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 I
EXECUTIVE SUMMARY

AUGUST 1998

NIPPON KOEI CO., LTD., TOKYO, JAPAN
[illegible] 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

Currency Exchange Rates Adopted for the Study

US$1.00 = Pesos 27.6679
Peso 1.00= ¥ 4.165
(in July 1997)

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct the Study on Water Resources Management in the Republic of the Philippines and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Mr. Norio Takayanagi, Nippon Koei Co., Ltd., associated with Nippon Jogesuido Sekkei Co., Ltd., three times between March 1997 and July 1998.

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 Philippines for their close cooperation extended to the team.

August, 1998

Kimio Fujita
President
Japan International Cooperation Agency

August, 1998

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

Dear Sir,

LETTER OF TRANSMITTAL

We are pleased to submit herewith the Final Report of the Master Plan Study on Water Resources Management in the Republic of the Philippines. The Report has been prepared for the Government of the Philippines as a guideline for consideration when implementing the country's water resources development and management to meet the socio-economic growth in the future.

The report deals with the formulation of a nation-wide master plan for water resources development and management towards the year 2025, which includes the water resources development plans for the major river basins and water supply to the major cities. As the short term strategy, the Study proposes to implement a master plan and feasibility study for water supply to the three major cities where severe water shortage is foreseen to take place in the near future, namely Metro Manila, Metro Cebu and Baguio City. The other main output of the Study is the institutional enhancement plan consisting of an interim measure and an ultimate measure.

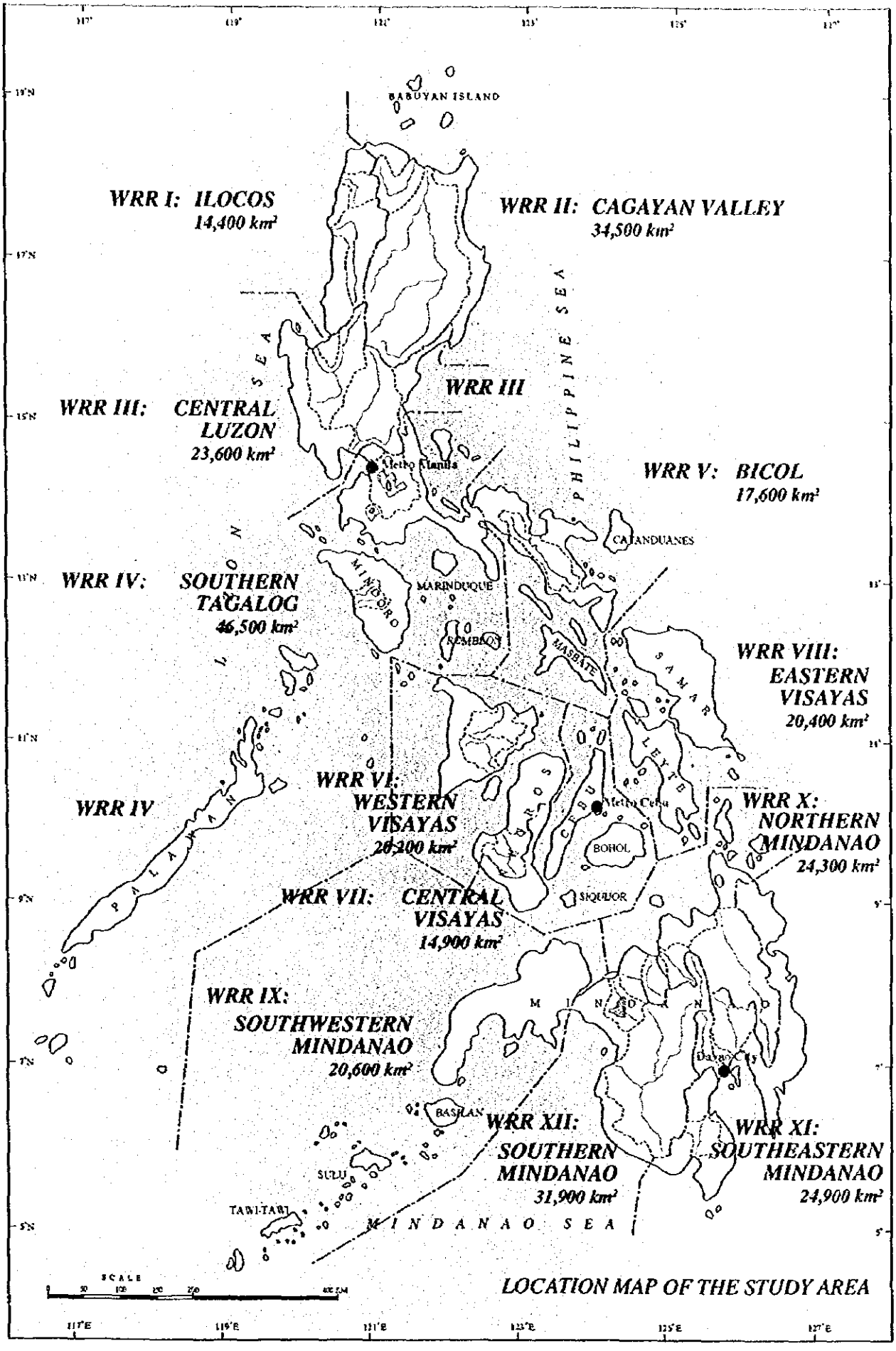
The report consists of 4 volumes; Volume I for Executive Summary, Volume II for Main Report, Volumes III for Supporting Report and Volume IV for Data Book. The main outputs of the Study are presented in the Executive Summary. The Main Report deals with the study results and conclusions in more detail as well as the master plan and the effective recommendations to realize the master plan. The Supporting Report, consisting of three volumes, explains the procedures and results of the Study by each of the disciplines. The Data Book compiles the basic data on hydrology, irrigation, and dam projects.

