JAPAN INTERNATIONAL COOPERATION AGENCY

NATIONAL WATER RESOURCES BOARD
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE GOVERNMENT OF THE REPUBLIC OF THE PHILIPPINES

MASTER PLAN STUDY
ON
WATER RESOURCES MANAGEMENT
IN
THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

VOLUME II
MAIN REPORT

AUGUST 19[illegible]

NIPPON KOEI CO., LTD., TOKYO, JAPAN
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Composition of the Final Report

Volume I : Executive Summary

Volume II : Main Report

Volume III-1 :Supporting Report

Part – A : Socio-Economy

Part – B : Hydrology

Part – C : Groundwater Resources

Part – D : Dam and Related Facility Engineering

Volume III-2 :Supporting Report

Part – E : Municipal and Industrial Water Demand

Part – F : Agricultural Water Demand

Part – G : Groundwater Resources Development Planning

Volume III-3 :Supporting Report

Part – H : Surface Water Resources Planning

Part – I : Environmental Study

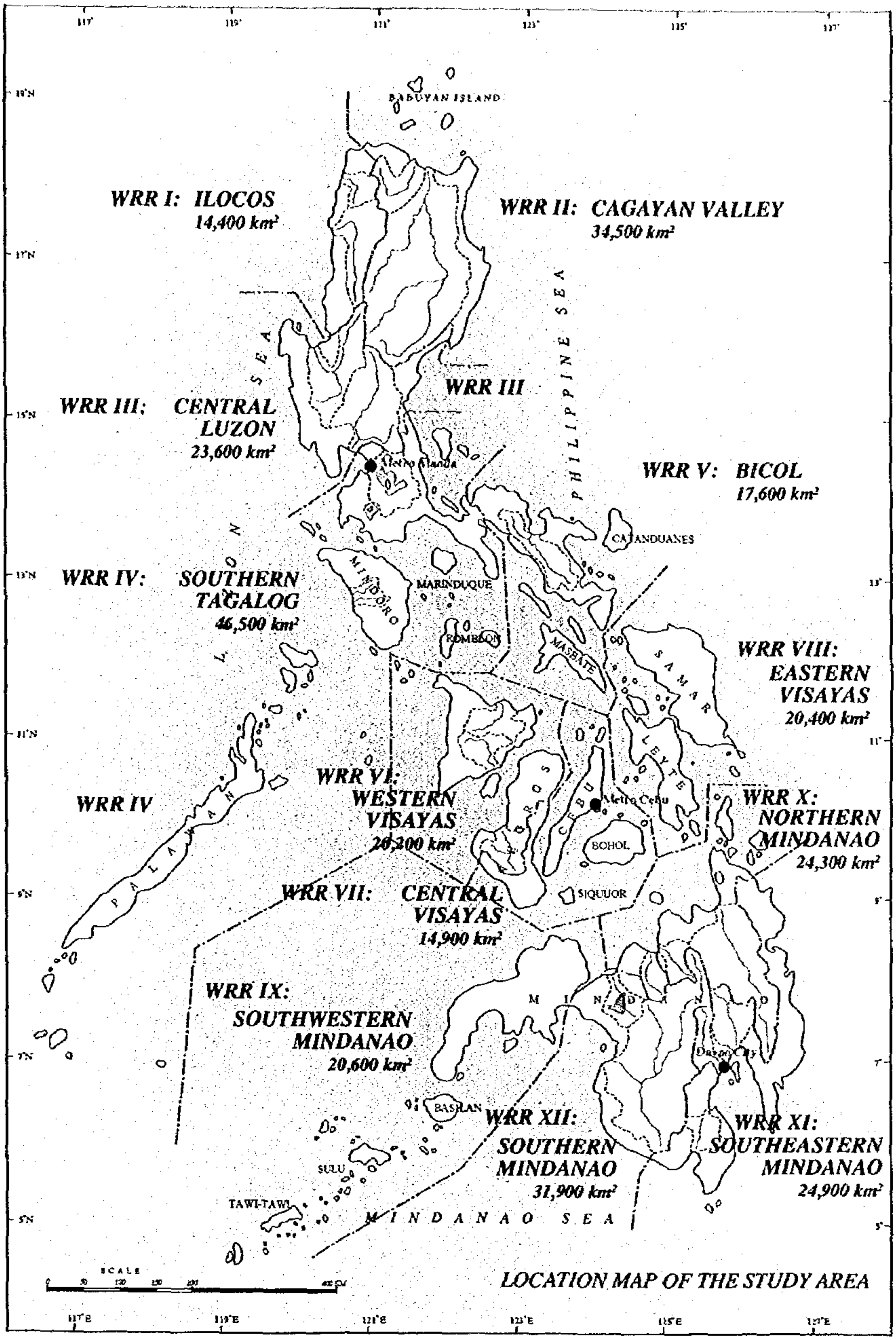
Part – J : Institutional Framework for Water Resources Management

Part – K : Database

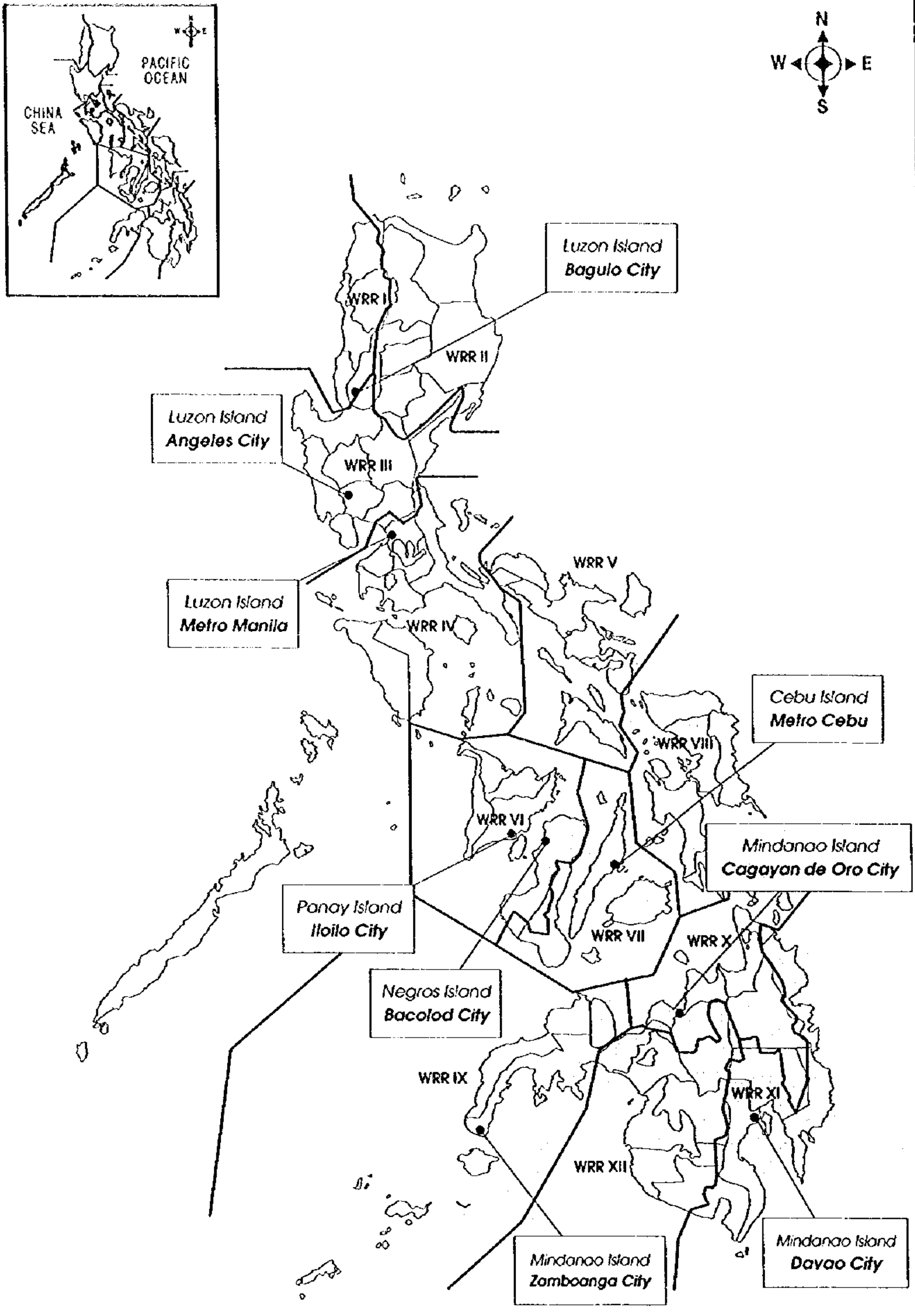
Part – L : Workshop Using Project Cycle Management (PCM)

Part – M : Water Demand by Administrative Region

Volume IV : Data Book



LOCATION MAP OF THE STUDY AREA



LOCATION OF SELECTED MAJOR CITIES FOR WATER SUPPLY PLANNING

Abbreviation

1. Organization

ADB	:	Asian Development Bank
BAS	:	Bureau of Agricultural Statistics
BAI	:	Bureau of Animal Industry
BCWD	:	Baguio City Water District
BFAR	:	Bureau of Fisheries and Aquatic Resources
BSWM	:	Bureau of Soils and Water Management
BWSA	:	Barangay Waterworks and Sanitation Association
DA	:	Department of Agriculture
DENR	:	Department of Environment and Natural Resources
DILG	:	Department of Interior and Local Government
DOH	:	Department of Health
DPWH	:	Department of Public Works and Highways
DTI	:	Department of Trade and Industry
DOE	:	Department of Energy
DCWD	:	Davao City Water District
EMB	:	Environmental Management Bureau
ERB	:	Energy Regulatory Board
IBRD	:	International Bank of Reconstruction and Development
JICA	:	Japan International Cooperation Agency
LDC	:	Livestock Development Council
LGUs	:	Local Government Units
LWUA	:	Local Water Utilities Administration
MCWD	:	Metro Cebu Water District
MWSS	:	Metropolitan Waterworks and Sewerage System
NAMRIA	:	National Mapping and Resources and Resource Information Authority
NEDA	:	National Economic and Development Authority
NGOs	:	None-Governmental Organizations
NIA	:	National Irrigation Administration
NPC	:	National Power Corporation
NSCB	:	National Statistical Coordination Board
NSO	:	National Statistics Office
NWRB	:	National Water Resources Board

