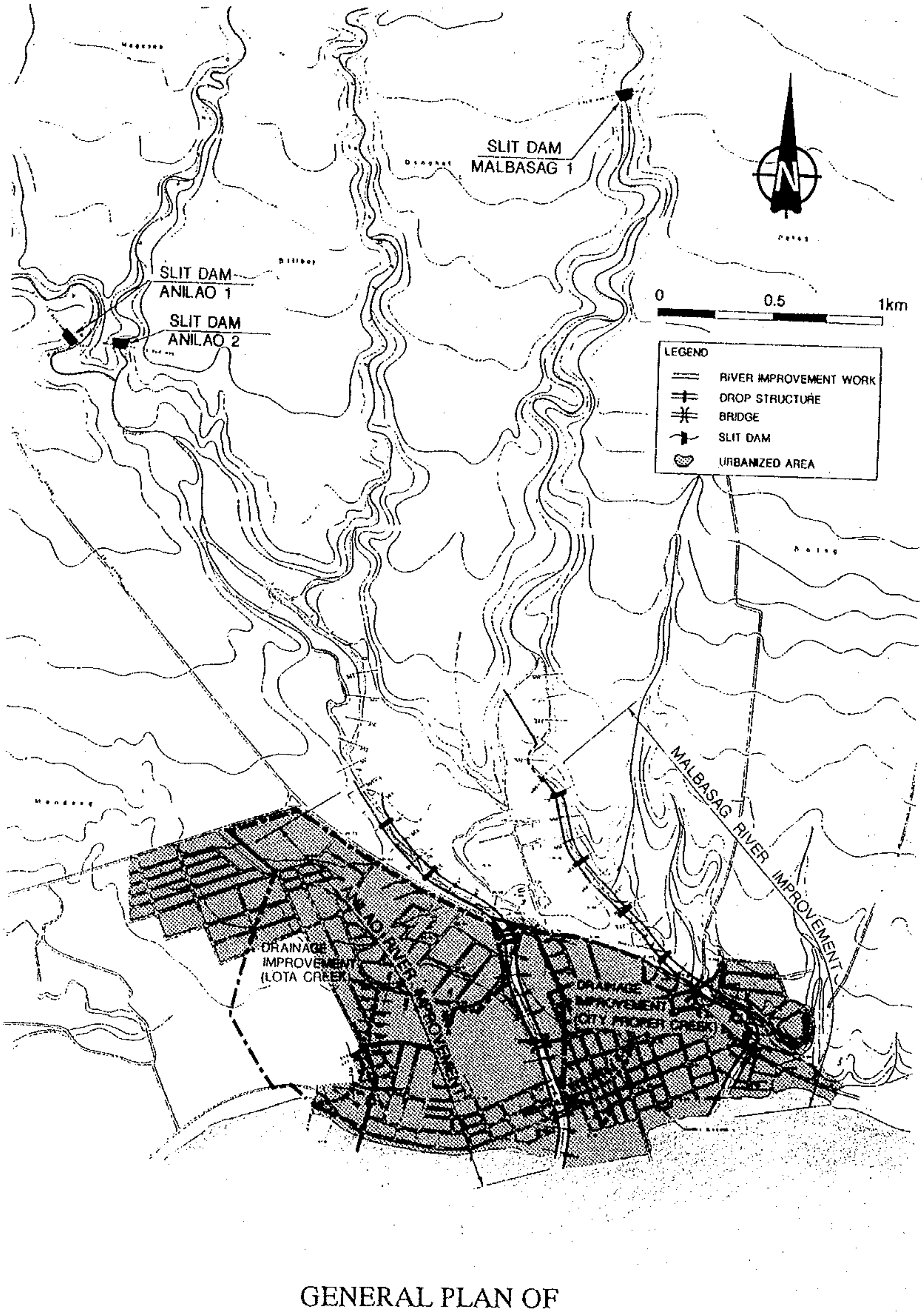

GENERAL PLAN OF
FLOOD CONTROL PROJECT IN ORMOC CITY

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a master plan and feasibility study on the Flood Control for Rivers in the Selected Urban Centers and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Mr. Katsuhisa Abe, CTI Engineering Co., Ltd., and composed of members from CTI Engineering Co., Ltd. and Pacific Consultants International, five times between January, 1993 and December, 1994.

The team held discussions with the officials concerned of the Government of the Philippines, 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 the Republic of the Philippines for their close cooperation extended to the Team.

February 1995

Kimio Fujita

KIMIO FUJITA
President
Japan International Cooperation Agency

February 1995

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Sir:

LETTER OF TRANSMITTAL

We are pleased to submit herewith the Final Report on the Study on the Flood Control for Rivers in the Selected Urban Centers, Republic of the Philippines. The report contains the advices and suggestions of authorities concerned of the Government of Japan and the Japan International Cooperation Agency (JICA), as well as the formulation of river and drainage improvement projects. Also included are the comments made by the Department of Public Works and Highways, Government of the Republic of the Philippines during the technical discussion on the Draft Final Report in Manila.

The Final Report presents the Master Plan covering the four urban centers selected out of the thirteen objective cities proposed for the Study. It also presents the Feasibility Study on the river and drainage improvement projects for the two cities selected, Iloilo and Ormoc.

In view of the urgency and necessity of socio-economic development, we recommend that the Government of the Republic of the Philippines shall adopt all means possible to promote the river and urban drainage projects to the next stage of project implementation at the earliest possible time.

Finally, we wish to take this opportunity to express our sincere gratitude to the Government of Japan, particularly, JICA, the Ministry of Foreign Affairs, the Ministry of Construction and other offices concerned. We also wish to express our deep appreciation to the Department of Public Works and Highways and other authorities concerned of the Government of the Republic of the Philippines for the close cooperation and assistance extended to the JICA Study Team during the Study.

Very truly yours,

KATSUHISA ABE
JICA Study Team Leader

Encl.: a/s

EXECUTIVE SUMMARY

1. Background

The geographical location and climatic conditions of the Philippines make it vulnerable to flood disasters. Losses due to recurrent flood disasters have been serious obstacles to the sustainable development of the country. The Government of the Philippines has been making a continuous effort to mitigate flood damage with the aim of providing a safer and a more pleasant living condition for the Filipino people.

However, most of the expenditures for flood control have been directed to Metro Manila and to large river basins with a catchment area of more than 1,400 km^2. Flood control works for medium and small rivers, especially in regional urban centers, have been neglected. Since the medium and small-scale river basins cover two-thirds of the whole land area of the Philippines, flood damage affecting a considerable lot of the population is always a hindrance to national socio-economic growth.

Therefore, it is essential to stimulate the regional economy through the even distribution of development works in future national development plans. A comprehensive flood control plan with a phased implementation program is imperative for medium and small-scale rivers nationwide, especially those flowing in regional urban centers.

2. Objective

The objectives of the Study are: (1) to collect and compile the existing data on representative medium and small-scale rivers in 13 urban centers and prepare a river inventory based on the aforementioned data; (2) to formulate a master plan on flood control for rivers located in the four cities considered as priority areas for the Master Plan Study; and, (3) to conduct a feasibility study on the most urgent flood control project identified in the Master Plan.

3. Study Area

The study area has been scaled down as the study progressed, as follows:

Inventory Study	:	13 urban centers having the total area of 8,746 km^2 nationwide and the related 21 rivers.

Master Plan Study : 4 cities having the total area of 902 km^2, namely Iloilo, Cebu, Ormoc and Tacloban, and the 9 related rivers in the Visayas with a total area of 618 km^2.

Feasibility Study : Iloilo and Ormoc cities with a total area of 157 km^2 and the related four rivers, namely Jaro and Iloilo rivers in Iloilo City, and Anilao and Malbasag rivers in Ormoc City.

4. Project Works

The project works have been formulated in a stagewise fashion, the Master Plan and the Urgent Plan.

Master Plan

In the Master Plan, the project scale adopted is 50-year return period for rivers and 3 or 5-year return period for drainage channels. For the four cities and 9 rivers, the flood control master plan formulated consists of the river improvement and the drainage channel improvement, as tabulated below.

City	Project Works	Dimensions	Major Structures
Iloilo	River Improvement	Jaro = 18.9 km	Revetment, Bridge, etc.
		Iloilo = 6.5 km	Revetment, Bridge, etc.
	Construction of Floodway	Jaro = 4.8 km La Paz = 0.6 km	Diversion works Diversion works
	Drainage Improvement	3 channels = 10,020 m	
Cebu	River Improvement	Bulacao = 2.7 km	Revetment, Drop, Bridge
		Kinalumsan = 4.0 km	Retaining Wall, Drop, Bridge
		Guadalupe = 4.0 km	Retaining Wall, Drop, Bridge
		Lahug = 5.0 km	Retaining Wall, Drop, Bridge
		Subang Daku =5.5 km	Retaining Wall, Drop, Bridge
	Drainage Improvement	9 channels = 10,850 m	
Ormoc	River Improvement	Anilao = 1.8 km	Revetment, Drop, Bridge, Slit Dam
		Malbasag = 1.9 km	Retaining Wall, Drop, Bridge, Slit Dam
	Drainage Improvement	2 channels = 1,830 m	
Tacloban	Drainage Improvement	7 channels = 15,930 m	
Total	River Improvement	9 rivers = 50.3 km	
	Drainage Improvement	21channels = 38,630 m	
	Floodway	2 floodways = 5.4 km	

Urgent Plan

The project scale for river flood control in the Urgent Plan is proposed to be a 20-year return period. The area of the Urgent Plan is delineated through the phased implementation program. For Iloilo and Ormoc cities, the urgent flood control plan is formulated as tabulated below.