All members of the Study Team wish to express grateful acknowledgement to the personnel from your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction, and Embassy of Japan in the Philippines, and also to officials and individuals of the Government of the Philippines for their kind assistance and advice extended to the Study Team. The Study Team sincerely hopes that the results of the Study will contribute to the future water resources development of the Philippines and to the socio-economic development and well-being.

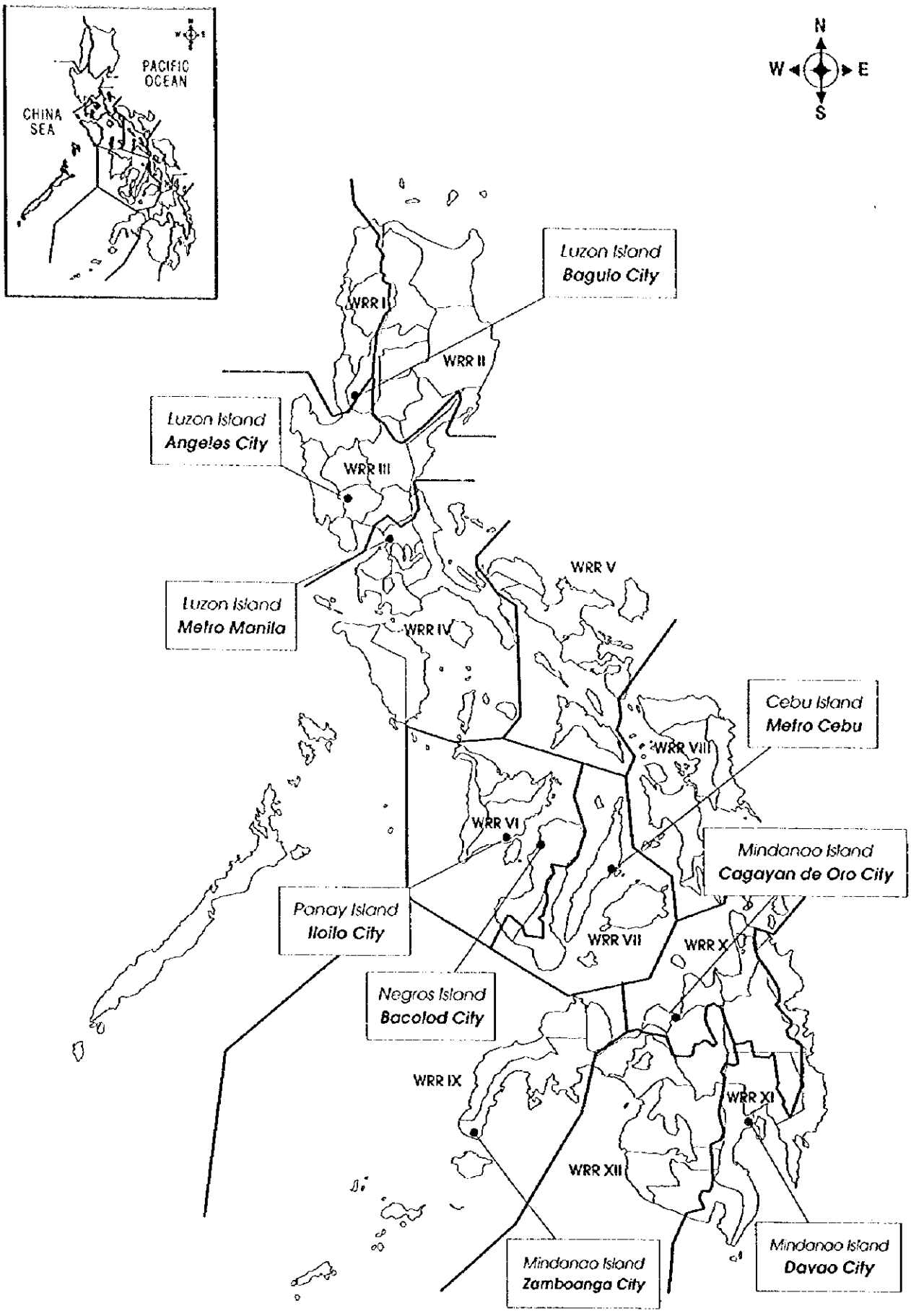
Yours sincerely,

N. Takayanagi

Norio Takayanagi
Team Leader



LOCATION MAP OF THE STUDY AREA



LOCATION OF SELECTED MAJOR CITIES FOR WATER SUPPLY PLANNING

Outline of the National Water Resources Management Master Plan

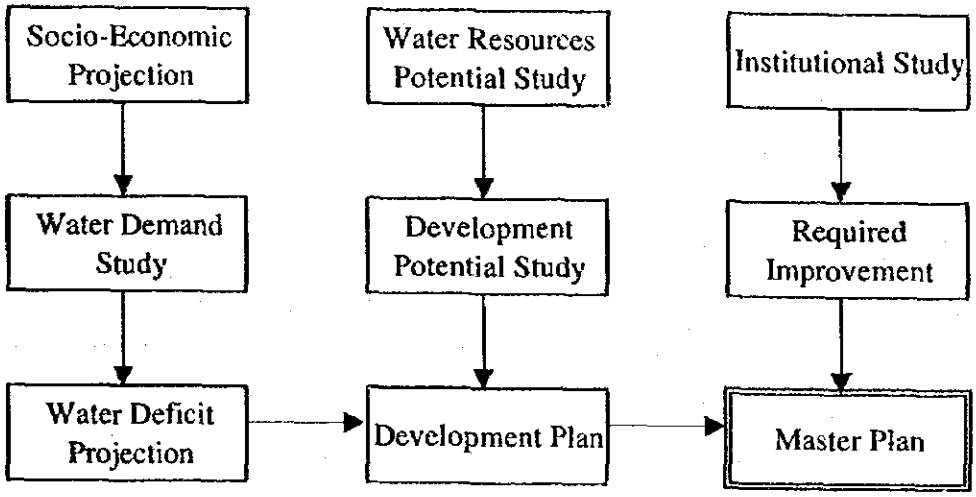
1. Targets of the Study

The targets of the Study are defined in the Implementing Arrangement of the Study as follows:

- Target area : The entire land of the Republic of the Philippines with an area of around 300,000 km^2
- Target period: From 1995 to 2025

2. Study Component

The Master Plan comprises two plans; the plan to develop water resources to meet the inflating water demand and the plan to enhance the water management institution. The components that formulate the Master Plan are illustrated in the following schematic diagram:



3. The Results of the Study

3.1 Socio-Economic Projection

Population

The national and regional populations were projected on the basis of the projection conducted by NSO. The projected national populations are presented below:

(Unit: Million persons)

Year	1995	2000	2005	2010	2015	2020	2025
Population	68.3	76.3	84.2	91.9	99.0	105.5	111.5

The average annual growth rate for the period from 1995 to 2025 was projected to be 1.6%.