NWRC : National Water Resources Council
OECF : Overseas Economic Cooperation Fund
PAGASA : Philippine Atmospheric Geophysical and Astronomical Services Administration
PECC : Pacific Economic Cooperation Council
PEZA : Philippines Economic Zones Authority
PTFWRM : Presidential Task Force on Water Resources Management
PWB : Philippines Weather Bureau
PWRA : Philippine Water Resources Authority
PMO : Project Management Office under DPWH
RWSA : Rural Waterworks and Sanitation Association
UNDP : United Nations Development Programme

2. Unit

GWh : giga-watt hour
ha : hectare
kg/head : kilogram per head
km : kilometer
km^2 : square kilometer
lpcd : liter per capita per day
lps and l/p/s : liter per second
m : meter
MCM or million m^3 : million cubic meter
MCM/year : million cubic meters per year
mg/l : milligram per liter
m^3/km^2/year : cubic meters per square kilometer per year
m^3/sec : cubic meter per second
mm : millimeter
mm/day : millimeter per day
mm/year : millimeter per year
MT/ha : million ton per hectare
MW : mega-watt

3. Chemical Index on Water Quality

pH : pH value
BOD : Biochemical Oxygen Demand
DO : Dissolved Oxygen

4. Others

AAGR : Average Annual Growth Rate
ARMM : Autonomous Region for Muslim Mindanao
BOT : Build-Operate-and-Transfer
C.A. : Catchment Area
CAR : Cordillera Administrative Region
CPI : Consumer Price Index
CIS : Communal Irrigation System
DB : Database
DBMS : Database Management System
DD : Diversion Dam
ECA : Environmentally Critical Project
ECC : Environmental Compliance Certificate
ECP : Environmental Critical Project
EIS : Environmental Impact Statement
EZ : Economic Zone
FC : Flood Control
GDP : Gross Domestic Product
GIS : Geographical Information System
GNP : Gross National Product
GRDP : Gross Regional Domestic Product
GVA : Gross Value Added
GW : Groundwater
HP : Hydropower
IOSPs : Irrigation Operation Support Projects
IR : Irrigation
L-I : Level-I Water Supply Facility
L-II : Level-II Water Supply System
L-III : Level-III Water Supply System
M/P : Master Plan

M&I	:	Municipal and Industrial
MTPDP	:	Medium-Term Philippine Development Plan
MTIP	:	DPWH-Medium Term Infrastructure Program Prepared by DPWH
MWSP III	:	Manila Water Supply Project III
NCR	:	National Capital Region
NIPAS	:	National Integrated Protected Areas System
NIS	:	National Irrigation System
NRW	:	Non-Revenue Water
NSDW	:	National Standard for Drinking Water
NWIN	:	National Water Information System
O&M	:	Operation and Maintenance
OS	:	Operation System
PD	:	Presidential Decree
PDP	:	Power Development Plan
PGDB	:	Philippine Groundwater Data Bank
SRIP	:	Small Reservoir Impounding Project
STWs	:	Shallow Tube Wells
SW	:	Surface Water
SWIMs	:	Small Water Impounding Management Projects
WD	:	Water District
WRDP	:	Water Resources Development Project
WRR	:	Water Resources Region

MASTER PLAN STUDY
ON
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FINAL REPORT

Volume II : MAIN REPORT

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CHAPTER I

INTRODUCTION

I. INTRODUCTION

1.1 Authorization

In response to the official request of the Government of the Republic of the Philippines (hereinafter referred to as "GOP"), the Government of Japan (hereinafter referred to as "GOJ") has decided to conduct the Master Plan Study on Water Resources Management (hereinafter referred to as "the Study"), and exchanged the "Notes Verbals" with GOP concerning the implementation of the Study.

Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the GOJ, has undertaken the Study, in accordance with the relevant laws and regulations in force in Japan. The GOP, meanwhile, has assigned the National Water Resources Board (hereinafter referred to as "NWRB") as a counterpart agency for the Study and also as a coordinating body in relation with other relevant governmental and non-governmental organizations concerned for the smooth implementation of the Study.

For the Study, JICA dispatched a Preparatory Study Team headed by Mr. Kazuyuki Sakanoi (hereinafter referred to as "the Preparatory Study Team") to the Philippines from September 17th to October 3rd, 1996 to discuss and determine the Implementing Arrangement for the Study.

During the stay in the Philippines, the Preparatory Study Team carried out field surveys of some parts of the study area, and had a series of discussions on the draft Implementing Arrangement with the authorities concerned of GOP, in particular with NWRB. Through intensive discussions in joint meeting with the authorities concerned of GOP, the Implementing Arrangement was agreed upon by both sides, and was signed on September 25th, 1996.

The signed Implementing Arrangement defined the objective of the Study. It framed the scope of works of the Study as well. This report presents the outcome of the Study carried out in line with the stipulations of the Implementing Arrangement.

1.2 Objective of the Study

The objectives of the Study as stipulated in the Implementing Arrangement mentioned above are as follows:

1. To formulate a master plan on water resources development and management in the twelve water resources regions of the Philippines.

2. To perform technology transfer to Philippine counterpart personnel in the course of the Study.

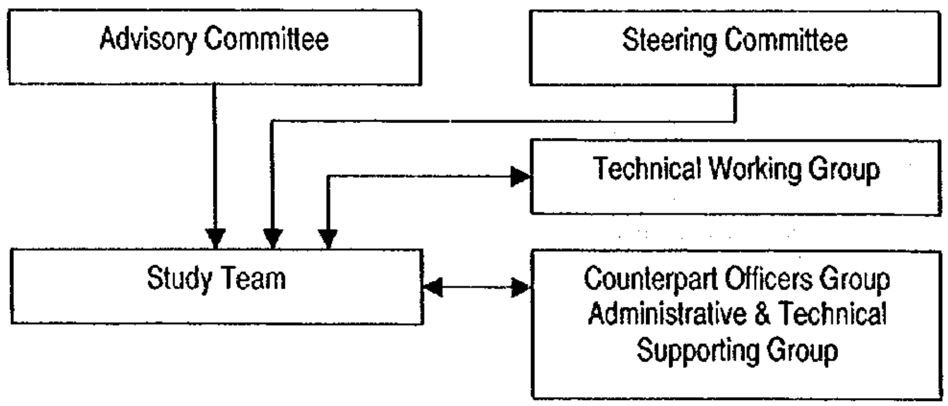
The target year of the Study is defined to be the year 2025.

1.3 Organization

JICA has organized the Study Team of consultants from various disciplines and entrusted the Study thereto. The JICA Study Team performed the Study in collaboration with the counterpart personnel, administrative and supporting staff groups nominated from the relevant Philippine authorities concerned. JICA organized the Advisory Committee comprising officials of GOJ and staff of JICA to furnish necessary advice to the Study Team.

GOP, meanwhile, organized the Steering Committee for the Study of representatives from agencies concerned to coordinate multi-sectoral issues inherent in the water resources development. It is expected that the water resources management master plan to be proposed by the Study will become effective when the committee accepts it. The technical working group was also formed by GOP through the selection of staff from the various agencies concerned. The group provides suggestions to the Study Team from time to time on technical aspects.

The organization of the Study is shown below and the members of committees and groups are listed in Table 1-1.



Note : ——▶ shows address of advices, suggestions and instructions.

The members of the JICA Study Team are listed in Table 1-2.

1.4 Progress of the Study

The Study Team, thus organized, commenced the works on 21 February 1997. The substantial work in this stage was the preparation of the Inception Report for the Study summing up the concept, approach and methodology of the Study to be conceivable. The first meeting of the Advisory Committee was held on 27 February 1997 in the meeting room of JICA, Tokyo to discuss the contents of the draft inception report. The Inception Report was duly finalized incorporating the advice given to the Study Team in the meeting.

The first field investigation works began on 5 March 1997 in Manila, Philippines. Holding the first Steering Committee meeting was the initial work of this stage to discuss about the Inception Report. The meeting was jointly attended by the members of Advisory Committee from Japan. Thus, all the members concerned with the Study obtained the consensus in the concept and approach of the Study. The major subjects of this stage were information and data collection concerning the water demand and the potential of the water resources. The existing institutional and environmental problems related to water resources were the information to be gathered. A database system constructed during the Study functioned well to store and retrieve the collected data. The Study Team prepared the First Progress Report and the GOP held the second Steering Committee Meeting to discuss the report on 30 July 1997 at the conference room of NIA building. The first field work was, thus, completed on 1 August 1997.

The first home office works were initiated on 2 August 1997 and the second Advisory Committee meeting was held on 21 August 1997. The Study Team reported the progress and observations of the field works. The Study focussed on the projection of water demands, assessment of the water resources and the preliminary water demand and supply balance study for the water resources region and the major river basins. The results of the Study were incorporated in the Interim Report. The first home office works terminated on 30 September 1997. JICA held the 4th Advisory Committee meeting 15 October 1977 to discuss the draft Interim Report. The Study Team finalized the Interim Report reflecting the comments and advice furnished by the Advisory Committee. The report was submitted to the JICA and duly distributed to the agencies concerned in the Philippines.

The Study Team commenced the second field investigation works on 16 November 1977 in Manila, the Philippines. The NWRB, the chair agency of the Steering Committee, held the 3rd committee meeting on 25 November 1977 to discuss about the Interim Report. The major subjects of this study period were the examination of water demand and supply balance in the selected areas, study on the water resource development schemes to suffice the water demand at the sites where water deficits are anticipated to take place and the study on the remedial measures against the institutional and environmental problems in the water resources management. The results of the Study in the period were compiled in the Progress Report (2) which was prepared and submitted to the GOP through the JICA Philippines office. The GOP held the 4th Steering Committee meeting to discuss about the Report. The second field work period came to an end on 13 February 1998.

The second home office works were performed between 14 February 1998 and 30 March 1998. The JICA held the 5th Advisory Committee meeting to let the Study Team to report the progress of the second field works and thereafter to the Committee on 18 March 1998. The substantial works in this period are to formulate master plan, short-term strategy, the examination of the viability of the projects contemplated in the proposed short-term strategy and the preparation of the Draft Final Report. The Advisory Committee reviewed the Draft Final Report through the discussion in the 7th Advisory Committee meeting. The Report was amended in line with the advice and comments given thereto and the Report was submitted to the JICA.