City	Project Works	Dimensions		Major Structures
Iloilo	River Improvement	Jaro =	7.22 km	Revetment, 2 bridges
		Iloilo =	6.5 km	Revetment, 4 bridges
	Floodway Construction	Jaro =	4.8 km	Diversion works
	Drainage Improvement	Ingore =	4,870 m	Diversion channel = 580 m
		Bo. Obrero =	4,220 m	Diversion channel = 200 m
		Rizal =	560 m	
Ormoc	River Improvement	Anilao =	1.8 km	Revetment, 3 drop, 2 bridge, 2 slit dams
		Malbasag =	1.9 km	Retaining wall, 4 drops, 2 bridges, 1 slit dam
	Drainage Improvement	Lotao =	1,200 m	

5. Project Cost

Master Plan

The total project cost of the Master Plan is estimated to be 7,535 million pesos, as tabulated below.

(Unit: Million Peso)

City/River	Construction*	Compensation	Total
Iloilo City	1,977.9	696.6	2,674.5
Jaro	1,257.8	526.2	1,784.0
Iloilo	567.7	138.1	714.0
Drainage	143.4	32.3	175.7
Cebu City	1,655.3	2,416.2	4,071.5
Bulacao	128.9	127.2	256.1
Kinalumsan	243.7	321.1	564.8
Guadalupe	253.4	422.3	675.7
Lahug	321.8	488.4	810.2
Subang Daku	366.7	629.9	996.6
Drainage	340.8	427.3	768.1
Ormoc City	377.8	65.6	443.4
Anilao	212.9	33.5	246.4
Malbasag	144.0	29.1	173.1
Drainage	20.9	3.0	23.9
Tacloban City	274.4	98.2	345.6
Drainage	274.4	98.2	345.6
Grand Total	4,258.4	3,276.6	7,535.0

* This consists of Main Construction Cost, Administration Cost, Physical Contingency and Engineering Services Cost.

Urgent Plan

The project cost of the Urgent Plan for Iloilo and Ormoc cities is estimated to be 1,868.8 million pesos and its breakdown is tabulated below.

(Unit: Million Peso)

City/River	Main Construction*	Compensation	Total
Iloilo City	1,194.4	293.0	1,487.4
Jaro	602.8	128.7	731.5
Iloilo	452.1	138.1	590.2
Drainage	139.5	26.2	165.7
Ormoc City	318.0	63.4	381.4
Anilao	179.8	33.5	213.3
Malbasag	128.9	29.1	158.0
Drainage	9.3	0.8	10.1
Grand Total	1,512.4	356.4	1,868.8

* This consists of Main Construction Cost, Administration Cost, Physical Contingency and Engineering Services Cost.

6. Project Evaluation

6.1 Economic Analysis

Master Plan

The city with most effective flood control plan for rivers is Ormoc City at an EIRR of 28.6%. Next in rank are Iloilo City at 21.9% and Cebu City at 19.8%. All the projects are viable from the economic point of view, because the EIRRs exceed the 15% of opportunity cost of capital in the Philippines.

Regarding the total integrated project including flood control and drainage improvement projects in the four cities, the project in Ormoc City is the most effective from the economic point of view, because it has the highest EIRR of 27.8%. Next in rank is the project in Tacloban City, which shows a high EIRR of 27.8% but does not include river improvement schemes. Iloilo City and Cebu City show the EIRR of 21.3% and 21.1%, respectively.

Urgent Plan

The implementation period for the Urgent Plan projects is assumed to be (a) one year for detailed engineering services, (b) two years for expropriation of project sites and preparation for construction, and (c) three years for construction work in Iloilo City and two years in Ormoc City. Accordingly, six years are needed for Iloilo City and five years for Ormoc City.

The economic indices of EIRR, NPV and B/C for the respective projects are summarized in the following table.

Item	Iloilo City			Ormoc City		
	River Project	Drainage	Total	River Project	Drainage	Total
Under Present Conditions						
EIRR (%)	27.8	5.9	26.3	23.5	16.5	23.2
NPV*(Mil. Peso)	4,396	14	4,410	748	10	758
B/C*	6.2	1.1	5.7	4.0	2.6	3.9
Under Future Conditions						
EIRR (%)	38.6	13.9	37.0	32.6	26.2	32.3
NPV*(Mil. Peso)	10,450	184	10,634	1,572	27	1,599
B/C*	13.3	2.8	12.2	7.3	5.2	7.2

* Discount rate is 10% for the computation of NPV and B/C.

The whole integrated project in Iloilo City gives the EIRR of 26.3%, which means that the projects are viable even under present conditions. The projects in Ormoc City are also viable because the EIRR is 23.2%.

6.2 Environmental Impact Assessment

The environmental impacts to be brought about by the implementation of the projects are limited to temporary noise, vibration and disruption of traffic during the construction work. In general, the project, by its nature, will bring remarkable improvements on the urban environment and living standards of the inhabitants.

On the other hand, the house evacuation and land acquisition in the urban area are the main social impacts of the project. Among the four cities in the Master Plan, Cebu City will encounter the biggest number of house evacuation, followed by Tacloban City, while house evacuation in Iloilo City can be minimized by constructing the floodway through the agriculture area. The right-of-way acquisition in Ormoc City will be easier owing to the city zoning ordinance for the riverine. Therefore, Iloilo and Ormoc cities have less adverse environmental impacts than Cebu and Tacloban cities.

Moreover, environmental improvements such as the improvement of river scenery are expected by taking the surrounding environment into account in designing the flood control works in Iloilo and Ormoc cities. The interview survey shows that 90% of the project-affected people believe that project implementation will be to their own benefit and they will give their utmost cooperation to realize such benefits.

7. Conclusion

7.1 Project Benefit

Other than flood damage mitigation, the following project benefits are expected:

- Overall improvement of public works in the city, which means that there will be lesser damage to other infrastructures or facilities with the improvement of flood control works.
- Reliable transportation system, free from traffic interruption caused by floods.
- Increase of land use potential and land value of the presently existing flood-prone areas.
- Activation of the regional economy with the provision of a flood-free urban center.
- Removal of solid wastes dumped into the river and drainage channels as a result of the channel widening or deepening work.
- Eradication of offensive odor and unhealthy environment with the removal of solid wastes dumped into the channels.
- A clean and healthful urban community, and a safe and more pleasant living condition in the urban area.
- Enhancement of the aesthetic potential of the waterfront with the river/drainage channel improvement.
- Generation of local employment during construction, and activation of trade and industry because of the construction and related materials that the project would require.

7.2 Recommendation

(1) Iloilo City

Aiming at the early realization of the Urgent Plan of flood control works in Iloilo City, the preparation of funds and execution body for the compensation works shall have to be started soon after completion of this Study, because the compensation work is the most critical factor that will obstruct the smooth implementation of the Urgent Project. Since the acquisition of right-of-way usually impedes the smooth implementation of projects, allocation of funds and execution body for the compensation works should be started soon after the completion of detailed engineering.

(2) Ormoc City

The urgency of flood control works in Ormoc City requires expeditious implementation. The required cost is small and compensation work is also easier compared to Iloilo City because a city zoning ordinance on flood-prone areas along rivers was enacted after the flood in November 1991. Therefore, the flood control works in Ormoc City can be implemented earlier than the proposed schedule with the allocation of special funds and manpower.

It is recommended that a comprehensive study shall be made during the detail design stage to evaluate if the river improvement works in Ormoc City can be undertaken with the full scale of a 50-year return period adopted in the Urgent Plan stage, on account of the following:

- The difference of 16% (62 million pesos) in the project costs between the scale of 50-year and 20-year is very small.
- In the full-scale project of a 50-year return period, the environmental design in the river improvement works can be fully employed and project benefits will be enjoyed earlier by people in Ormoc City.

STUDY ON FLOOD CONTROL OF RIVERS IN THE SELECTED URBAN CENTERS

FINAL REPORT

VOL. 1

SUMMARY

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ABBREVIATIONS

AGENCIES/ORGANIZATIONS

ADB	:	Asian Development Bank
BCGS	:	Bureau of Coast and Geodetic Survey
BOD	:	Bureau of Design, DPWH
BPW	:	Bureau of Public Works (former DPWH)
CAR	:	Cordillera Administrative Region
DENR	:	Department of Environmental and Natural Resources
DPWH	:	Department of Public Works and Highways
EDC	:	Energy Development Corporation
EMB	:	Environmental Management Bureau
GOP	:	Government of the Philippines
GOJ	:	Government of Japan
IBRD	:	International Bank for Reconstruction and Development (World Bank)
JICA	:	Japan International Cooperation Agency
LGU	:	Local Government Unit
LWUA	:	Local Water Utility Administration
MCDP	:	Metro Cebu Development Project
MCWD	:	Metro Cebu Water District
MIWD	:	Metro Iloilo Water District
MPWH	:	Ministry of Public Works and Highways (presently, DPWH)
NAMRIA	:	National Mapping and Resources Information Authority
NCR	:	National Capital Region, DPWH
NEDA	:	National Economic and Development Authority
NEPC	:	National Environmental Evaluation Commission
NIA	:	National Irrigation Administration
NGO(s)	:	Non-Governmental Organization(s)
NPC	:	National Power Corporation
NPCC	:	National Pollution Control Commission
NSCB	:	National Statistical Coordination Board
NSO	:	National Statistical Office
NWRB	:	National Water Resources Board
OCD	:	Office of Civil Defense, Department of National Defense
OECF	:	Overseas Economic Cooperation Fund, Japan
PAGASA	:	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PMO	:	Project Management Office, DPWH
PNOC	:	Philippine National Oil Company
PPA	:	Philippine Ports Authority
RDC	:	Regional Development Council
USC	:	University of San Carlos