Gross Domestic Product (GDP) and Regional Gross Domestic Product (GRDP)

GDP and GRDP were projected by sector under the assumed high and low economic growth scenarios. The projected GDPs under the high economic growth scenario are presented at constant 1985 prices as follows:

(Unit : Billion pesos)

Sector	Year						
	1995	2000	2005	2010	2015	2020	2025
Agriculture	173.0	202.6	246.5	300.0	373.8	477.1	623.5
Industry	285.2	431.7	656.9	996.9	1,498.9	2,249.7	3,434.6
Service	345.2	479.7	672.8	943.6	1,323.5	1,900.0	2,791.7
Total	803.4	1,114.0	1,576.2	2,240.5	3,196.2	4,626.8	6,849.8

The projected average annual growth rates (AAGR) for the period from 1995 to 2025 are as follows:

Sector	AAGR between 1995 and 2025
Agriculture	4.4%
Industry	8.7%
Service	7.2%
Whole Sectors	7.4%

3.2 Water Demand Projection

The Study projected the water demands for agriculture, industry, service and domestic use. The projected water demands in the agricultural sector and municipal and industrial (M & I) sector under the high economic growth scenario are as follows:

(Unit : MCM/year)

Sector	Year						
	1995	2000	2005	2010	2015	2020	2025
Agriculture	-	38,167	46,664	52,419	60,003	65,955	72,973
M & I	4,421	5,186	6,174	7,376	8,720	10,283	12,427
Total	-	43,353	52,838	59,795	68,723	76,238	85,400

The projected municipal and industrial (M & I) water demand comprises domestic water demand and water demands by service and industry.

3.3 Regional Water Resources Potential

The Study estimated the regional water resources potentials for groundwater and surface water as follows:

(Unit : MCM/year)

Region	Groundwater	Surface Water	Total
VII (min.)	879	3,770	4,649
X (max.)	2,116	42,100	44,216
Other	17,205	160,360	177,565
Total	20,200	206,230	226,430

Note : The daily discharge with a occurrence provability of 50% was adopted as the surface water potential of each region.

3.4 Regional Water Demand and Potential Balance

The Study examined the regional water demand and potential balances for high and low economic growth scenarios. As a result, the following 4 water resources regions were assessed to be the most critical of all the regions because of their smaller ratios of water resources potential to total water demand in 2025:

Water Resources Regions (WRR)	Ratio of Potential to Water Demand in 2025	
	High Economic Growth	Low Economic Growth
WRR II	1.57	2.58
WRR III	0.69	0.86
WRR IV	2.10	2.87
WRR VII	1.70	2.09

The rate of WRR III enunciate that the projected demand therein cannot be met with the potential therein and that a trans-regional water conveyance might be necessary. The demand and supply could be managed to balance within the other regions.

3.5 Water Demand and Groundwater Potential in the Selected 9 Major Urban Areas

The Study identified water critical urbanized areas where water are consumed intensively. Their projected water demands are as follows:

Major City	Exploitable Groundwater (MCM/Year)	Water Demand (MCM/Year)		Ratio of Demand in 2025 to Demand in 1995
		In 1995	In 2025	
Metro Manila	191	1,068	2,883	2.7
Metro Cebu	60	59	342	5.8
Davao City	84	50	153	3.1
Baguio City	15	12	87	7.3
Angeles City	137	11	31	2.8
Bacolod City	103	37	111	3.0
Iloilo City	80	9	47	5.2
Cagayan De Oro City	34	29	98	3.4
Zamboanga City	54	28	203	7.3

Consequently, it is estimated that the water demand in 2025 is sufficed with groundwater in Angeles and Iloilo, as well as Bacolod in case that the recycle use of groundwater for the industrial use is realized in the future. In others , certain surface water development measures might be required to secure sound socio-economic growthes.