1.5 The Final Report

The Final Report was prepared to present the proposed master plan of the national water resources development and management of the Philippines. The Report discusses the estimated water resources potential and the projected water demands by sectors. The water demand and supply balances in the water resources regions, in the major river basins and in the selected major cities are the main subjects of the discussion in the Report. The Report proposes a plan to cope with the projected water deficits in the form of the master plan.

The Final Report comprises the following volumes:

Volume I		:	Executive Summary	
Volume II		:	Main Report	
Volume III-1	Supporting Report	:	Part-A	Socio-Economy
			Part-B	Hydrology
			Part-C	Groundwater Resources
			Part-D	Dam and Related Facility Engineering
Volume III-2	Supporting Report	:	Part-E	Municipal and Industrial Water Demand
			Part-F	Agricultural Water Demand
			Part-G	Groundwater Resources Development Planning
Volume III-3	Supporting Report	:	Part-H	Surface Water Resources Planning
			Part-I	Environmental Study
			Part-J	Institutional Framework for Water Resources Management
			Part-K	Database
			Part-L	Project Cycle Management (PCM)
			Part-M	Water Demand by Administrative Region
Volume IV	Data Book			

The Executive Summary Report briefs the summary of the works and the results of the Study. The Report does not explain the details of the data collected and methods applied in the formulation of the master plan. The Report is, however, convenient to understand the proposed master plan together with the fundamental conditions contemplated in the formulation of the plan easily without consuming time.

The Main Report comprises eleven chapters describing the Study and the results thereof on each discipline. The Report present complete information of the master plan and the procedures applied to its formulation. However the Supporting Reports supplement the information. The Supporting Reports explain the logics of the methods applied in plan formulation in more detail.

The data collected and arranged through the Study are assembled in the Data Book.

Table 1-1 ORGANIZATION OF COMMITTEE CONCERNED WITH THE STUDY

A. JICA ADVISORY COMMITTEE

(i) Before March 1998		(ii) After March 1998	
Position	Name	Position	Name
Team Leader	Mr. Kazuyuki Sakanoi	Team Leader	Mr. Shigeo Ochi
Member	Mr. Katsunori Takagi	Member	Mr. Takahisa Hikichi
Member	Mr. Yuji Watanabe	Member	Mr. Yuji Watanabe
JICA Coordinator	Mr. Katsuyoshi Saito	JICA Coordinator	Mr. Katsuyoshi Saito

B. STEERING COMMITTEE

Agency	Position	Name
National Water Resources Board (NWRB)	Chairman	Mr. Luis M. Sosa Executive Director
National Economic and Development Authority (NEDA)	Member	Mr. Ruben S. Reinoso Director
Department of Public Works and Highways (DPWH)	-do-	Ms. Helen G. Marvilla OIC, Project Manager
Department of Environment and Natural Resources (DENR)	-do-	Mr. Jose D. Malvas, Jr Director
Department of Health (DOH)	-do-	Mr. Mario Villaverde Director
Department of Interior and Local Government (DILG)	-do-	Mr. Normando J. Toledo Director, OPDS
Department of Agriculture (DA)	-do-	Mr. Rogelio Concepcion Director
Department of Trade and Industry (DTI)	-do-	Mr. Celestiano B. Santiago OIC, Director
National Irrigation Administration (NIA)	-do-	Mr. Edilberto B. Punzal Manager
Local Water Utilities Administration (LWUA)	-do-	Mr. Edwin Ruiz Department Manager
Metropolitan Waterworks and Sewerage System (MWSS)	-do-	Ms. Jose Dimatulac Department Manager
National Power Corporation (NPC)	-do-	Mr. Emmanuel E. Antiola OIC, Division Manager
Presidential Task Force on Water Resources Management.	-do-	Ms. Mary Mai Flor Exec. Director
Bureau of Research & Standard, DPWH	-do-	Mr. Raul C. Asis Director

C. TECHNICAL WORKING GROUP / COUNTERPART PERSONNEL

Designation	Name	Agency	
Team Leader	Melchor O. Baltazar	NWRB	Full -time assignment
Water Resources Planner	Lope R. Villenas	NWRB	-do-
Hydrologist	Jorge M. Estioko	NWRB	-do-
	Antonio V. Molano, Jr.	DPWH	Part-time assignment
Hydrogeologist	Isidra D. Penaranda	NWRB	Full-time assignment
Water Demand	Emmie L. Ruales	NWRB	-do-
Forecasting Planner	Arlene C. Diaz	NWRB	-do-
(Industrial Water)	Evangeline Dacanay	MWSS	Part-time assignment
Water Demand	Pacita F. Barba	NWRB	Full-time assignment
Forecasting Planner	Evelyn V. Ayson	NWRB	-do-
(Irrigation)	Silvino Alonzo, Jr.	NIA	Part-time assignment
Groundwater	Jesusa T. Roque	NWRB	Full-time assignment
Resource Planner	Higino C. Mangosing, Jr.	NWRB	-do-
	Jose Rene Rancesvalle	LWUA	Part-time assignment
Dam Engineer	Luis S. Rongavilla	NWRB	Full-time assignment
	Romualdo T. Beltran	NPC	Part-time assignment
Database Specialist	Susan P. Abano	NWRB	Full-time assignment
	Ma. Charina M. Gonzales	NWRB	-do-
	Ma. Victoria M. Astraquillo	NWRB	-do-
Construction Planner	Leonila A. Cagatin	NWRB	-do-
	Filomeno Ventura	NIA	Part-time assignment
Institutional Planner	Jesus G. de Leon	NWRB	Full-time assignment
	Elena Luz J. Alojipan	NWRB	-do-
	Rogelio B. Ocampo	DILG	Part-time assignment
Socio-economist	Florimel R. Balbedina	NWRB	Full-time assignment
	Francis Hilarie	NWRB	-do-
	Librado F. Quitoriano	NEDA	Part-time assignment
Environmentalist/Water	Dolores S.D. Cleofas	NWRB	Full-time assignment
Quality Analyst	Jose J. Beltran	NWRB	-do-
	Marcelino Rivera, Jr.	DENR	Part-time assignment
Coordinator	Felisa M. Manlulu	NWRB	Full-time assignment
	Ramon G. Romero	NWRB	-do-

D. ADMINISTRATIVE AND SUPPORTING STAFF

Designation	Name	Agency	
Administrative & Financial Officer	Belen T. Tormon	NWRB	Full-time assignment
Accountant	Marilyn T. San Pedro	NWRB	-do-
Budget Officer	Elizabeth P. Sepina	NWRB	-do-
Personnel Officer	Normita G. Flores	NWRB	-do-
Disbursing Officer	Remigia V. Beadoy	NWRB	-do-
Supply Officer	Susan V. Tenorio	NWRB	-do-
Data Encoder/Researcher	Lilian P. Gacusan	NWRB	-do-
Data Encoder/Researcher	Milagros M. Velasco	NWRB	-do-
Data Encoder/Researcher	Josephine R. Billones	NWRB	-do-
Data Encoder/Researcher	Ma. Angelica T. Raquepo	NWRB	-do-
Tracer/Draftsman	Nora M. Andrade	NWRB	-do-
Liaison Officer	David M. de Jesus	NWRB	-do-
Secretary	Arleen E. Batac	NWRB	-do-
Machine Operator	Larry E. Aquino	NWRB	-do-
Utilityman	Alberto V. Bautista	NWRB	-do-
Driver	Isidro L. Simeon	NWRB	-do-
Driver	Eduardo F. Pacio	NWRB	-do-
Driver	Meynardo C. Balba	NWRB	-do-

Table 1-2 LIST OF JICA STUDY TEAM MEMBERS

Name	Organization	Position
(1) Norio Takayanagi	NK	Team Leader
(2) Toshio Katayama	NK	Water Resources Planner
(3) Harold E. Mullis	(NK)	Hydrologist
(4) Kenji Takayanagi	NJS	Hydrogeologist
(5) Nobuki Abe	NJS	Water Demand Analyst (Municipal and Industrial Water)
(6) Emerson M. Coloma	(NK)	Water Demand Analyst (Agricultural Water)
(7) Nobukatsu Sakiyama	NJS	Groundwater Resources Planner
(8) Yasuo Iwasaki	NK	Dam Engineer
(9) Takenori Morita	NK	Databse Specialist
(10) Hidenori Matsuura	NK	Construction Planner
(11) Aramando C. Lizaso	(NJS)	Institutional Planner
(12) Kiminari Tachiyama	(NK)	Socio-Economist
(13) Juntaro Mizutani	NJS	Environmental Expert
(14) Shigeyoshi Hanada	NK	Project Cycle Management (PCM) Expert
(15) Yutaka Baba	NK	Assistant Coordinator

Note

NK : Nippon Koei Co., Ltd.

NJS : Nippon Jogesuido Sekkei Co., Ltd.

CHAPTER II

NATURAL AND SOCIO-ECONOMIC CONDITION

II. NATURAL AND SOCIO-ECNOMIC CONDITION

2.1 Land

2.1.1 Land Area and Topography

The Philippines which is an archipelago composed of about 7,100 islands and islets lies between latitude 4° 23'N and 21° 25'N and between longitude 116° E and 127° E. The archipelago is bounded by the South China Sea on the west, by the Pacific Ocean on the east, by the Sulu and Celebes Seas on the south and by the Balintang channel on the north. The total land area of the Philippines is approximately 300,000 km^2, about 94% of which is contained within the 11 principal islands, namely Luzon, Mindanao, Samar, Negros, Palawan, Panay, Mindoro, Leyte, Cebu, Bohol and Masbate in order of their sizes. The rest, consisting of small coralislets, is mostly uninhabited. Luzon is the largest island, while Mindanao, the southernmost major island, is the second largest. The country is divided into three major island groups, namely Luzon with an area of 141,000 km^2, Mindanao with 102,000 km^2 and Visayas with 57,000 km^2.