ACRONYMS

BOD	:	Biological Oxygen Demand
DBMS	:	Database Management System
ECC	:	Environmental Compliance Certificate
ECP	:	Environmentally Critical Project
ECA	:	Environmentally Critical Area
EIA	:	Environmental Impact Assessment

EIS	:	Environmental Impact Statement
E/N	:	Exchange of Notes
GDP	:	Gross Domestic Product
GRDP	:	Gross Regional Domestic Product
MSL	:	Mean Sea Level
MSHHWL	:	Mean Spring Higher High Water Level
PAR	:	Philippine Area of Responsibility
PD	:	Project Description
P.D.	:	Presidential Decree
PREMIUMED	:	Program for Essential Municipal Infrastructure, Utilities, Maintenance and Engineering Development
T-DS	:	Total Desolved Solids
T-SS	:	Total Suspended Solids
VA	:	Value Added

MEASUREMENTS/SYMBOLS

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer
g, gr.	:	gram
kg	:	kilogram
t, ton	:	metric ton
m^2	:	square meter
ha, has	:	hectare(s)
km^2	:	square kilometer
l, lt., ltr	:	liter
m^3	:	cubic meter
s, sec	:	second
min.	:	minute
hr	:	hour
yr	:	year
mm/hr	:	millimeter per hour
m/s	:	meter per second
km/hr	:	kilometer per hour
mg/l	:	milligram per liter
m^3/s	:	cubic meter per second
$m^3/s/km^2$	:	cubic meter per second per square kilometer
%	:	percent
Y	:	Japanese Yen
P	:	Philippine Peso
$	:	US Dollar

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The geographical location and climatic conditions of the Philippines make it vulnerable to flood disasters. The annual average flood damage is estimated to be around 5.0 billion pesos, and losses due to recurrent disasters are serious obstacles to development.

The Government of the Philippines has been making continuous effort to mitigate flood damage with the aim of providing a safer and more pleasant living condition for the people. The flood control program is 13.8% (1.91 billion pesos) of the 1994 DPWH Infrastructure Investment and 24 billion pesos is proposed in the Medium Term Development Plan for 1993-1998.

However, most of the expenditures for flood control were directed to Metro Manila and to large river basins having a catchment area of more than 1,400 km^2. Flood control works for medium and small rivers, especially in regional urban centers, were neglected. Since the medium and small-scale river basins cover two-thirds of the whole land area of the Philippines, flood damage affecting a considerable lot of the population is always a hindrance to national socio-economic growth.

Therefore, it is essential to stimulate regional economy through the even distribution of development works in future national development plans. A comprehensive flood control plan with a phased implementation program is imperative for medium and small-scale rivers nationwide, especially those flowing in regional urban centers. In response to the request of the Government of the Republic of the Philippines (GOP), the Government of Japan (GOJ) decided to conduct the Study on Flood Control for Rivers in the Selected Urban Centers in the Republic of the Philippines (the Study).

The Study has been carried out in stages. The Japan International Cooperation Agency (JICA), the agency responsible for the implementation of technical cooperation programs of GOJ, dispatched the JICA Study Team (the Study Team) to the Philippines on January 6, 1993, to carry out the First Stage Study (Inventory Study). Through the Inventory Study, which was completed in February 1993, four (4) priority urban centers; namely; Iloilo City, Cebu City, Ormoc City and Tacloban City were selected for the Second Stage Study (Master Plan Study).

The Master Plan was carried out from March to November 1993. Compiled in the Interim Report are the results of the Inventory and the Master Plan Study, and two (2) cities, Iloilo and Ormoc, were selected for the Third Stage Study (Feasibility Study) which commenced on May 15, 1994.

This Final Report is prepared to present all results of the three-staged Study.

1.2 Objectives of the Study

The objectives of the Study are:

(1) To collect and compile the existing data on representative medium and small-scale rivers in thirteen (13) urban centers and prepare a river inventory based on the aforementioned data;

(2) To formulate a master plan on flood control for rivers located in the four (4) cities considered as priority areas for the Master Plan Study;

(3) To conduct a feasibility study on the most urgent flood control project identified in the Master Plan; and

(4) To carry out transfer of technical knowledge to Philippine counterpart personnel concerned through the foregoing series of studies and project formulation in the Philippines and in Japan.

CHAPTER 2 INVENTORY STUDY

2.1 Study Area

The study area for the river inventory covers the representative medium and small-scale rivers in the thirteen (13) selected urban centers (hereinafter referred to as SUC or SUCs); namely, the cities of Laoag, Ilagan, Olongapo, Batangas, Lucena, Puerto Princesa, Legaspi, Iloilo, Cebu, Tacloban, Ormoc, Zamboanga and Davao. The area and population of the urban centers and their related river basins are given as follows:

Item No.	Name of SUC	Area (km^2)	Population (1990)	Related Rivers	Catchment Area (km^2)
1.	Laoag	108	83,756	Laoag	1,319.0
2.	Ilagan	1,394	99,120	Ilagan	1,840.0
3.	Olongapo	103	193,327	Sta. Rita	95.0
4.	Batangas	283	184,970	Kalumpang	406.0
5.	Lucena	69	150,624	Tayabas	269.0
6.	Puerto Princesa*	2,107	92,147		
7.	Legaspi	154	121,116	Yawa	70.0
				Macabalo	25.0
8.	Iloilo	56	309,505	Jaro	412.0
				Iloilo	106.0
9.	Cebu	281	610,417	Bulacao	10.7
				Kinalumsan	17.8
				Guadalupe	16.3
				Lahug	6.3
				Subang Daku	12.6
10.	Tacloban	464	136,891	Mangonbangon	4.9
				Abucay	2.4
				Burayan	6.5
11.	Ormoc	101	129,456	Anilao	25.2
				Malbasag	11.1
12.	Zamboanga	1,415	442,345	Tumaga	228.0
13.	Davao	2,211	849,947	Davao	1,623.0
	Total	8,746	3,403,621		6,508.8

* Puerto Princesa is not related to or affected by any river.

Hydrology

(1) Rainfall

To evaluate the safety of SUCs and their related rivers against flood, extreme rainfall conditions were analyzed on the basis of daily rainfall. Maximum daily rainfall which measures the scale of floods is higher in Luzon Region and less in the Visayas and Mindanao regions. The recorded first, second and third maximum daily rainfalls for each SUC are given in the following table:

(Unit: mm/day)

Item No.	City	1st Max. Rainfall	2nd Max. Rainfall	3rd Max. Rainfall	Recording Period
1.	Laoag	510.3	498.4	437.2	31 yrs. (1961-1991)
2.	Ilagan	746.0	349.7	345.4	31 yrs. (1961-1991)
3.	Olongapo	471.8	449.4	422.3	18 yrs. (1975-1992)
4.	Batangas	765.8	499.2	283.6	31 yrs. (1961-1991)
5.	Lucena	557.7	359.7	306.0	20 yrs. (1970-1989)
6.	P. Princesa	269.3	265.9	252.0	31 yrs. (1961-1991)
7.	Legaspi	484.6	458.6	432.3	31 yrs. (1961-1991)
8.	Iloilo	303.0	255.6	203.8	31 yrs. (1961-1991)
9.	Cebu	374.0	129.0	112.8	19 yrs. (1972-1991)*
10.	Tacloban	204.0	167.9	163.6	31 yrs. (1961-1991)
11.	Ormoc	259.1	257.8	217.1	22 yrs. (1971-1992)
12.	Zamboanga	193.2	138.7	117.5	30 yrs. (1961-1990)
13.	Davao	174.3	150.3	149.6	31 yrs. (1961-1991)

* Except 1990.

(2) River Runoff

There are a few streamflow gauging stations in and around the study area. The maximum discharge and mean monthly discharge of the related rivers are given in Table 2.1. The range of specific discharge in the related river basins is from 1.2 $m^3/s/km^2$ to 15.3 $m^3/s/km^2$.

The range of runoff coefficient of the related rivers is estimated to be from 57% to 99%, and the average runoff coefficient is about 75%. The study by NWRC/BRS gave the relation of runoff to size of drainage area for Philippine rivers, as shown in Fig. 2.1.

Socio-Economy

(1) Population

Among the 13 SUCs, the largest SUCs in terms of population are the cities of Davao, Cebu, Zamboanga and Iloilo in order of the number of population, which have more than 300 thousand in the 1990 census. Regarding population growth rate between 1980 and 1990, Puerto Princesa City had attained the highest annual rate of 4.2% on average. Succeedingly, Lucena, Davao, Tacloban, Batangas and Zamboanga have grown at a higher rate than the national average rate of 2.4% per annum. Laoag City showed the lowest rate of 1.9% per annum.

City population in the 1990 census was classified into urban and rural populations. Table 2.2 shows the urban and rural populations and their density in the 13 SUCs.

The following five (5) SUCs have been identified as the most densely inhabited Poblacions among 13 SUCs: Ormoc, Batangas, Davao, Laoag and Iloilo in order of population density. On the other hand, the poblacions of Zamboanga, Tacloban and Olongapo recorded lower population density; less than 20 persons/ha. In particular, that of Zamboanga City was only 9.7 persons/ha.