3.6 Candidate Scheme for Water Resources Development

The Study adopted various water resources development schemes proposed in the previous studies and newly identified ones through the map study as the candidates for the Master Plan. The number of the candidate schemes and their active storage volumes are as follows:

Water Resources Region (WRR)	Number of Candidate Scheme	Total Active Storage (MCM)
I	4	1,133
II	10	7,354
III	16	5,156
IV	3	1,609
V	2	1,101
VI	3	465
VII	6	589
IX	1	14
X	1	102
XI	4	878
XII	2	1,218
Total	52	16,619

3.7 Institutional Issues to be Considered

The water resources management has been carried out by various authorities and agencies diversely. The responsibilities of water management are diversified as well. The National Water Resources Board, the secretariat, has not been granted sufficient power to coordinate the legal, technical and budgetary aspects of water related issues.

4. Master Plan

4.1 Water Resources Development for the Anticipated Water Critical Regions

As a result of the water balance study carried out for the 20 major river basins, it was foreseen that a water deficit would take place in 17 major river basins until the year 2025. For each of these 17 major river basins, a water resources development plan was proposed adopting some of the aforesaid candidate schemes to meet the water demand until the year 2025. The water resource development schemes in the critical 4 water resource regions as mentioned above, were proposed to solve the water deficit problem as follows:

Water Region Region (WRR)	Major River Basin	On-going BOT Project	Proposed New Schemes
WRR II	Cagayan Abulug	- -	Mallig II, Matsuno, Addalam A, Ilaguen B Agbulu
WRR III	Agno Pampanga	San Roque Casecnan T.B.	Balog-Balog Balintingon, Bayabas & Massim
WRR IV	Pasig-Laguna Bay* Amnay-Patric	- -	- Amnay
WRR VII	No major river is located in the water resources region		

Note : * ; For the Pasig-Laguna Bay basin, 2 SWIM projects are proposed.

The water deficit in the water resources region IV and VII is attributable to the huge water demand in Metro Manila and Metro Cebu, respectively. The water supply projects were proposed to meet the future water demands as discussed in the following Clause.

4.2 Water Resources Development for the Anticipated Water Critical 9 Urbanized Areas

The promising measures to develop groundwater and surface water are identified in this Study in order to cope with the anticipated water deficits until the year 2025 as follows:

Major City	Candidate Projects to Meet Water Demand Until Year 2025	
	Groundwater	Surface Water
Metro Manila	- None -	(i)* Development of Laguna Lake (ii)* MWSP III (Laiban dam) (iii) Kanan-Umiray transbasin (iv) Bayabas dam & Massim dam (v) Kaliwa-Cogeo water supply (vi) Pampanga water conveyance
Metro Cebu	23 Infiltration Wells Mananga Phase-I (Under construction)	(i)* Mananga II dam (ii) Malubog-Mananga transbasin (iii) Lusam-Pulanbato transbasin (iv) Bohol-Cebu water supply
Baguio City	Australian Aid Project (Under construction)	(i) BOT Scheme (Bulk water supply) (ii) Rehabilitation of existing facilities (iii) Laboy dam (iv) Laboy weir and ponds
Davao City	6 deep wells – PCWSP-III (Under construction)	BOT Scheme (The Davao II multi-purpose dam is proposed as an alternative of the BOT Scheme.)
Angeles City	18 deep wells – PCWSP-II	- Not necessary -
Iloilo City	65 deep wells	- Not necessary -
Bacolod City	PCWSP-IV (Under construction) Additional 46 deep wells	- Not necessary - (The Bago multi-purpose dam is proposed as an alternative of the groundwater development.)
Cagayan De Oro City	4 deep wells – PCWSP-III (Under construction)	BOT Scheme (Bulonog-Batang dam)
Zamboanga City	60 deep wells	Pasonaca dam

Note : The feasibility of the projects marked with "*" was verified in the previous studies.