Owing to its archipelagic nature, topographic variations characterize the Philippines. The previous study of the geological history of the archipelago exhibits that the islands are actually the peak of mountains uplifted from the sea floor by the horizontal pressure exerted by the Indo-Australian Plate and the Aslatic Plate on the eastern boarders of the Philippine Plate during the Miocene Period. The series of small islands composed of "half-drowned mountains" form part of a long and wide cordillera extending from Indonesia to Japan while other peaks are of volcanic origin.

2.1.2 Geology

The Philippine Archipelago could be, as the basic conception, considered as wedges caught between sets of two oppositely dipping subduction zones. The north and central Luzon are situated between the Manila Trench and the east Luzon Trench. These trenches are interpreted as subduction zones where the ocean submarine floor under thrusts beneath the continental or island massif. This situation can be observed also in the Visayan Shelf between the Sulu-Negros Trench and the Philippine Trench, and in the Mindanao island between the Cotabato Trench and the Philippine Trench.

The alignment of these trenches, especially of the two major trenches, the Philippine Trench and the East Luzon Trench trending toward NNW to N, characterizes the Philippine Archipelago as a zonal structure with several wide belts connecting island to island arch-wise in the same trend with trenches.

The archipelago consists essentially of two separable and distinct structural units, a mobile belt and a stable region. The mobile belt covers almost all the archipelago and is characterized by the concentration of earthquake epicenters, numerous active and inactive volcanoes and deeply sheared zone forming narrow canyons, intermontane basins and straits. The stable region, the southwestern part of the archipelago which embraces mainly Palawan and Sulu Sea, is essentially aseismic and shows the virtual absence of Tertiary igneous activity.

The mobile belt, is farther subdivided into three structural belts running parallel from northwest to southeast.

Western structural belt is a stretch of ridges with intervening troughs, and extends from Ilocos passing through Zambales range, west Mindoro and Antique range in west Panay to Zamboanga Peninsula in west Mindanao. The belt is characterized by the underlying basement complex with metamorphic rocks and by numerous overthrust and normal faults which have sheared the rocks deeply so as to form steep canyons and intermontane basins. The quaternary volcanic activity in this belt, however, is very rare.

The central structural belt is composed of cordilleras, lowlands, troughs and offshore basin. It extends from Cagayan passing through central Luzon, Bondoc Peninsula, Sibuyan, Masbate, western and central Visayas and Leyte to Cotabato. The belt is characterized by thick sequences of Cretaceous to Tertiary sedimentary rocks intruded by Neagene diorite botholith. Numerous Quaternary volcanoes, inactive or still active, heavily concentrate into this belt. The other prominent aspect of this belt is the presence of the Philippine fault zone which is traceable for about 1,200 km from Lingayen Gulf through Dingalan Bay in central Luzon to Masbate, Leyte thence to Agusan-Davao lowland in eastern Mindanao. Activity in the Philippine fault appears to have been continuous since the paleogene.

The eastern structural belt constitutes a narrow belt limited on the east by the Philippine Trench and on the west by the western limits of Sierra Madre, Bicol range, Samar highland and Diwata range in eastern Mindanao. This belt is characterized by the presence of the post-Jurassic metamorphic rocks, numerous overthrust faults and heavy concentration of earthquakes with shallow focus which signify dynamothermal activities along the ridge system fronting the Philippine Trench and the East Luzon Trench. The other prominent aspect in the belt is the Bicol volcanic belt fringing northeastern coast of the Bicol Peninsula.

2.1.3 River Systems and Major River Basins

There are 343 independent principal river basins that have at least 40 km^2 of basin area each identified over the whole country. Out of these, 20 river basins that have at least 990 km^2 of the basin area each are identified as the major river basins. They are Laoag, Cagayan, Pampanga, Agno, Abra, Pasig-Laguna de Bay, Bicol and Abulug river basins in Luzon island, the Mindanao, Agusan, Tagum-Libuganon, Tagoloan, Agus, Davao, Cagayan De Oro and Buayan-Malungum river basins in Mindanao island, the Panay and Jalaur river basins in Panay island, the Amnay-Patrick river basin in Mindoro island and the Ilog-Hilabangan river basin in Negros island. The locations of the major river basins are shown in Figure 2-1. The 343 principal river basins cover a total land area of 199,637 km^2 which is equivalent to 66.5% of the total land area of the Philippines. The 20 major river basins cover a total area of 111,269 km^2 equivalent to 37.1% of the total land area of the Philippines or 55.7% of that of the principal river basins.

2.1.4 Water Resources Regions and Administrative Regions

Usually, the land of the Philippines is delineated in accordance with two different categories, namely boundaries of the water resources regions (WRR) and administrative regions.

In the former case, the Philippines is divided into 12 water resources regions (WRR) by the National Water Resources Council (NWRC) in consideration of hydrological boundaries for the purpose of comprehensive planning of water resources development. These are the Ilocos (WRR I), Cagayan Valley (WRR II), Central Luzon (WRR III), Southern Tagalog (WRR IV), Bicol (WRR V), Western Visayas (WRR VI), Central Visayas (WRR VII), Eastern Visayas (WRR VIII), Southwestern Mindanao (WRR IX), Northern Mindanao (WRR X), Southeastern Mindanao (WRR XI), and Southern Mindanao (WRR XII). The locations of the 12 water resources regions are depicted in Figure 2-1.

From the administrative aspect, the Philippines is divided into the 16 regions, namely region 1 to region 12, and 4 other regions as shown in Figure 2-2. The 4 regions comprise the National Capital Region (NCR), CAR, ARMM and CARAGA, out of which NCR covers the Metro Manila, the capital area of the country. These 16 administrative regions are further subdivided into such smaller political or administrative units such as provinces and municipalities. The smallest administrative unit is the barangay. The provinces included in each of the administrative regions are shown in Figure 2-3.

The two different boundaries of the water resources regions and administrative regions are illustrated in Figure 2-2, which reveal that there is no large difference between both delineation in case of Luzon and Visayas, aside from the two administrative regions of NCR and CAR delineated by the administrative boundaries. On the other hand, the boundaries of the water resources regions in Mindanao are quite different from those of administrative regions in terms of their areas as seen in Figure 2-2.

In a broad sense, the three Water Resources Regions in Mindanao, Southwestern Mindanao (WRR IX), Southeastern Mindanao (WRR XI) and Southern Mindanao (WRR XII), correspond to Western Mindanao, Southern Mindanao and Central Mindanao in the administrative regions. Thus, the names of these three water resources regions differ from those of the corresponding administrative regions.

2.2 Climate and Climate Regions of the Study Area

There are four climatological types that exist in the Philippines characterized as follows:

i) Type I: Two pronounced seasons, dry from November to April, wet during the rest of the year

ii) Type II: No dry season with a very pronounced maximum rainfall period from November to January

iii) Type III: Seasons are not very pronounced with relatively dry season from November to April and wet season during the rest of the year.

iv) Type IV: Rainfall more or less distributed throughout the year.

Figure 2-4 shows the distribution of these climate regions for the entire study area. Rainfall intensities in the study area range from very light to heavy and may occur as continuous, intermittent, or showery. Precipitation is influenced by prevailing air streams or monsoons, tropical typhoons, the Intertropical Convergence Zone (ITCZ), topography, fronts, easterly waves, and local thunderstorms. The significance of each of these climatic influences varies with the time of year.

2.3 Hydrology

2.3.1 Data Collection

(1) Rainfall Data Collection

During the first stage field investigation, the rainfall data were obtained from PAGASA for 50 synoptic stations. These data include daily rainfall total as well as monthly and annual summary data. For most of the synoptic stations, daily rainfall data are available for the period from 1961 to 1995. The representative rainfall gauging stations were selected for each of the major river basins. In a few basins, rainfall data from sources other than PAGASA were used because they were determined to be more representative of the particular river basin. Other sources of rainfall data included NIA and NPC. The rainfall data were used along with the flow data from the selected stream gauging stations to validate the streamflow record as described in Part-B of the Supporting Report. The locations of the representative rainfall gauging stations are shown in Figures 2-5 to 2-16.

The frequency analyses were performed using total annual rainfall for each of the 50 PAGASA synoptic stations in order to assess the draught years of various probabilities.

(2) Streamflow Data Collection

The streamflow data were gathered for many of the stations within the study area. The data from a minimum of two stations per major river basin were attempted to be gathered. The representative streamflow gauging stations for each major river basin were selected from these ones. The streamflow records were obtained from BRS, NPC and NIA. Some of the data were in computer format and others were only available in hard copy format.

2.3.2 Hydrologic Analysis

(1) General

The hydrologic analysis carried out in the first stage field investigation involved the following elements:

- Identification of representative stream gauging stations for each major river basin,
- Verification of streamflow data using double mass curve analysis,
- Flow frequency analysis for the selected representative stream gauging stations using mean annual discharge, and
- Selection of drought years based on frequency analysis

(2) Identification of Representative Streamflow Gauging Stations

Criteria for Selecting Representation Stream Gauging Stations

The representative streamflow gauging stations were selected for each of the major river basins based on the following criteria:

(i) Period of available record; Both the length of record and the period covered by the record were considered. When possible, stations with recent records were selected.

(ii) Size of tributary catchment area; the representativeness of streamflow data is dependent on the size of the tributary catchment area relative to the size of the catchment area for which the data are intended to represent. When possible stations with relatively large catchment areas were selected.

(iii) Location of the station within the basin; when possible, representative stations were selected so that the tributary area reasonably represented the general topography and rainfall patterns of the entire basin.

(iv) No upstream flow manipulation; ideally, stations downstream of features such as lakes, reservoirs and flow diversion structures were not selected as the representative stations. However, only limited information was available at the time of the station selection.

It was not possible to meet all of these selection criteria with the representative station for every major river basin. In some cases, only one of the criteria could be met due to the limited number of gauging stations within a basin.

Data Validation

The reliability of the data from prospective representative gauging stations was validated through comparison with data from selected rainfall stations and, in some cases, other stream gauging stations. Correlation plots and double mass curve plots were produced for this purpose by plotting the mean annual discharge against the total annual rainfall. Finding long-term streamflow records that produced a smooth double mass curve was not possible for every basin. In some cases, streamflow data from adjacent or nearby basins were used. The selected long-term streamflow data were used to perform frequency analyses of the mean annual discharge. The double mass curve plots worked out through the procedures are compiled in Part-B of the Supporting Report.