(2) Gross Regional Domestic Product

Among Regions related to the 13 SUCs, the GRDP of Region IV (Southern Tagalog) was the largest, ₱148 billion in 1990. It shares approximately 14% of the GDP. The Region's GRDP per capita was ₱17,863, almost the same as the national one. Per capita GRDPs of other Regions were lower than the national average. Only Region XI (Southern Mindanao) attained close to the national average. The lowest value of GRDP per capita was shown in Region V (Bicol), accounting for ₱7,896 or less than half of the national one.

The Region which showed the highest growth of GRDP in 1990 is Region III (Central Luzon), at the growth rate of 7.1%. The second highest growth was attained by Region VII at 3.9%. Regarding the growth of GRDP per capita, the following three Regions could slightly exceed the national growth rate of 2.3% per annum during 1985 to 1990: Region VII, Region III and Region V. Hence, the disparity between the regional per capita GRDPs and the national one has gradually been increasing as understood in Table 2.3.

2.2 Floods and Flood Control Works

Flood Problems

Floods in the SUCs, in general, occur as a result of overbank flow of rivers and stagnant water due to inadequate drainage systems during periods of intense storm runoff. As shown in Table 2.4, the total flood area in the city proper of the 13 SUCs is 2,385 ha or 2.2% of the whole urbanized area.

Among the 13 SUCs, the five (5) largest cities in terms of flood area are Iloilo, Legaspi, Laoag, Ormoc and Cebu, which have more than 190 ha of the flood area in each city proper. Regarding the ratio of flood area to the total urbanized area of the city proper, Ormoc City has the largest flood area ratio, followed by Batangas, Laoag and Iloilo, which have more than 9% of flood area's ratio.

Flood and Damage

The Office of Civil Defense (OCD), Department of National Defense has compiled damage records of major typhoons that occurred at the 13 SUCs, as enumerated in Table 2.5. Although the OCD damage records cannot be directly substituted as flood damages, they indicate the tendency of flood damage conditions, because most of the major floods occurred during the typhoons.

Among the SUCs, Ormoc City has the largest casualty of 4,561 dead with total direct damages amounting to 560 million pesos. The damage in Ormoc City was mostly caused by Typhoon Uring on November 5, 1991.

In terms of population affected by the typhoon, the largest are Cebu, Legaspi, Ormoc, Tacloban and Iloilo in order of population scale, which have more than 100 thousand in the records. The largest affected population of 638 thousand in Cebu City for the last 11 years was brought by the inadequate capacity of rivers and drainage systems with intense rainfall in the busy city areas

Existing Flood Control Works

The existing flood control works are as follows:

(1) River

The conditions of existing flood control works for medium and small-scale rivers in the Philippines are summarized as follows. The inventory is given in Table 2.6.

(a) Main river flood control works are bank protection works with boulder concrete revetments, or concrete walls without embankment.

(b) These structures were designed based on the records of past floods.

(c) There is no comprehensive master plan of flood control for the medium and small-scale rivers except Laoag and Yawa rivers which have rather old plans.

(d) Maintenance works of flood control structures are usually inadequate due to budgetary constraints.

(e) Expansion of SUC urban areas to low-lying areas has increased the flood damage potential.

(f) Most small-scale rivers in urban areas are clogged with heavy siltation and dumping of solid waste/garbage.

As mentioned above, the existing flood control works have been partially provided only to prevent bank failure, not overflow. Therefore, every river would require river improvement works under a comprehensive master plan of the river basin.

(2) Drainage

The results of inventory of the existing drainage systems are given in Table 2.7, and summarized as follows:

(a) The planning and designing of drainage systems in the SUCs are conducted by the Planning Division of each City Government, and construction is executed by the City Engineer's Office.

(b) For the SUCs, drainage networks are constructed for densely populated areas; the surrounding areas have no drainage works.

(c) Only drainage pipes were installed at many places without overall plans have not been formulated. Therefore, inundation has been chronic due to the insufficient capacity of pipes.

(d) Maintenance of drainage systems are rarely executed by local government organizations concerned.

(e) Siltation in the pipes and deterioration of pipe capacity are remarkable.

2.3 Selection of Master Plan Study Area

<u>Prioritization of SUCs</u>

To select the master plan study areas, the priority of each SUC has been determined on the aspects of necessity, urgency, benefit, and regional equality. These four aspects are evaluated by the following factors with data and information collected in the Inventory Study.

Item No.	Aspect	Evaluation Factor
1.	Necessity	Extent of floods
2.	Urgency	Flood control capacity
3.	Benefit	Extent of flood damage
4.	Regional Equality	Improvement program

Selection of Study Area

The cumulative point of priority ranking for each SUC is summarized in Table 2.8. It indicates that the SUC ranked at the highest is Ormoc, followed by Tacloban. Iloilo, Cebu, Legaspi and Laoag, which have more than 10 points in the evaluation.

Evaluation Point	Urban Center
10 to 12 points	Ormoc, Tacloban, Iloilo, Cebu, Legaspi and Laoag
8 to 9 points	Olongapo, Batangas, Lucena, Zamboanga, Davao and Ilagan
6 to 7 points	Puerto Princesa

As discussed and agreed between DPWH and the JICA Preparatory Survey Team, the four (4) SUCs of Tacloban, Ormoc, Cebu and Iloilo are evaluated to have higher priority among the 13 SUCs, and Legaspi and Laoag are also ranked at the same priority. Therefore, the first four (4) SUCs are selected as the master plan study areas.

CHAPTER 3 STUDY AREA

The area for the Master Plan covers four (4) cities; Iloilo, Cebu, Ormoc and Tacloban. The area also covers the 12 related river basins of the Jaro, Iloilo (Iloilo City), Bulacao, Kinalumsan, Guadalupe, Lahug, Subang Daku (Cebu City), Anilao, Malbasag (Ormoc City), Abucay, Mangonbangon, and Burayan (Tacloban).

For the urban drainage, 21 drainage areas having an aggregate area of approx. 62 km^2 are selected to formulate the Master Plan; namely, three (3) in Iloilo, nine (9) in Cebu, two (2) in Ormoc and seven (7) in Tacloban, as three small rivers in Tacloban are regarded as urban drainage channels. The following table gives information on the study area.

Item No.	Name of SUC	Area (km^2)	Population (1990)	Related River/ Drainage	Catchment/ Drainage Area (km^2)
1.	Iloilo	56	309,505		
	- River			Jaro	412.00
				Iloilo	106.00
	- Drainage			Ingore Creek	8.02
				Bo. Obrero Creek	3.89
				Rizal Creek	0.50
2.	Cebu	281	610,417		
	- River			Bulacao	10.70
				Kinalumsan	17.80
				Guadalupe	16.30
				Lahug	6.30
				Subang Daku	12.60
	- Drainage			Mabolo Creek	2.78
				Lahug Tributary	0.65
				Tinago Creek	1.10
				Pahina Central	1.00
				Calamba	0.79
				Sta. Teresita	3.80
				Basag-San Nicolas	0.67
				Sto. Niño	5.11
				Brgy. Inayawan	1.29
3.	Ormoc	101	129,456		
	- River			Anilao	25.20
				Malbasag	11.10
	- Drainage			Lotao Creek	1.03
				City Proper Creek	0.32
4.	Tacloban	464	136,891		
	- River			Abucay	2.38
				Mangonbangon	5.12
				Burayan	5.49
	- Drainage			Naga-Naga Creek	1.21
				Langhas-Lirang	4.38
				Pleasantville	1.25
				Sagkahan	0.14
Total		902	1,186,269	River	630.99
				Drainage	37.93

3.1 Hydrology

Probable Maximum Daily Rainfall

Probable maximum daily rainfalls at the respective stations are computed by the Iwai Method, as summarized below:

(Unit: mm/day)

Return Period	Iloilo	Cebu Lahug	Ormoc Merida	Tacloban
2	121.1	91.4	130.7	119.9
5	159.6	123.5	184.7	146.1
10	191.7	145.7	221.7	161.2
20	227.3	167.5	259.1	174.5
50	280.7	196.7	309.5	190.2
100	326.7	219.4	349.0	201.3

Probable Flood Discharge

Probable flood discharges of the rivers were computed for 2, 5, 10, 20, 50 and 100-year return periods. The probable discharges at respective base points are given below:

(Unit: m^3/s)

City	River	2-yr	5-yr	10-yr	20-yr	50-yr	100-yr
Iloilo	Jaro	360	493	696	966	1,391	1,765
	Tigum*	146	204	293	415	616	797
	Aganan*	214	289	403	551	775	968
	Iloilo	190	255	314	390	584	774
	Mandurriao*	36	45	54	63	91	119
Cebu	Bulacao	110	140	164	187	214	236
	Kinalumsan	109	140	162	185	213	235
	Guadalupe	118	153	177	202	233	257
	Lahug	63	80	93	106	121	134
	Subang Daku	107	138	160	181	209	229
Ormoc	Anilao	247	313	362	453	603	719
	Malbasag	129	162	195	250	328	387

* Major tributary

For the urban drainage area, the probable flood discharge is computed using the Rational Formula. In this formula, runoff coefficient is determined depending on the land use conditions according to the table below. Specific discharges of drainage areas in the four cities are shown in Fig. 3.1.

Land Use in River Basin	Runoff Coefficient
Urban Area-1 (Low Density, Residential)	0.50
Urban Area-2 (Middle Density, Residential)	0.65
Urban Area-3 (High Density, Residential)	0.80
Mountain and Hill of Tertiary	0.70 - 0.80
Rolling Land and Forest	0.50 - 0.75
Basin with Around Half of Flat Land	0.50 - 0.75

Flood Inundation Analysis

From the inundation conditions on record, flood discharge beyond the river channel flow capacity widely spread over the low land. To express the hydraulic condition, the Two-Dimensional Unsteady Flow Model was employed with the whole flood-prone area divided into mesh blocks of 250 m by 250 m. For Ormoc City, however, mesh blocks of 125 m by 125 m were applied.

On the other hand, stormwater inundation along the primary drainage channel was analyzed by means of uniform flow computation for each cross-section of the channel. The inundation area for each channel was delineated by enveloping the inundation width at each cross-section.

The maximum inundation areas and depths of a 50-year return period flood in each river are expressed in both patterns and figures and shown in Fig. 3.2.

3.2 Flood Condition

River Flood

The data on flood conditions such as area, depth and duration are obtained for rather recent floods during typhoons Ruping (November 1990) and Uring (November 1991), as well as the monsoon rain in Iloilo (July 1994).

(1) Typhoon Ruping

With heavy rains brought by Typhoon Ruping, the flood overflowed at several sections of the river bank in the middle reaches of Jaro River. The flood peak discharge was estimated at approx. 800 m^3/s which is almost equivalent to a 10-year return period flood discharge.

The flooded area was, as shown in Fig. 3.3, estimated at approximately 1,400 ha. The flood depth was reported at 0.5 to 1.0 m, and flood duration was estimated to be several hours.

During the typhoon in Cebu City, no overflow was reported in the middle reaches of five (5) rivers. However, it has been reported that the a narrow belt along the seashore was flooded due to flood overflows in every lower reach of the five (5) rivers. The flooded area was estimated at approx. 800 ha as illustrated in Fig. 3.4, and the flood depth was about 0.5 m to 1.5 m at the deepest site. Flood duration was rather short at 1 to 5 hours.

(2) Typhoon Uring

A big flush flood caused by the downpour brought by Typhoon Uring on November 5, 1991 swept Ormoc City. A simple computation of flood runoff shows the peak flood discharges of Anilao and Malbasag rivers to be 600-700 m^3/s and 250-300 m^3/s, respectively. They correspond to floods of about a 20-year return period.

The flood area is rather small at approx. 200 ha as shown in Fig. 3.5, although flood depths were reported to be 1.5 m to 4.0 m at the deepest site

(3) Flood on July 29, 1994

Iloilo City suffered from widespread flooding on July 29 to August 1, 1994 caused by the unusual heavy monsoon rains. Massive rainfall (319 mm/day) was recorded at the PAGASA Station near the Iloilo Airport on July 29, 1994. The heavy rain started in July 28 and lasted for three days with a 3-day total rainfall of 628.6 mm. Under this unpredictable circumstance, 80% of Iloilo City was submerged for two days/nights, especially low-lying areas, and infrastructures were destroyed and human activities disrupted. The flooding areas are plotted in Fig. 3.6.

A total of 25,000 families at Jaro District in Iloilo City and Oton in Iloilo Province were affected. More than two-thirds of the casualties and total/partial destruction of houses have been reported.

<u>Stormwater Inundation</u>

The flood-prone areas in the urban area experience regular inundation brought about by the inadequate drainage systems. The major inundation areas and conditions are given as follows:

Item No.	Flood Area	Inundation Condition Area (ha)	Depth (m)	Duration (hrs)
Iloilo				
1.	City Proper-Molo (5 places)	53.8	0.1 - 0.3	1 - 2
2.	Jaro-La Paz (4 places)	18.6	0.2 - 0.3	2
3.	Ingore Creek Upstream	42.4	0.3 - 1.0	2 - 12
Sub-Total		114.8	-	-
Cebu				
1.	Mabolo Creek	14.0	0.5	2
2.	Lahug Tributary	8.0	0.3 - 0.6	1 - 3
3.	Tinago Creek	7.2	0.3 - 0.5	1 - 2
4.	Sta. Teresita Village	10.0	0.5 - 1.2	1 - 2
5.	Sto. Niño Creek	18.0	0.2 - 0.3	1
Sub-Total		57.2	-	-
Ormoc				
1.	Gov't. Center	9.5	0.2 - 0.4	1
2.	Punta	6.8	0.2 - 0.4	24 - 48
3.	Lotao Creek	17.1	0.5 - 1.0	6 - 12
4.	Rizal Extension	4.1	0.2 - 0.4	2 - 6
Sub-Total		37.5	-	-
Tacloban				
1.	Abucay River	16.6	0.3 - 0.5	5 - 6
2.	Naga-Naga Creek	7.8	0.3 - 1.0	2 - 4
3.	Mangonbangon River	40.0	0.3 - 1.0	2 - 72
4.	Langhas-Lirang Creek	24.4	0.2 - 1.0	2 - 24
5.	Old Sagkahan Creek	1.2	0.2 - 0.5	4 - 5
6.	Pleasantville Creek	18.2	0.5 - 0.8	12 - 24
7.	Burayan River	97.6	0.1 - 0.6	1 - 36
Sub-Total		205.8	-	-

3.3 Assets and Flood Damage

<u>**Socio-Economic Projection**</u>

The Medium-Term Philippine Development Plan for 1993-1998 presents the national economic development policies to support the long-term goals of poverty alleviation and improved income and wealth distribution. The major macro-economic objectives in the medium-term plan are: (a) a sustained and broad growth of output and employment; (b) price stability; and, (c) a sound balance of payments position.

As of September 1994, the Medium-Term Plan is still under discussion in the Government. Therefore, the proposed figures as the aggregate targets in the plan are not concrete, which would be essential to project the future socio-economic frame for the current study. In this study, however, the targets are applied to project the future framework, although they are still tentative. The targets of GNP and GRDP during the period are proposed as follows:

Item	1993	1994	1995	1996	1997	1998	Average
GNP *	759.8	809.2	869.9	939.5	1,019.4	1,121.3	-
Annual Growth Rate (%)	4.5	6.5	7.5	8.0	8.5	10.0	7.5
Per Capita GNP **	11.4	11.9	12.4	13.1	13.9	14.9	-
Annual Growth Rate (%)	2.0	3.9	4.8	5.4	6.0	7.6	4.9
GRDP Growth Rate (%)							
Region VI	2.8	6.7	7.1	7.7	8.1	9.6	7.0
Region VII	5.1	7.6	9.8	10.6	10.9	12.8	9.4
Region VIII	3.2	4.2	4.9	6.7	6.8	8.0	5.6

* Million pesos at 1993 constant prices.
** Thousand pesos at 1993 constant prices.

(1) Population Projection

The future population is projected on the basis of the NSO projection, taking the 1990 census into account. The following table shows the projected population in the four cities up to the year 2020.

(Unit: Thousand)

City	1990	2000	2010	2020
Iloilo	308	353	387	415
Cebu	610	742	851	946
Tacloban	136	158	177	194
Ormoc	129	150	168	183

(2) GRDP Projection

By 2020, GRDPs in the respective regions were projected at 1985 constant prices as follows:

Item	GRDP (Billion Pesos)	Per Capita GRDP (1,000 Pesos)
Region VI	155 (3.1)	20.8 (2.3)
Region VII	206 (4.4)	33.0 (3.2)
Region VIII	44 (2.5)	10.4 (1.8)

Note: Figures in parentheses indicate the rate of increase for 1990

Assessment of Assets

This structure of damage losses is illustrated in Fig. 3.7. Taking this structure into consideration, the flood damage is estimated by the following items below.

(a) Direct damage, which is divided into the five items, as follows:

- Dwelling units which include the building itself and the indoor movable or household effects in it.

- Industrial establishments consisting of factory building, machinery, equipment for production, inventory stock such as finished products, works-in-process, raw materials and goods for resale and expected profit through production.
- Trading establishments including store, furniture, equipment, inventory stock such as merchandise and materials for sale, and expected profit through damageable inventory of stock.
- Palay production consisting of accumulated production cost and expected net income. Irrigation facilities are considered to be a kind of physical infrastructure.
- Inland fishery production represented by prawn farm consisting of accumulated production cost expected net income.

(b) Infrastructure damage, both social and physical, is assumed to be 35% of the above direct damage, as derived from similar studies and past flood damage records.

(c) Indirect damage comprises (i) opportunity losses of business and/or production activities and (ii) emergency activities. Business losses take into account only the affected establishments in the manufacturing and trading sectors while damage due to emergency activities and operation losses are based on the government flood damage reports. However, due to the ambiguity of data, the amount of indirect damage will be assumed to be the same 10% of the direct damage.

Probable Flood Damage

Flood damage is calculated as a product of damageable property and damage rate. The damage rate for assets vulnerable to flood is determined with inundation depth. The results of respective rivers in Iloilo, Cebu and Ormoc cities are summarized in the table below.

(Unit: Million Pesos in Economic Terms)

City/ River	Return Period (Year) 2	5	10	20	50	100
Iloilo City	389	583	837	1.125	1,378	1,591
Jaro River	290	405	558	751	921	1,041
Iloilo River	99	178	279	374	457	550
Cebu City	356	597	752	1,016	1,325	1,515
Bulacao River	44	74	83	94	102	108
Kinalumsan River	65	123	180	277	331	355
Guadalupe River	80	159	213	333	441	518
Lahug River	96	144	168	186	291	365
Subang Daku River	71	97	108	126	160	169
Ormoc City	106	186	205	229	252	262

In the same manner, flood damages of poor drainage areas in Iloilo, Cebu, Ormoc and Tacloban are summarized in the table below.