(3) Mean Annual Discharge Frequency Analysis

The frequency analyses were performed using streamflow data from the selected representative stations. Mean annual discharge values were used for this analysis. The values were ranked and fitted to Log Pearson Type III distribution. The cycle used for calculating the mean annual discharge was adjusted to begin at the time of peak annual runoff for each station. The annual precipitation patterns vary with locations throughout the study area. In western Luzon, for example, the peak of the rainy season occurs in August. In other areas peak flows occur in November. The flow frequency analysis plots for the selected representative stations are presented in Part-B of the Supporting Report. The frequency analyses results were used to identify the magnitude of the theoretical mean annual streamflow for the 5-, 10-, and 20-year return periods.

(4) Drought Year Selection

Based on the theoretical drought year magnitudes identified through the frequency analyses, representative drought years were selected and the daily values for those years were used for a more detailed analysis. Ideally the annual cycle with the mean annual discharge closest to that of the theoretical drought year was selected for this purpose. However, in some cases, that was not possible due to missing daily data. In those cases, the year with the next closest mean annual discharge was selected. In some cases, the second closest year was considered to be too dissimilar to the theoretical drought year or too similar to another of the representative drought years. In those cases, missing streamflow data for the closest year were estimated by converting rainfall data to discharge using the average annual runoff coefficient. The average annual runoff coefficients were calculated using the total annual rainfall and the total annual runoff depth for the years when both data sets were available.

It was intended that the selected drought year cycles begin at the peak of the runoff season and carried through the following dry season. In some cases this required that one or two months of daily data from the prior year be added to the beginning of the drought year data series. The representative drought year hydrographs for each of the selected stream gauging stations are presented in Part-B of the Supporting Report. As previously mentioned the annual cycle used to perform the frequency analysis was adjusted to begin at the typical peak runoff period. The drought year designation corresponds to the calendar year in which the annual cycle ends. For example, a representative drought year that begins in August 1989 and ends in July 1990 is identified as 1990.

The hydrographs of daily runoff at the representative gauging stations for the selected drought years, which are worked out through the above procedures, are graphically shown in Part – B of the Supporting Report.

(5) Representative Flow Duration Curves

The representative flow duration curve for each of the regions of Luzon, Visayas and Mindanao was constructed by averaging the curves at the stream gauging stations selected in this study as shown in Figure 2-17. The flow duration curves were worked out by means of the series method. The Table shows that a discharge of 80 % probability per 100 km^2 for Mindanao comes to about 2 and 3 times those for Luzon and Visayas. Thus, it appears that in general the low flow in Mindanao is considerably abundant even in the dry season due to the uniform rainfall throughout the year.

2.3.3 Flood Analysis and Sedimentation Study

(1) Flood Analysis

The data used in this study were obtained through reviewing previous study reports including pre-feasibility, feasibility, definite design, and project rehabilitation reports. The flood flow data used in the evaluation were in the form of estimated Probable Maximum Flood (PMF) or 10,000-year return period flows. Generally these flow values are calculated for the purpose of determining the required spillway capacity of proposed dams.

To represent the magnitudes of the PMF and 10,000 year probable floods which were derived through the previous studies on the major water resources development projects, the following Creager's formula was used:

$$Qp = 46 \times C \times A^{\alpha}$$
$$\alpha = 0.894 \times A^{-0.043} - 1$$

where, C : Creager's coefficient (Creager's C Value)
A : Catchment area in $mile^2$
Qp : Specific discharge in feet3/sec/mile2

The Creager's C value derived for each of the regions of Luzon, Visayas and Mindanao is depicted in Figure 2-18 together with the corresponding curve and summarized below:

Location	Creager's C value
Luzon Island	158
Visayas	196
Mindanao	102

In the Philippines, the Creager's C values corresponding to design floods for the Dams are derived to be more than 100. In particular, the Creager's C values in the regions of Luzon and Visayas are by far larger than those in Mindanao due to the frequent passage of tropical tyhoons.

(2) Sedimentation Study

The sediments inflow rates estimated or adopted in the previous studies on dam projects are plotted by location, i.e., Luzon, Visayas and Mindanao, as illustrated in Figure 2-19.

The plots in the figure show the expected trend of decreasing sediment yield per unit area with increasing drainage area except for Luzon. However, due to the low number of data points and the scattered positions, developing envelope curves was not possible. Instead, each plot is shown with a representative trendline as well as the average sediment yield. The equations for these trendlines and the average sediment yield are presented on the plots as well as in the following table.

Location	Equation of Trendline	Average Sediment Yield ($m^3/km^2/year$)
Luzon	-	868
Visayas	$q = 5693.7x^{-0.226}$	1,093
Mindanao	$q = 1670x^{-0.1992}$	662

In these equations q is the annual specific sediment discharge ($m^3/km^2/yr$) and x is the drainage area (km^2).

The above table slows a general tendency that the denudation rates in Luzon and Visayas are larger than those in Mindanao. In general, the denudation rate in certain basin increases as the basin development is accelerated. Therefore, it is necessary to take into consideration the sufficient allowance for the dead storage capacity in planning a storage type dam. Besides, it is essential to contemplate and implement the basin conservation plan so as to enable the sustainable operation of the planned reservoir.

2.4 Groundwater

2.4.1 Groundwater Development Potential

The groundwater development potential of each water resources region (WRR) was roughly estimated in this study. In general, the total groundwater development potential of the WRRs is considered equal to their groundwater recharge. The future groundwater development of the WRRs' potential corresponds to the portion which is not currently used. The sufficiency of the available groundwater resources needs to be determined by comparing the future development potential with the future demand projection for the period up to the year 2025 in this study.

(1) Methodology

By definition, groundwater recharge is the inflow flux to a groundwater basin. To estimate the residual groundwater potential of each WRR, the total development potential of each WRR needs to be compared with the present groundwater usage. There are two basic methods which can be used to estimate groundwater recharge. One method is to use a water balance approach and the other is to estimate it with empirical methods. The water balance approach is generally done using the following equation:

$$P = Rr + Et + Gr +/- Sm$$

Where:

P;	Precipitation	Rr;	River runoff	Sm;	Soil moisture content
Et;	Evapotranspiration	Gr;	Groundwater recharge		

In general, it is reasonable to ignore soil moisture in a water balance equation if the water cycle period is assumed to be one year or longer. The available data indicate that for most basins the sum of Rr and Et exceeds P. It was therefore concluded that the water balance method should not be used to estimate groundwater recharge due to the unreliability of the data. Thus, the groundwater development potential was estimated using the empirical method which was previously used by NWRC.

(2) Groundwater Recharge

The previous water resources development studies carried out by NWRC include: 1) Groundwater of the Philippines (1980), and 2) Framework Plans of 41 major river basins (1979-1983). These previous studies concluded that groundwater recharge is approximately 10% of the basin average rainfall. The estimated recharge values extracted from the previous studies are shown in Tables 2-1 and 2-2. Out of these, the results of two studies are similar each other. The difference in the values reflects the difference in the time frames of the rainfall records used for each study. The groundwater recharge values for the Jalaur river basin and the Panay river basin of the Western Visayas were not included in the previous study reports. Thus, these values were estimated using the rainfall data and isohyetal maps from the previous reports. According to the Framework Plans, the yearly groundwater recharge was calculated at 49,315 MCM/year, which were broken down by region as follows:

Groundwater Recharge (MCM/year)		Groundwater Recharge (MCM/year)		Groundwater Recharge (MCM/year)	
WRR I	2,635	WRR V	3,384	WRR IX	654
WRR II	10,055	WRR VI	4,004	WRR X	5,744
WRR III	5,900	WRR VII	519	WRR XI	3,568
WRR IV	5,550	WRR VIII	4,826	WRR XII	2,458

In the two recent studies on groundwater development in Metro Manila (1992) and in Cavite Province (1996), which were conducted under the assistance of JICA, groundwater recharge was estimated in detail using a computer simulation model. According to the study done for Cavite province, it was estimated that the direct recharge of the study area was about 153.6 mm (6.1% of mean annual rainfall, which was about 2,499 mm) in the northern part of Metro Manila. In the southern part of Metro Manila, it was estimated at 114.7mm (5.0% of mean annual rainfall, which was about 2,308 mm). The latter one estimated that the groundwater recharge was only 3.9% of the annual total rainfall. Thus, the groundwater recharge rate of the annual rainfall varied from 3.9% to 6.1% (5% on average). In this study, the same methodology was adopted.

The mean annual rainfall in each water resources region was estimated using the isohyetal maps prepared based on recent rainfall data. This was then used to estimate the groundwater potential there by means of multiplying the area rainfall by the estimated groundwater recharge rate, which was adopted to be 5 % of the annual rainfall. The newly estimated groundwater potentials in the respective water resources regions are indicated in Table 2-3.

(3) Groundwater Availability and Storage

Groundwater storage was estimated based on the measured results, including: a) shallow and deep well area (alluvial area) and b) deep well area (diluvium and tertiary area). These features are categorized based on the groundwater availability maps of each WRR as described in Part-C of the Supporting Report.

The basic data were broken down into three areas: Quaternary formation area (shallow and deep well area), Tertiary formation area (deep well area) and other area (difficult area). The first two formations generally have a potential capacity to store groundwater therein. The availability of groundwater resources in these areas was then assessed based on the relevant hydrogeological maps. The groundwater storage of each area was then calculated using the following formula:

Groundwater storage = area x avg. well depth x storage rate

The effective storage rates were roughly estimated at 15% in alluvial plains and 10% in diluvium and tertiary formations based on general information. The results are also shown in Table 2-3. The groundwater storage represents the scale and magnitude of a groundwater basin. As a result, the shallow and deep well areas are one third that of the deep well areas. However, the storage volume of the former occupies about 60% of that of the latter. This indicates not only that the alluvial areas are narrower than that of the diluvium and tertiary areas, but also that the groundwater storage volume is fairly larger in comparison with the diluvium and tertiary areas.

(4) Water Resources Region and Province-wide Groundwater Potential

The groundwater potential of the water resources regions (WRR) and provinces is dependent on their relative surface area, their hydrogeology and the amount of precipitation they receive. Using these basic data, it was attempted to estimate the groundwater potential for each of the water resources regions and provinces as discussed below.