(Unit: Million Pesos in Economic Terms)

City	Return Period (Year) 1	2	3	5
Iloilo City	14	15	16	16
Cebu City	118	167	167	168
Ormoc City	2	2	2	3
Tacloban City	78	98	102	107

3.4 Environment

EIS System

The EIS System refers to the entire process of organization, administration and procedure institutionalized for the purpose of assessing the significance of effects of physical development on the quality of the environment.

The Environmental Impact Assessment (EIA) is done during the feasibility stage of the project cycle where inputs from the study can really help in shaping a particular project to be both environmentally sound and economically viable. It should be started as early as possible and in parallel with other studies so that the environmental consequences of the project can be taken into account from the earliest planning stage. Recommendations can also easily be implemented without considerable change in plans and increase capital outlay.

The Environmentally Critical Projects and Areas fall under the scope of the EIS system. Proponents are required to apply for ECC before these projects can be implemented.

The DPWH is preparing a Department Order (DO) to revise Ministry Order (MO) No. 72 proclaiming certain areas and types of projects as environmentally critical and within the scope of the EIS system. New guidelines proposed in the draft DO are to supplement other infrastructure projects as the projects covered by the EIS system in consonance with the Memorandum of Agreement (MOA) entered into by and between DENR and DPWH dated 26 June 1992. The supplemented projects include development, construction and maintenance of national roads, bridges and major flood control infrastructure projects. "Major flood control project" refers to any large scale activity which will involve river control works, channel widening, dredging and embankment and urban drainage works including cross drainage of diversion highway. The project cost of this type of project shall be at least one hundred million pesos (₱100,000,000) or more. The DO is expected to be signed and to take effect within 1994. Therefore, it is desirable that the projects proposed in this study should follow the EIS procedure.

Procedure of EIS System

The EIS was conducted in accordance with the procedures for EIS system, as shown in Fig. 3.8.

CHAPTER 4 MASTER PLAN

4.1 Planning Conditions

Project Scale

The project scale of the Master Plan is proposed taking the following conditions into account:

(1) The flood damage potential and flood control capacity of the river basins;

(2) The magnitude of recorded maximum floods in the river basins; and

(3) The project scale employed in existing and proposed flood control plans in the Philippines.

The project scale of the Master Plan for flood control of rivers in this Study is generally proposed at a 50-year return period in consideration that: (1) the objective rivers have only a small catchment area but they are located in regional urban centers; and, (2) the magnitude of past maximum floods as estimated by rainfall frequency analysis is 30-year to 50-year return period.

As for urban drainage, a higher scale of 5-year return period is applied to major drainage systems with drainage areas of more than 50 ha, while a lower scale of 3-year return period is adopted for those with less than 50 ha.

Target Year

The target year of the Master Plan is proposed, taking the following conditions into account which have to be consistent with the background and objective of the Study:

(1) The four cities selected for the Master Plan in the First Stage Study shall represent the 13 urban centers and all medium and small-scale rivers in the country which have flooding problems;

(2) Periods for implementation of flood control works for the respective rivers are different depending on scales and areas of flood problems, and the socio-economic and financial conditions, therefore, the target year shall be set at the farthest time possible for estimating physical conditions; and

(3) Flood control plans are parts of national and regional development plans; hence, the target year and purpose of the former shall be consistent with the latter.

The National Physical Framework Plan for 1993 to 2022 has been arranged by the government as a long term development plan in addition to the Medium-Term Regional Development Plans for 1993-1998 proposed by respective NEDA regional offices. In accordance with the aforementioned conditions, the year for completion of flood control works in the 13 urban centers (one urban center for each region except the National Capital Region) is assumed to be the year 2022. Therefore, the target year of the Master Plan of flood control for the four cities is proposed to be the year 2016, while that for the 13 urban centers is assumed to be the year 2022. The implementation plan is shown in Fig. 4.1.

4.2 Flood Control Plan

<u>River</u>

Based on the project scale proposed for the river flood control plan, estimates of design discharges of river improvement works were made as presented in Fig. 4.2 to 4.4. The estimates were derived from the river flood control measures described hereinafter.

(1) Jaro River

The flood control plan is a combination of river improvement works for 18.9 km of Jaro-Tigum River and 3.0 km for Aganan River and two floodways; 4.8 km of Jaro Floodway and 0.6 km of La Paz Floodway for the flood discharge of Jaro River to Iloilo Strait.

The proposed alignment and typical cross-sections are shown in Fig. 4.5 and the proposed longitudinal profiles are also given in Fig. 4.6. The related river structures are provided as follows:

River Structure	Dimension/Site	Remarks
Earth Dike	26,700 m	Jaro River
Revetment	12,750 m	
Diversion Works	2 sites	Jaro & La Paz Floodways
Groundsill	3 sites	
Sluice with Slide Gate	2 sites	
Sluice with Flapgate	10 sites	
Invert Siphon	3 sites	Jaro Floodway
Bridge	2 sites	Reconstruction
Bridge	4 sites	New

(2) Iloilo River

For the main stream of Iloilo River, channel improvement works for 6.5 km from the river mouth such as raising of river banks and dredging are employed to confine the design flood discharge and to protect river banks.

In the urban area along Iloilo River, a concrete dike is employed to minimize land acquisition and house evacuation. Besides, earth dikes are provided at the fishpond area.

The proposed alignment and typical cross sections are shown in Fig. 4.7 and the proposed longitudinal profiles are also given in Fig 4.8. The related river structures are provided as follows:

River Structure	Dimension/Site	Remarks
Earth Dike	3,430 m	For fishpond area
Concrete Dike	4,780 m	For urban area
Revetment	300 m	
Sluice with Flapgate	5 sites	
Bridge Protection Works	1,200 m^2	For 3 bridges

For Mandurriao River, the main tributary of Iloilo River, only channel improvement for 4.8 km from the confluence with Iloilo River is employed.

The proposed alignment and typical cross sections are shown in Fig. 4.9 and the proposed longitudinal profiles are also given in Fig 4.10. As for the related river structures, two sluices with slide gates, two sluices with flapgates and three bridges shall be constructed or reconstructed.

(3) Bulacao River

River improvement for 2.7 km is required to increase channel flow capacity.

The channel alignment and typical cross-section are shown in Fig. 4.11. The design riverbed is set at the average existing riverbed slope. The longitudinal profile is shown in Fig. 4.12. The related river structures are as follows:

River Structure	Dimension/Site	Remarks
Earth Dike	1,400 m	
Revetment	680 m	
Drop	8 sites	
Bridge	1 site	Reconstruction

(4) Kinalumsan River

River improvement for 4.0 km such as widening, excavation, diking and revetment works is required to increase flow capacity and stabilize flood flow.

The channel alignment and typical cross-section are shown in Fig. 4.13. The design riverbed is set along the average existing riverbed. Since the velocity along the upper stretch is more than 4 m/s, drops are provided along the stretch. The longitudinal profile is shown in Fig. 4.14. The related river structures are as follows:

River Structure	Dimension/Site	Remarks
Retaining Wall	8,000 m	
Drop	9 sites	
Bridge	6 sites	Reconstruction

(5) Guadalupe River

River improvement for 4.0 km is the optimum measure for flood control.

The channel alignment and typical cross-section are shown in Fig. 4.15. The design riverbed is set along the average existing riverbed. Some drops are provided to reduce the flow velocity. The longitudinal profile is shown in Fig. 4.16. The related river structures are as follows:

River Structure	Dimension/Site	Remarks
Retaining Wall	6,400 m	
Drop	3 sites	
Bridge	4 sites	Reconstruction

(6) Lahug River

River improvement for 5.0 km such as widening, excavation and revetment works is required to confine the flood in the river channel.

The channel alignment and typical cross-section are shown in Fig. 4.17. The design riverbed is set along the average existing riverbed. Some drops are placed to reduce flow velocity. The longitudinal profile is shown in Fig. 4.18. The related river structures are as follows:

River Structure	Dimension/Site	Remarks
Retaining Wall	8,000 m	
Drop	6 sites	
Bridge	10 sites	Reconstruction

(7) Subang Daku River

River improvement for 5.5 km such as widening, excavation and revetment works is required to confine the design flood discharge.

The channel alignment and typical cross-section are shown in Fig. 4.19. The design riverbed is set along the average existing riverbed. Some drops are provided to reduce flow velocity. The longitudinal profile is shown in Fig. 4.20. The related river structures are as follows:

River Structure	Dimension/Site	Remarks
Retaining Wall	10,500 m	
Drop	2 sites	
Bridge	8 sites	Reconstruction

(8) Anilao River

River improvement of 1.8 km in the lower reaches, emphasizing realignment of the river course is required. Two slit dams shall be provided to stop floating logs.

The proposed alignment and typical cross sections are shown in Fig. 4.21 and the proposed longitudinal profiles are also given in Fig. 4.22. Other than the slit dams, river structures are provided as follows:

River Structure	Dimension/Site	Remarks
Earth Dike	1,800 m	
Revetment	4,000 m	
Sluice with Flapgate	3 sites	
Drop	3 sites	
Bridge	3 sites	Osmeña Bridge is under construction.

(9) Malbasag River

River improvement of 1.9 km in the lower reaches, emphasizing realignment of the river course is required. As in Anilao River, a slit dam is proposed to stop floating logs and debris flow.