As mentioned above, the possible groundwater recharge for the WRRs and provinces was taken to be 5% of the annual precipitation volume. These calculation results are shown in Table 2-4. To further refine the above recharge rate, the land use patterns of each water resources region and province (provided by NWRB) was used to determine the land which would yield recharge to the groundwater basin of the area. The ratio of the different land types was then applied to calculate the rechargeable land ratio as seen in Table 2-5.

Based on the amount of agricultural land available, the possible irrigable area as well as the presently irrigated area were used to determine the rechargeable amount added to the groundwater, which was calculated for each five-year period, as shown in Table 2-6. Urbanization reduces the amount of groundwater recharge due to the increase of the land area covered with concrete, asphalt and other non-porous materials, in addition to the water-dependent activities of human habitations including industrial activities. To determine the amount of groundwater recharge reduction incurred by urbanization in a given area, the urban population and the urban area occupied by the dense population were used. The urban population and land area is shown in Table 2-7 and the results of the estimate in Table 2-8.

2.4.2 Hydrogeology

With regard to groundwater development, the groundwater conditions are predominantly controlled by geology, topography and the structure of the groundwater basin. The structure of the groundwater basin consists of distribution and hydrogeological conditions such as the aquifer structure and aquicludes, the physical characteristics of the formations as per transmissibility and storage coefficient and chemical characteristics of groundwater. These factors need be defined in relation to the possible development depth and overall development potential.

The hydrogeological conditions were broadly evaluated on a region-wide basis. The groundwater availability map for each WRR was produced as shown in Figures 2-20 to 2-31. The hydrogeological conditions of each water resources region are discussed in more detail in Part-C of the Supporting Report. Figure 6-7 in the succeeding Chapter VI shows the piezometric condition of Metro Manila. From the viewpoint of groundwater development, each area was divided into the following three categories in terms of hydrogeology:

(1) Shallow & deep well area : equivalent to the alluvial plain area that has a groundwater basin consisting of several aquifers and aquicludes. The aquifers consist of sand and gravel layers as well as impervious layers of clay and/or silt. In these areas, shallow and deep groundwater is available. The aquifers in these areas generally have enough magnitude, scale and permeability to produce a large quantity of groundwater. Especially, the high yielding areas distributed in the alluvial plains are formed by good aquifers mostly consisting of sand and gravel, and others.

(2) Deep well area : corresponds to diluvium and/or tertiary sediments mainly of the Neogene age which have low groundwater potential as compared with shallow and deep well areas.

This type of area is the best suited to the development by handpump deep wells that require small pumping rates.

(3) Difficult area : corresponds to areas that are difficult in terms of groundwater development. The geology of this type of area is composed mainly of intrusive rocks, metamorphosed rocks and volcanic rocks.

In the hydrogeological evaluation, the reference materials utilized were the previous studies such as the "Rapid Assessment of Water Supply Sources in the Philippines" which consist of 73 volumes (NWRC, 1982), the "Study on the Provincial Water Supply, Sewerage and Sanitation Sector Plan (JICA-DILG, 1996)" and the "Geological Map of the Philippines (Bureau of Mines, 1963)", etc.

2.4.3 Present Problems

(1) Saline Water Intrusion

Saline water intrusion can be observed along any seashore. The main reason for this phenomenon stems from an insufficient and/or declining groundwater recharge rate, geological conditions, and the difference of density between salt water and fresh water coming from inland areas. This problem usually has been induced by the over-exploitation of groundwater.

DENR has the White Paper (1995) on the Philippines environment. However, there is no mention of the groundwater environmental problems. Accordingly, based on the available data/information and hydrogeological information, the major saline water intrusion areas were attempted to be identified. As a result, it is found that, in particular, Metro Manila and Cebu city have serious saline water intrusion problems.

(2) Groundwater Pollution and Subsidence

The situation is similar to the saline water intrusion problems mentioned above. The DENR's white paper (1995) does not deal with the groundwater environmental problems such as pollution and subsidence area by groundwater over-exploitation. In consideration of the situation in the Philippines, the major pollutants might be sewage, factory wastes and agricultural chemicals (fertilizer). Accordingly, all populated, industrial and agricultural areas have a possibility of groundwater pollution.

Ground subsidence is observed mainly in wide plain areas although the scale of subsidence is not too serious. The main cause of ground subsidence is considered to be the drainage of groundwater from clay sediments. Artificial subsidence means that groundwater has been extracted emphatically by artificial structures such as wells. However, the densely populated areas such as Metro Manila, Metro Cebu, Davao city are located in areas composed of consolidated sediments or thin unconsolidated sediments. To date, subsidence leading to an environmental problem hasn't been reported to DENR yet.

2.5 Present Socio-Economic Condition

2.5.1 Population

(1) Nation

During 35 years from 1960 to 1995, the total population of the Philippines has increased from 27,090 thousand in 1960 to 68,612 thousand in 1995 at an average annual rate (AAGR) of 2.7%. Thus, the national population has increased 2.53 times for the period. After 1970, the population increased at the rates of more than 2.0%, but the rates have slightly decreased from 2.7% in the period from 1975 to 1980 to 2.3% in the period from 1990 to 1995 as shown in Table 2-9.

(2) Region

During the five years from 1990 to 1995, Southern Tagalog (Region IV) increased at the highest annual average growth rate (AAGR) of 3.5% followed by National Capital Region (NCR), Central Mindanao (Region XII), and Southern Mindanao (Region XI). On the contrary, Ilocos (Region I) and Western Visayas (Region VI) have increased at the lowest AAGR followed by Cagayan Valley (Region II), Central Visayas (Region VII) and CAR.

The population of Southern Tagalog (Region IV) amounting to 9,941 thousand people occupies the highest share of 14.5% of the national population, followed by NCR, 13.8%, Central Luzon (Region II), 10.1% and Western Visayas (Region VI), 8.4%. CAR has the least population, 1.8%, followed by CARAGA, 2.8%, ARMM, 3.0% and Central Mindanao (Region XII), 3.4% as shown in Table 2-9. The summary is shown in the following table.

(Unit: 1,000 persons)

Year	Administrative Region																Total
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII			
	NCR	CAR	Ilocos	Cagayan Valley	Central Luzon	Southern Tagalog	Bicol	Western Visayas	Central Visayas	Eastern Visayas	Western Mindanao	Northern Mindanao	Southern Mindanao	Central Mindanao	ARMM	CARAGA	
1990	7,948	1,146	3,551	2,341	6,199	8,263	3,910	5,393	4,594	3,055	2,460	2,197	4,007	2,033	1,837	1,764	60,608
1995	9,454	1,255	3,504	2,536	6,933	9,941	4,325	5,777	5,015	3,367	2,795	2,483	4,604	2,360	2,021	1,942	68,612
AAGR (%)	3.31	1.72	1.30	1.51	2.12	3.53	1.91	1.30	1.66	1.84	2.42	2.32	2.64	2.84	1.81	1.82	2.32

2.5.2 GDP and GRDP

(1) Nation

During the past eleven years from 1985 to 1996, gross domestic product (GDP) has grown from 571,883 million pesos to 848,451 million pesos at an AAGR of 3.7% at constant 1985 price level as shown in Table 2-10. The per capita GDP has increased from 10,461 pesos in 1985 to 27,130 pesos in 1995 or to 2.6 times at an AAGR of 10.0% at current price level. The per capita GDPs at constant 1985 price level are 10,461 pesos and 11,434 pesos in the respective years. But it has decreased from 1991 to 1993 as shown in Table 2-11.

According to the NEDA's assessment in the Medium-Term Philippine Development Plan (MTPDP) with the targeted period from 1993 to 1998, the economic recovery was attained in 1993 and sustained throughout 1994 and 1995. The economy staged a strong recovery from the recession of 1991 and 1992. Gross national product (GNP) expanded by 2.1% in

1993. This growth was achieved notwithstanding the serious power problem which plagued the country during the period. The unexpected acceleration in GNP was partly due to the recovery of domestic production which, as measured by gross domestic product (GDP), expanded by 2.1% as shown in Table 2-12. The agriculture and service sectors made up for the slump in industrial production, particularly in the manufacturing sub-sector, which was badly hit by the power crisis.

The economic growth accelerated in 1994 by the resolution of the power supply problem. GDP expanded by 4.4% as targeted. Strong domestic production, as well as substantial inflows of income from remittances of overseas contract workers, raised GNP growth rate to 5.3% in real terms, exceeding the target rate of 3.5 % to 4.5% in the MTDPD.

The growing confidence in the economy and the implementation of market-friendly policies led to improved performance of all production sectors, except for agricultural sector. The industrial sector, which was adversely affected by the power crisis in 1993, rebounded in 1994. The growth was sustained and was well within the target rate of 5.2 to 7.9% in 1995. The service sector, on the other hand, has kept their growth consistently within its target for the period from 1993 through 1995, keeping pace with industrial expansion. Despite the government's efforts to assist the agricultural sector, the output badly suffered in 1995 as a result of adverse weather conditions such as the prolonged dry weather and the severe typhoons.

During the period from 1985 to 1996, gross value added (GVA : the same meaning as gross domestic product) of the combined agriculture, fishery and forestry sector has increased from 140,554 million pesos to 178,143 million pesos at an AAGR of 2.2%. The share of agricultural sector has decreased from 24.6% to 20.1% during the same period. GVA of agricultural sector in 1996 attained the higher AAGR by 2.97% than those in the period from 1993 to 1994 as shown in Tables 2-10 and 2-12.

The GVA of industrial sector has increased from 200,548 million pesos in 1985 to 302,482 million pesos in 1996 at an AAGR of 3.8%. For the period, the positive growth rate of 1.6% took place in 1993 after the recovery from the crippling power crisis in 1992, and reached a peak of 7.2% in 1995. The share of industrial sector has slightly decreased from 35.1% to 35.7% during the same period.

The GVA of service sector has increased at an AAGR of 4.3% during eleven years from 1985 to 1996, which is the highest growth rate of all the sectors. The share of service sector increased from 40.4% to 43.3% during the same period. It seems to have increased keeping pace with domestic production. With output growing, the AAGR of GVA of service sector increased from 2.5% in 1993 to 4.9% in 1995, falling well within the planned targets in the MTDPD as shown in Tables 2-10 and 2-12.