The proposed alignment and typical cross sections are shown in Fig. 4.23 and the proposed longitudinal profiles are also given in Fig. 4.24. Other than one slit dam, the related river structures are as follows:

River Structure	Dimension/Site	Remarks
Earth Dike	1,250 m	
Retaining Wall	2,400 m	
Revetment	1,250 m	
Sluice	4 sites	
Drop	4 sites	
Bridge	2 sites	Reconstruction

Urban Drainage

Channel improvement such as widening and deepening the drainage channel excluding diking is basically adopted for all objective watercourses. Improvement works are planned to remove acute bends and constrictions, bottleneck culverts and bridges, squatter encroachment and clogging with sediment and garbage.

Embankment is, in principle, not adopted for drainage channel improvement since inundation water could be drained by gravity. Construction of pumping station is not also physically required.

Considering the ease of operation of drainage systems, the existing drainage channels to be improved are, principally, to remain as open watercourses, not to be enclosed by box culvert. As for the improvement of the existing four drainage mains in Cebu, however, the box culvert type of drain is proposed since they are to be located under the existing roads.

A single trapezoidal shaped section with slope protection is typically employed for under-urbanized areas, while a rectangular shaped section formed by retaining facilities is employed for densely urbanized stretches in consideration of the difficulty of land acquisition and house evacuation/settlement.

The bank slope for a trapezoidal shaped section takes three gradients, 1:0.5, 1:1 and 1:2, depending on the progress of urbanization. A summary of the cross-section types employed for the Master Plan is shown below.

Type	Shape	Bank Slope	Slope Protection	Land Use
I	Rectangular	Vertical	Retaining Wall	Dense Urban
II	Trapezoidal	1 : 0.5	Lining	Medium Urban
III	Trapezoidal	1 : 1	Lining	Scattered Urban
IV	Trapezoidal	1 : 2	Sodding	Open Space

The total length of drainage channels in the four cities is 38,630 m. The breakdown of improvement works is as follows:

City	Improvement Length (m)	Remarks
Iloilo City	10,020	3 channels
Cebu City	10,850	9 channels
Ormoc City	1,830	2 channels
Tacloban City	15,930	7 channels

Non-Structural Measures

As described before concerning the current conditions of riparian areas, flooding problems of the rivers are partly brought about by encroachment of houses, deposit of solid waste/garbage, as well as lack of proper maintenance on river channels. Therefore, non-structural measures such as land use regulation/zoning, afforestation and enforced maintenance works will be effective.

The non-structural measures required for the respective river basins are discussed below.

(1) Land Use Regulation/Zoning

This measure shall be employed for all rivers, especially riparian areas along river channels. Houses have been built on the river banks even inside river channels. All five rivers in Cebu City have a problem of encroachment on channels. Subdivisions to be developed in the upstream hilly area of Cebu City shall have to be screened through land use regulation.

A river code or structural standards is necessary to control and avoid the problem. Zoning regulations along river channels as issued for Anilao and Malbasag rivers in Ormoc City shall be enforced.

The middle reach of Tigum River in Iloilo is dendritic in shape and has a wide floodplain which is partly used for rice paddy. Through the hydrologic analysis in this Study, this middle reach has been identified to have a large flood retarding effect. Land use regulations will maintain the function of the middle reach as a retarding basin so as to reduce flood discharge to the downstream areas. The location of the proposed retarding basin is presented in Fig. 4.25.

(2) Afforestation

Watershed management has been practiced for the catchment area of Buhisan Dam on Kinalumsan River. The upstream areas of other rivers in Cebu City will require the same watershed management works including afforestation.

(3) Enforced Maintenance

Most of the river channels are used as dumping sites for city dwellers' wastes and garbage. Wastes have accumulated in the channels, and channel flow capacity has been very much reduced in all rivers in Cebu City.

Enforced maintenance works to remove solid wastes and sediments from river and drainage channels will be effective to recover flow capacity and to restore a pleasant river environment.

4.3 Construction Plan and Cost Estimate

Construction Plan

The following basic conditions are taken into consideration for the construction plan and schedule:

(1) Outline of Work

The work items and their volumes for the river improvement lengths in the four cities are given below.

Item No.	Particulars	Unit	Iloilo (2 rivers)	Cebu (5 rivers)	Ormoc (2 rivers)
1.	Excavation	1,000 m^3	3,144	1,176	391
2.	Embankment	1,000 m^3	598	30	45
3.	Dredging	1,000 m^3	1,265	-	-
4.	Revetment	1,000 m	17	1	10
5.	Retaining Wall	m	-	42,400	2,190
6.	Backfill Concrete	1,000 m^3	43	9	105
7.	Sodding	1,000 m^2	275	39	22
8.	Gravel Pavement	1,000 m^2	183	16	22
9.	Drops	m	-	528	219
10.	Bridge	m^2	5,100	6,665	2,080
11	Slit Dam	No.	-	-	3

The work items and volumes of drainage channel improvement in the four cities are summarized in the following table:

Item No.	Particulars	Unit	Iloilo (3 channels)	Cebu (9 channels)	Ormoc (2 channels)	Tacloban (7 channels)
1.	Excavation	1,000 m^3	178	85	6	183
2.	Revetment	1,000 m	17	14	3	25
3.	Bridge	m^2	1,100	285	174	480

(2) Standard Construction Method

Construction is to be carried out by conventional construction methods using standard types of equipment.

(3) Construction Period

Based on the construction capability and budget availability, river and drainage improvement works are carried out for periods of three and two years, respectively.

Cost Estimate

The conditions for cost estimate are as follows:

(1) Project Cost

Project cost is estimated on the following assumptions:

(a) Construction works are to be executed by the contract system;

(b) Unit cost of each construction work item is estimated on the unit price basis, except for some work items which are estimated on lump sum/percentage basis;

(c) Unit prices are based on the price level of June 1993; and

(d) Local currency is used for the cost estimate.

(2) Constitution of Project Cost

The financial project cost consists of main construction cost, compensation cost, administration cost, engineering cost, and contingencies.

(3) Main Construction Cost

The main construction cost consists of the cost of preparatory works, main works and miscellaneous works.

(a) Preparatory Works

The cost of preparatory works for flood control and river improvement is estimated at 15% of the cost of main construction works.

(b) Main Works

The cost for main works is computed by multiplying the unit cost with the work quantity. The unit cost of each item consists of direct cost and indirect cost. The direct cost in unit cost consists of materials cost, equipment expenses and labor cost. Indirect cost consist of four items: (i) overhead, contingencies and miscellaneous (OCM); (ii) profit; (iii) mobilization and demobilization expenses of the contractor; and, (iv) value added tax (VAT).

(c) Miscellaneous Works

The cost of miscellaneous works is, in general, accounted as 10% of the sum of preparatory works and main works.

(4) Compensation Cost

Compensation cost is divided into land acquisition and house evacuation.

(5) Administration and Engineering Services

Administration cost for the government is computed at 5% of the sum of the main construction cost and compensation cost.

The engineering services cost is to cover the detailed design and construction supervision; therefore, 16% of main construction works is adopted as the rate of engineering cost.

(6) Physical Contingencies

Physical contingencies are usually estimated at 15% of main construction cost and compensation cost excluding engineering services cost.

Project Cost

The total project costs of the optimum flood control plans are estimated at 7,535 million pesos as given below. The breakdown is shown in Tables 4.1 to 4.7.

(Unit: Million. Peso)

City/River	Construction*	Compensation	Total
Iloilo City	1,977.9	696.6	2,674.5
Jaro	1,257.8	526.2	1,784.0
Iloilo	567.7	138.1	714.8
Drainage	143.4	32.3	175.7
Cebu City	1,655.3	2,416.2	4,071.5
Bulacao	128.9	127.2	256.1
Kinalumsan	243.7	321.1	564.8
Guadalupe	253.4	422.3	675.7
Lahug	321.8	488.4	810.2
Subang Daku	366.7	629.9	996.6
Drainage	340.8	427.3	768.1
Ormoc City	377.8	65.6	443.4
Anilao	212.9	33.5	246.4
Malbasag	144.0	29.1	173.1
Drainage	20.9	3.0	23.9
Tacloban City	274.4	98.2	345.6
Drainage	274.4	98.2	345.6
Grand Total	4,258.4	3,276.6	7,535.0

* This consists of Main Construction Cost, Administration Cost, Physical Contingency and Engineering Services Cost.

4.4 Project Evaluation

Economic Evaluation

Economic evaluation is carried out to ascertain the economic viability by comparing the economic benefit and the economic cost. As a method of project evaluation, economic internal rate of return (EIRR) is utilized as a tool of assessing economic viability on whether the proposed projects are to be worth being invested.

Table 4.8 summarizes the EIRRs of the projects. Among flood control projects in the cities under future condition, the most effective one is Ormoc City with an EIRR 28.6% as shown in the table. Next are Iloilo City with 21.9% and Cebu City with 19.8%. All the projects are viable from the economic point of view, because EIRRs exceed the 15% of opportunity cost of capital in the Philippines.

Regarding drainage improvement projects, the proposed schemes in Tacloban City are the most economically effective with the EIRR of 27.8%. The schemes in Cebu City are viable as well. On the other hand, the EIRRs of other schemes in Iloilo and Ormoc cities are 12.7% and 11.9%, respectively; not so high compared with the other projects.

Regarding total integrated projects including flood control and drainage improvement projects in the four cities, Ormoc City has the most effective from the economic point of view, with the highest EIRR of 27.8%. Next are the integrated projects in Tacloban City which show the same EIRR of 27.8% as Ormoc City but with a lower NPV and B/C; besides, Tacloban City projects do not include river improvement schemes. Those in Iloilo City and Cebu City show the EIRR of 21.3% and 21.1%, respectively, however, the EIRR under present conditions is estimated to be 13.5% for Iloilo City and 11.2% for Cebu City. From the economic viewpoint, the projects in Iloilo City have a more urgent priority than the projects in Cebu City.