(2) Region

With regard to the gross regional domestic product (GRDP) at constant 1985 prices, CAR has increased from 11,342 million pesos in 1985 to 17,638 million pesos in 1995 at an AAGR of 4.5%, followed by Central Luzon (Region III) as shown in Table 2-14. In 1996, NCR has the largest share of 30.3% in the Philippines concerning the total GRDP, followed by Southern Tagalog (Region IV) of 15.7%, Central Luzon (Region III) of 9.8%, Western Visayas (Region VI) of 7.2%, Central Visayas (Region VI) and South Mindanao (Region XI) of 6.6%. The summary is shown in the following table.

(Unit: 1,000 persons)

Year	Administrative Region															
	NCR	CAR	I Ilocos	II Cagayan Valley	III Central Luzon	IV Southern Tagalog	V Bicol	VI Western Visayas	VII Central Visayas	VIII Eastern Visayas	IX Western Mindanao	X Northern Mindanao	XI Southern Mindanao	XII Central Mindanao	ARMM	Total
1985	221,753	13,549	21,859	15,548	68,250	109,509	21,687	50,747	47,193	17,322	21,132	37,092	50,074	24,959	-	720,691
1996	25,686	17,638	25,136	17,007	83,149	13,373	24,489	61,266	56,108	20,081	22,325	43,003	56,301	23,548	8,392	843,452
AAGR (%)	2.48	4.49	2.35	1.51	3.35	3.31	2.05	3.19	2.93	2.49	0.92	2.49	1.97	-0.97	-	2.76

The per capita GRDP of NCR at current prices reached 67,894 Pesos in 1995, which is ranked at the highest level of all the regions, followed by CAR. The lowest level took place in ARMM of 8,630 pesos, which is less than one-seventh of that of NCR. The highest AAGR for per capita GRDP at current price level is 13.1% in Western Mindanao (Region IX) where it has increased from 9,760 pesos in 1990 to 18,047 pesos in 1995. The summary is shown in the following table:

(Unit: Pesos)

Year	Administrative Region															
	NCR	CAR	I Ilocos	II Cagayan Valley	III Central Luzon	IV Southern Tagalog	V Bicol	VI Western Visayas	VII Central Visayas	VIII Eastern Visayas	IX Western Mindanao	X Northern Mindanao	XI Southern Mindanao	XII Central Mindanao	ARMM	Total
1990	43,593	17,608	9,246	9,601	14,966	19,225	7,276	13,337	15,331	8,413	9,760	15,248	17,229	12,653	-	17,522
1995	67,894	29,166	14,451	15,170	22,083	28,303	12,433	21,906	23,557	14,206	18,047	24,605	24,164	21,989	8,630	27,131
AAGR (%)	9.27	10.62	9.34	9.55	8.09	8.04	11.31	10.43	8.97	11.05	13.08	10.04	7.00	11.34	-	9.14

At constant 1985 price level, NCR also attained the largest per capita GRDP of 26,355 pesos in 1995 of all the regions, followed by Southern Tagalog (Region IV) of 13,024 pesos. ARMM is ranked at the lowest level of per capita GRDP of 3,795 pesos at the constant price level. The summary is shown in the following table:

(Unit: Pesos)

Year	Administrative Region															
	NCR	CAR	I Ilocos	II Cagayan Valley	III Central Luzon	IV Southern Tagalog	V Bicol	VI Western Visayas	VII Central Visayas	VIII Eastern Visayas	IX Western Mindanao	X Northern Mindanao	XI Southern Mindanao	XII Central Mindanao	ARMM	Total
1990	27,810	11,772	6,222	6,292	11,112	13,511	4,942	8,947	10,224	5,155	6,614	10,262	11,554	8,434	-	11,722
1995	26,355	12,603	5,959	6,076	10,937	13,024	5,238	9,460	9,981	5,493	7,474	10,158	10,281	9,234	3,795	11,434
AAGR (%)	-1.07	1.37	-0.86	-0.70	-0.32	-0.73	1.17	1.12	-0.45	1.28	2.47	-0.20	-2.31	1.71	-	-0.50

2.5.3 Labor Market

(1) Nation

In 1995, the ratios of employed household population of 15 years old and over in agriculture and non-agriculture are 44.1% and 55.9%, respectively. The unemployment is estimated to be 19.8% of those employed.

The total number of labor force has increased from 18.5 million in 1982 to 28.0 million in 1995 at an AAGR of 3.3%. The ratio of number of employed labor force to total number of labor force slightly increased from 90.2% in 1982 to 91.6% in 1995, while the one of unemployed labor force slightly decreased from 9.4% to 8.4%. The agricultural sector still occupies the highest share of 44.1% in 1995, which is slightly smaller than 44.8% in 1989.

According to the Updated Medium-Term Philippine Development Plan (UMTPDP), 1996-1998, the Philippines' labor market is expected to improve through the recovery of the national economy for the period. The number of labor force grew at an annual average rate of 2.6% for the period of 1993 to 1995. On annual average, about 697,000 entrants joined the labor force. About two million jobs were created during the assessment period of 1993 to 1995. The number of workers who get higher allowance and better quality jobs increased at an annual average rate of 3.7% in the last three years. Furthermore, the economic recovery of the industrial and service sectors led to the higher job creation in 1994 and 1995, generating 503,000 and 784,000 new jobs in industrial and service sectors, respectively.

(2) Region

In 1995, the highest employment ratio of agricultural sector is 76.3% in ARMM, followed by Cagayan Valley (Region II) of 66.2% and CAR of 64.2%. On the contrary, the lowest ratio is 1.5% in NCR. Southern Mindanao (Region XI) keeps the highest underemployment ratio of 37.7% in 1995, which has increased from 26.0% in 1985.

Labor force participation rate of Cagayan Valley (region II) has increased from 66.4% in 1985 to 71.3% in 1995 exhibiting the highest ratio, followed by CAR of 71.2% and Southern Mindanao (Region XI) of 69.8%. The lowest ratio of 57.3% took place in ARMM. In spite of its lowest labor participation ratio, ARMM has attained the highest employment ratio of 99.4% in 1995. The ratio of NCR is as the lowest as 84.2%. This implies that the labor force is more effectively employed in ARMM than in NCR. The summary for the year of 1995 is shown in the following table:

(1995)

Sector	NCR	CAR	I Ilocos	II Cagayan Valley	III Central Luzon	IV Southern Tagalog	V Bicol	VI Western Visayas	VII Central Visayas	VIII Eastern Visayas	IX Western Mindanao	X Northern Mindanao	XI Southern Mindanao	XII Central Mindanao	ARMM	Total
	Administrative Region															
Projected household population 15 years old and over (1,000)	6,164	815	2,464	1,741	3,365	5,915	2,961	3,877	3,263	2,267	1,739	2,583	3,081	1,363	1,169	42,770
Labor force participation rate(%)	60.0	71.2	64.7	71.3	62.8	65.3	68.9	65.8	65.5	68.0	63.5	69.3	69.8	70.5	57.3	65.6
Employment rate(%)	84.2	93.8	92.3	97.3	91.0	91.0	93.4	91.3	91.1	94.1	93.4	94.5	92.8	94.7	99.4	91.6
Unemployment rate(%)	15.8	6.2	7.7	2.7	9.0	9.0	6.6	8.9	8.9	5.9	6.6	5.5	7.2	5.3	0.6	8.4

In NCR, service sector occupies 71.7% of the total number of employed laborers. The share of the service sector is the highest of those of the whole administrative regions in the Philippines, which is much more than 42.8% of Central Luzon (Region III), the second highest share in terms of the share of service sector on number of employed labor. Thus, the outstandingly high share of labor force in service sector characterizes NCR. The summary for share by sector in 1995 is shown in the following table:

(Unit: %)

Sector	NCR	CAR	I Ilocos	II Cagayan Valley	III Central Luzon	IV Southern Tagalog	V Bicol	VI Western Visayas	VII Central Visayas	VIII Eastern Visayas	IX Western Mindanao	X Northern Mindanao	XI Southern Mindanao	XII Central Mindanao	ARMM	Total
	Administrative Region															
Agriculture	1.5	64.2	51.6	66.2	36.5	34.8	51.7	52.6	42.7	59.5	54.5	52.9	50.5	62.3	76.3	44.1
Industry	26.8	9.7	13.5	6.5	20.7	23.4	13.2	10.8	19.5	7.5	8.4	12.6	13.1	6.8	6.5	10.8
Service	71.7	26.1	34.9	27.3	42.8	41.8	35.1	36.6	37.8	33.0	37.1	34.5	36.4	30.9	17.2	45.1

2.5.4 Family Income and Expenditures

(1) Nation

The total families of the Philippines have increased from 9.9 million in 1985 to 12.8 million in 1994 at an AAGR of 2.80%. During the period, the average family income has increased from 31,052 pesos to 83,161 pesos at an AAGR of 11.57%. Besides, the average expenditures and savings have increased at AAGRs of 10.81% and 15.65%, respectively, as shown in Table 2-15.

(2) Region

Based on average income in 1994, the richest regions are ranked in order of NCR, Central Luzon (Region III) and Southern Tagalog (Region IV). Likewise, the poorest region is Eastern Visayas (Region VIII), followed by ARMM and Bicol (Region V). The high expenditures usually take place in those rich regions. The highest ratio of average expenditures to average income is recorded at 90% in Western Visayas (Region VI) in 1994, followed by Western Mindanao (Region IX) of 86%, Southern Mindanao (Region XI) of 84%. The ratio of average expenditures to average income and that of savings to average income have the relation of trade-off each other.

2.5.5 Price Level and Inflation

(1) Nation

Prudent fiscal and monetary management dampened the price effects of a rice-supply shock to keep inflation in check in 1996. The nation's annual inflation rate moderated from 12.2% in 1988 to 8.4% in 1996. The consumer price index (CPI) of all items raised up to 2.2 times during the period. The annual average inflation rate during the period was 10.8% as shown in Table 2-16.

In 1997, inflation rate seems to have been more stable. The average inflation rate during period from January to June was only 3.5%. But after June, the depreciation of peso to US$ dollar had begun and the exchange rate of peso to US$ was around 40 in early part of 1998. This depreciation of peso will push up inflation rate in near future.