<u>Environmental Impact Assessment</u>

The prediction and assessment of impacts was made through the use of interaction matrices filled in for each specific site and project stage. The matrices for the cities of Iloilo, Cebu, Ormoc and Tacloban are given in Table 4.9 to 4.12. Referring to these matrices, the evaluation for environmental impacts is summarized below.

(1) Significant Beneficial Impacts

- Dramatic improvement in hydraulic conditions of Jaro, Iloilo and Mandurriao river systems, and urban drainage systems;
- Removal of solid wastes dumped in the river and the drainage channels which will be brought with the channel widening or deepening work;
- Improvement of offensive odor and unhealthy environment by the removal of solid wastes dumped in the channels;

- Increase of aesthetic potential of waterfronts by the river/drainage channel improvement;
- Activation of the regional economy by providing a flood-free urban center;
- Increase of land use potential and land values of the existing flood-prone areas;
- Reliable transportation system free from stagnant traffic caused by floods;
- A clean and healthful urban community, and a safe and more pleasant living condition in the urban area;
- Enhanced environmental health conditions in the flood-alleviated areas;
- Local employment generation during construction; and
- Activation of trade and industry by the construction and related materials that the project would require.

(2) Significant Adverse Impacts

- Relocation of the inhabitants that would be forced by right-of-way acquisition for the floodways and channel improvement;
- Noise and vibration problem caused by construction work in the crowded areas;
- Effect on the river water quality and on the ecological conditions caused by the excavation work;
- A large amount of spoils generated by excavation work, which would disperse as dust or cause offensive odor;
- Impacts on the transport of goods and services to/from the city caused by a disruption of the traffic for construction work in the crowded areas of commercial and industrial districts;
- The proposed floodways which would diminish the rice paddies and the fish ponds; (only for Iloilo City);
- Mangrove vegetation around the mouths of the proposed floodways which might be diminished by the diverted flood water; (only for Iloilo City); and
- The proposed Jaro floodway which might be felt somehow out of place in a flat plain (only for Iloilo City).

4.5 Implementation of Master Plan

Implementation Schedule

The implementation schedule of the Master Plan for the four cities is prepared by placing higher priority on flood control works that could satisfy the following conditions:

(1) Urgency in implementation to mitigate flood damage, especially the menace to human life;

(2) Higher economic efficiency is expected with the implementation;

(3) Less adverse effects and promotion of better environmental conditions are expected with the implementation; and

(4) Less obstacles and social problems on implementation due to land acquisition and house evacuation.

Among the flood control works, those in Ormoc City are evaluated to have the highest EIRR as well as the most urgent for implementation. The city suffered from a disastrous flood in November 1991 and is still under the menace of a similar tragedy.

From economic efficiency, Iloilo and Tacloban cities are superior to Cebu City, while Cebu and Iloilo cities have more urgency for implementation of flood control works on account of the destructive floods in these cities. On the other hand, flood control works in Tacloban City are only the improvement works on urban drainage channels.

From the social aspect, however, Cebu City is expected to have more problems in implementation due to land acquisition and house evacuation; rather small compared to Tacloban City but much compared to Iloilo City.

To summarize, priority of implementation is in the order of: (1) Ormoc, (2) Iloilo, (3) Cebu and (4) Tacloban. Based on this prioritization, the implementation schedule is proposed in consideration of the construction periods and effectiveness of construction works, as presented in Fig. 4.26.

Selection of Area for the Urgent Plan

Ormoc City is top priority in the implementation schedule because of economic efficiency and urgency. In consideration of all the conditions mentioned before, Iloilo City and Ormoc City are selected as the areas for the Urgent Plan.

CHAPTER 5 URGENT PLAN

5.1 Planning Conditions

Project Scale

The project scale of the Urgent Plan is proposed to be equivalent or smaller than that of the Master Plan on account of the following considerations:

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

(2) Higher economic efficiency of the project.

To implement the project without a lapse of time, a smaller project cost is chosen for easier realization. On the other hand, the past practices of river improvement works in the Philippines have shown the optimum project scale to be a 20-year return period or less.

From the above considerations, the scale of urgent projects on rivers is proposed to be a 20-year return period. The design discharges corresponding to a 20-year return period are shown below as illustrated in Fig. 5.1.

River Name	Design Discharge (m^3/s) (20-year Return Period)
Jaro River	1,000
- Tigum River	450
- Aganan River	550
Iloilo River	400
- Mandurriao River	70
Anilao River	460
Malbasag River	250

As proposed in the Master Plan, a 5-year return period is adopted for the design scale of drainage improvement in major drainage systems with an area of more than 50 ha and a 3-year return period is adopted for those with less than 50 ha

Project Area

The project area of the Urgent Plan is delineated, based on a phased implementation program formulated in coordination with the implementation schedule of river improvement works in the Master Plan.

The phased implementation plan for each river is prepared where the Urgent Plan is firstly implemented and the flood control works successively undertaken and upgraded to the scale of the Master Plan.

(1) Jaro River

To confine a 20-year return period flood to the Iloilo Strait, a combination of construction of Jaro Floodway and partial improvement of Jaro River is implemented in the Urgent Plan, since Jaro Floodway is proposed to carry the discharge of 850 m^3/s and the existing channel of Jaro River has the flow capacity of 250 m^3/s except at a few narrow sections in low-lying areas at the river mouth. The implementation of the Master Plan is, therefore, divided into two (2) phases, as mentioned below. The area of the Urgent Plan is shown in Fig. 5.2.

First Phase (Urgent Plan):	The works consisting of the construction of Jaro Floodway and improvement of the narrow sections of Jaro River to secure a flow capacity of 150 m^3/s.
Second Phase (Master Plan):	The works consisting of river improvement and construction of La Paz Floodway for a 50-year return period flood as in the Master Plan.

(2) Iloilo River

Since the elevation of existing river banks of Iloilo River is about EL. 2 m above mean sea level (MSL) and the tolerance from MSHHWL is only 90 cm which is less than the required freeboard, the heightening of river bank is required to assure the freeboard. On the other hand, the water level of a 20-year return period flood under the existing condition is almost the same as the design high-water level corresponding to a 50-year return period flood. Therefore, the area for the Urgent Plan is delineated as shown in Fig. 5.3. The works are divided into two (2) phases, as follows:

First Phase (Urgent Plan):	The works consisting of the construction of concrete and earth dikes, demolition of the abandoned railway bridge to assure the flow capacity for the flood of a 20-year return period.

Second Phase (Master Plan): The works consisting of dredging and bridge protection works for the flood of a 50-year return period as in the Master Plan.

The Urgent Plan of the Mandurriao river improvement works is prepared for a 20-year return period flood, which is the same as the Master Plan. Therefore, a phased implementation plan for Mandurriao River is not considered.

(3) Anilao River

To secure the channel improvement area for the Urgent Plan, the same channel width as the Master Plan is adopted. A compound cross-section channel with high water channel revetments is employed. The Urgent Plan of Anilao river improvement works is implemented as given below. The cross sections are shown in Fig. 5.4.

First Phase (Urgent Plan): The works consisting of the construction of compound cross-section channel with high water channel revetment, and construction of two (2) slit dams on the upstream reaches.

Second Phase (Master Plan): The works consisting of excavation works of high water channel to increase the flow capacity for a 50-year return period flood and construction of revetments for low water channel as in the Master Plan.

(4) Malbasag River

The present land use along the channel improvement section for approx. 2 km is classified as below:

(a) Urbanized Area : Right bank, the river mouth to STA. 1+400
Left bank, the river mouth to STA. 0+400

(b) Rural Area : Right bank, the upstream from STA. 1+400

(c) Mountain Slope : Left bank, the upstream from STA. 0+400

From the above land use condition, the river improvement works in the Urgent Plan is limited to the widening of right bank for the river section in urbanized area from the river mouth to STA. 1+200. The phased implementation plan is formulated as below. The cross-sections are shown in Fig. 5.5.

First Phase (Urgent Plan):	The works for the STA. 0+000 to STA. 1+200 section consisting of the construction of retaining wall at the right bank, compound cross-section channel works with high water channel revetment at the left bank and construction of maintenance water channel; and, for the section upstream of STA. 1+200, construction of compound cross-section channel with high water channel revetments at the right bank and low water channel excavation at the left bank and construction of a slit dam on the upstream reaches.
Second Phase (Master Plan):	The Master Plan for the STA. 0+000 to STA. 1+200 section consisting of the excavation works of high water channel and construction of retaining wall at the left bank; and, for the section upstream of STA. 1+200, excavation work of high water channels, construction of low water channel revetment at the both banks and high water channel revetment at the left bank.

(5) Drainage Channel

As the priority stretches of four (4) drainage basins, the following main channel sections are proposed to be improved. Figs. 5.6 and 5.7 show the location of these stretches.

City/Creek		Objective Stretch
Iloilo City		
Ingore Creek	4,870 m	(Jaro-Lebanes Road Bridge to Jaro River)
Bo. Obrero Creek	4,220 m	(Burgos St. to Iloilo Strait)
Rizal Creek	560 m	(Luna St. to Iloilo River)
Ormoc City		
Lotao Creek	1,200 m	(Osmeña Ext. to Ormoc Bay)
Total	10,850 m	

Aiming at the mitigation of a larger scale of drainage inundation damage in the basins, the improvement of primary channels including some secondary drains is