(2) Region

Most of the regions had lower inflation rates in 1995 as compared with those in 1994. Except for the Region V, which was hit by strong typhoons during the year, inflation rates were kept at single-digit in all of the other regions. The highest annual average inflation rate of 12.49% is recorded in NCR during seven years from 1988 to 1995 as shown in Table 2-16.

2.5.6 Education

(1) Nation

The total number of schools in the Philippines increased from 41,863 in 1985 to 52,442 in 1995 at an AAGR of 2.28%. The public schools accounts for 82.3% of the total number, amounting to 43,160. The rest or 17.7% of the total number is occupied by private schools. The number of schools per 100,000 population in 1995 is 7.9, consisting of 6.5 public ones and 1.4 private ones as shown in Table 2-17.

The total number of school enrollments except tertiary one in the Philippines increased from 12.6 million in 1986 to 16.8 million in 1996 at an AAGR of 3.38%. The dominant share of 85% is also kept by public school. The largest number of school enrollments per 100 population in 1995 falls in 21.0 for public school, which accounts for 86% of the total number of 24.5, while the private one is only 3.5 as shown in Table 2-18.

(2) Region

Out of the administrative regions, the largest total number of pre-school, elementary and secondary is 7,096 (14.20%) in Southern Tagalog (Region IV) in 1995, followed by Western Visayas (Region VI) of 4,213 (8.43%), Bicol (Region V) of 3,953 (7.91%). The least number of schools is 1,609 (3.22%) in CAR. Concerning the ratio of the number of schools to population, the largest number in total per 10,000 population is 12.8 in CAR, which has the least total number of schools, followed by Eastern Visayas (Region VIII) of 11.7 and CARAGA of 9.8 as shown in Table 2-19.

The largest number of school enrollments in total of pre-school, elementary and secondary schools also lies in Southern Tagalog (Region IV), amounting to 2.4 million (14.53%) in 1995, followed by NCR of 2.0 million (12%). The least number of schools is 325 thousand (1.98%) in CAR. Concerning the ratio of the number of school enrollments to population, there is no considerable difference among the regions. The largest total number of schools per 100 population is 26.3 in Bicol (Region V), followed by 25.3 in Western Visayas (Region VI) as shown in Table 2-20.

2.5.7 Hospital

(1) Nation

The total number of hospitals in the Philippines slightly decreased from 1,799 in 1985 to 1,700 in 1995 at a annual average rate of 0.71%. The number of public and private hospitals are 1,111 (65.4%) and 589 (34.6%), respectively. The number of hospitals per 100,000 population are 0.9 for public school, 1.6 for private school and 2.5 in total of public and private hospitals as shown in Table 2-21.

(2) Region

The largest number of hospitals is provided in Southern Tagalog (Region IV), amounting to 249 (14.65%), followed by Southern Mindanao (Region XI) of 169 (9.94%), NCR of 168 (9.88%) and Central Luzon (Region III) of 159 (9.35%). The regions showing increase in the number, in spite of decrease in the whole country, are only three regions, namely Central Luzon (Region III) of the AAGR of 2.39%, Bicol (Region V) of 0.25% and Western Visayas (Region IX) of 0.16% as shown in Table 2-21.

2.5.8 Government Finance

(1) Revenue

The cash balance of the Government finance has continued to be at a deficit since 1970 but turned to be surplus after 1994. The cash operations resulted in a 6.3 billion pesos surplus in 1996, 11.2 billion short of the programmed 17.5 billion peso. As shown in Table 2-22, national government revenue increased from 68,961 million peso in 1985 to 410,449 million peso in 1996. In 1996, shares of tax revenue and non-tax revenue were 89.6% and 10.4%, respectively. The share of tax revenue has increased year by year.

In 1996, improved collections by the Bureau of Internal Revenue (BIR) contributed to the 57.4 billion peso hike in tax revenue. Meanwhile, the slowdown in earning from the government's privatization program caused the large decrease of 8.1 billion peso in non-tax revenues. But the financial basis of the tax revenues of the Philippines has been considered to be weak. At present, the Government is striving to prepare comprehensive tax reform acts to strengthen the base of tax revenues.

(2) Expenditure

According to government expenditure program for recent three years from 1995 to 1997, it recorded the increase of 28% from 372,081 mill. peso to 476,170 million peso. In 1997, among economic services, the expenditure of communication, roads and other transport section has the largest portion of 10.6% of the total expenditure, followed by agriculture, agrarian reform and natural resources of 6.6%. On the other hand, the total expenditure of water resources development and flood control sector accounts for only 1 % thereof in these three years, although it has increased gradually from 3,940 million peso to 4,056 million peso as shown in Table 2-23.

The shortage of electricity and water has not been solved completely. Particularly, the water shortage in major cities in the Philippines has been casting serious problems to the inhabitant and manufacturing industry. More financial investment for water resources development is indispensable for sustainable economic growth of the Philippines.

2.5.9 Foreign Trade

(1) Total Trade

During thirty five years (1971- 1996), total trade in the Philippines on the basis of FOB value grew from 2,450 million US dollars to 52,970 million US dollars, but the balance of trade revealed the increase of deficits from 71.6 million peso to 11,884.4 million peso as shown in Table 2-24.

(2) Exports

Of the ten commodity groups shown in Table 2-25, manufacturing has the largest portion of the total export amount and increased its share from 69.7 % in 1990 to 83.3 % in 1996. It is remarkable that electronics and electronic equipment/parts and telecommunication grew rapidly from 1,964 million US dollars to 9,990 million US dollars at an annual average growth rate of 31.1 %, accounting for almost 50 % in total export amount. On the contrary, the share of agricultural products decreases to less than 10%. During six years, rapidly grown commodities are (i) mangoes and banana in fruits and vegetables, (ii) natural rubber in other agro-based products, (iii) textile yarns/fabrics, travel goods and handbags, machinery and transport equipment, baby carriers, toys, games and sporting goods, except for electronic products in manufactures as shown in Table2-25.

(3) Imports

Of the five commodity groups shown in Table 2-26, the import of raw materials and intermediate goods have the largest portion of 44.15% of the total import amount in 1996, followed by capital goods of 32.9%, consumer goods of 10.6% and mineral fuels and lubricant of 9.4%. In the Philippines, rice was imported in the years of 1990, 1993, 1995 and 1996. The high value of rice imported in 1996 of 294 million peso could be considered to be a temporal phenomenon because of bad weather condition of drought. The government has targeted to keep the self-sufficiency ratio of 100 per cent and this policy will continue in the future. Actually NIA has positive irrigation development plan to increase rice production.

The highest growing commodities in each commodity group are (i) telecommunication equipment and electric machines (37.9% of annual average growth rate) in capital goods, (ii) materials for electric equipment (29.1%) in raw materials and intermediate goods, (iii) coal and coke (14.4%) in mineral fuels and lubricant, (iv) home appliances (30.4%) in consumer goods, and (v) articles temporary imported and exported (29.4%) in special transactions. It is noticeable that the almost all commodities of imports grew in six years without drastic fluctuation unlike exports as shown in Table 2-26.

2.5.10 Balance of Payment

As shown in Table 2-27, during six years from 1990 to 1996, overall balance of payment changed from deficits of 93 million US dollars to surplus of 4,107 million US dollars at an annual growth rate of 88% and realized the increase of 4,200 million US dollars in amounts.

(1) Current Account

Current account is composed of trade and transfers. During six years from 1990 to 1996, trade in net grew in deficits from 3,281 million U.S. dollars to 4,503 million US dollars and the rate to GNP decreased negatively from -7.4% to -5.2%. Deficits are generated from goods in net foreign trade balance. Transfer in net indicates slight decrease from 714 mill. U.S. dollars to 589 million US dollars.

(2) Capital and Financial Account

Capital and financial account is composed of five elements : (i) medium and long-term loans, (ii) investment, (iii) change in the net foreign assets (NFA) of commercial banks, (iv) purchase of collateral, (v) short-term capital. The investments from resident abroad have most rapidly increased from 18 million US dollars in 1990 to 2,453 million US dollars in 1996 followed by short-term capital net from 19 million US dollars to 540 million US dollars. Net capital and financial account realized grew from 1,776 million US dollars to 8,609 million US dollars at annual growth rate of 30.1%. The country's net foreign investments reached 1,168 million US dollars in 1996 or 441 million US dollars below the

1995 of 1,609 million US dollars.

(3) Gross International Reserves

The substantial surplus in the country external transactions helped increase BSP(Central Bank of Philippines) total foreign assets or gross international reserves (GIR) including its reserve position in the IMF in 1996.

The level of international reserves reached 11,745 million US dollars or 51% higher than 7,762 million US dollar at the end of 1995. At this level, the BSP-GIR was equivalent to 3.1 month worth of imports of goods and services, including interest payment.

2.5.11 External Debt

During the period from 1990 to 1996, external debt service burden increased from 3,547 million US dollars to 4,961 million US dollars at annual average growth rate of 5.8%. Principal indicates faster increase than interest. After 1992, principal exceeded interest and shares of principal and interest was 56.3% and 43.7% respectively in 1996 as shown in Table 2-28.

As a whole, it is observed that external debt service burden has given less affection to the economy of the Philippines. According to comparison for selected external debt ratios (DSB), the best improvement ratio is considered to be gross international reserves to DSB, figuring out 57.7% in 1990 and 236.8% in 1996. The ratios of DSB to following items indicates the improvement by decrease of their figures as follows; to export of goods and services (27.2% to 12.5%), to export shipment (43.3% to 24.2%), and to GNP (8.1% to 5.7%) respectively.

2.5.12 Peso Per US Dollar Rate

As shown in Table 2-29, the Philippines peso per US dollar depreciated around 4 times, changing from 7.440 in 1976 to 28.771 in 1997.

It is reported in the Annual Report of Central Bank of Philippines (1996) that peso was relatively stable in 1996. Trading within a relatively narrow band of 20 centavos during the year, it depreciated by only 1.9 percent. While relative stability in the exchange rate reflected the sound underlining macro-economic fundamentals, it was facilitated by BSP's swift response to discourage speculative activities in the market.

But after July in 1997, peso began to depreciate moderately and since December in 1997, higher depreciation of peso happened and peso to US dollar rate still remained more than 40 during January. One of the main factors of this high depreciation of peso seems to be the speculative behavior of investors and does not reflect the substantial economic change in the Philippines. The future economic situation in the Philippines should be observed carefully.