The Study contemplated the development scenario(s) of the water supply projects for each of the selected 9 major cities by combining the above projects. With regard to the proposed water supply projects for the three most water-constrained cities, Metro Manila, Metro Cebu and Baguio city, whose viability has not yet been examined at a level of feasibility study, the preliminary assessment was made from a economic and social and natural environmental viewpoint. The preliminary assessment concluded that the following projects have comparatively high economic internal rate of returns(EIRRs) of more than 10%, although some of them might be associated with the environmental issues:

Major City		Name of Project
Metro Manila	1	Kanan-Umiray transbasin
	2	Massim dam & Bayabas dam
	3	Kaliwa-Cogeo water supply
Metro Cebu	1	Malubog-Mananga transbasin
	2	Lusarn-Pulanbato transbasin
	3	Bohol-Cebu water supply
Baguio City	1	Laboy dam

Since the Study aims principally to contemplate measures as a national framework to cope with the water crisis from a nation-wide viewpoint, it is recommended to carry out a regional master plan study to optimize the regional water resources development plan as well as a feasibility study on the priority project to be selected through the master plan study for each of the 9 major cities at the earliest opportunity.

4.3 Institutional Enhancement Plan

The proposed institutional enhancement plan consists of two measures, namely the Interim Measure and the Ultimate Measure.

The Interim Measure (Strengthening of the NWRB)

- NWRB to be attached to the Office of the President and later on to the DENR
- Memberships in the NWRB to be limited to agencies or sectors that are responsible for policy in water resources.
- Regional offices of the NWRB to be created to assume the line functions now in large part delegated to deputized agencies and offices.
- A legal affairs unit to be created in NWRB.
- Incremental staffing, training and equipment to be provided to NWRB. Along this measure, the strengthening of dam engineering for the NWRB that is essential for the periodical review of the water resources master plan should be envisaged.
- Improvement of the data collection network and establishment of a national water information network.

The Ultimate Measure

- Legislative action to create the Water Resources Authority of the Philippines (WRAP) which would be responsible for the integrated planning and regulation of the water resources sector.

4.4 Short Term Strategy

The Study identified Metro Manila, Metro Cebu and Baguio City as the most water critical sites. Urgent actions are required to secure preparation against the anticipated crisis. The study, along this line, proposes Short Term Strategies as follows:

Metro Manila

The Agos river might be the most promising water source for water supply to Metro Manila. The Study proposed waters resources development of the Agos river including the development of Kanan dam as a part of the short-term strategy. In this respect, a regional master plan study as well as a feasibility study on the most priority project selected through the master plan study should be carried out under the national frameworks as soon as possible.

Metro Cebu

In addition to the water resources development schemes contemplated by the Metro Cebu Water District, the Study identified the Malubog-Mananga transbasin water conveyance scheme and Lusaran-Pulanbato transbasin water conveyance scheme as the alternative water supply projects for Metro Cebu. The early implementation of a master plan study for Metro Cebu water supply as well as a feasibility study on the priority project selected through the master plan study is strongly recommended in consideration of the aggravated situation on water demand and supply balance as well as the limited water resources to be exploited around the city area.

Baguio City

The Study enumerated the high cost requisite to the proposed surface water development schemes for the water supply to Baguio City. The running costs of the scheme will be extraordinarily high because of the energy consumption of pumping to lift the water. Consequently, the Study recommends to carry out a master plan including the study on groundwater resources development in the vicinity of Baguio city and to own the resources jointly with the relevant municipalities. In succession, it is recommended that a feasibility study on the priority project selected through the master plan study be carried out. Besides,

the master plan study should verify the necessity of the urgent implementation of the rehabilitation projects on deteriorated existing water supply facilities.

4. Recommendations

- Promotions of the proposed short term strategies which are to be implemented as soon as possible.
- Improvement of data acquisition system and establishment of a national water information system (NWIN).
- Environmental consideration on the proposed water resources development plans.
- Enhancement of water management system, which will contribute to achieve proper demand control.
- Establishment of a system to review the water resources management master plan so that the Plan could adapt to the changes in the socio-economic conditions.
- Execution of a master plan study for specific major river basin with the frameworks proposed in this national master plan.

MASTER PLAN STUDY
ON
WATER RESOURCES MANAGEMENT
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FINAL REPORT

Volume I : EXECUTIVE SUMMARY

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ABBREVIATION

1. Organization

BAS	:	Bureau of Agricultural Statistics
BAI	:	Bureau of Animal Industry
BFAR	:	Bureau of Fisheries and Aquatic Resources
BSWM	:	Bureau of Soils and Water Management
DA	:	Department of Agriculture
DENR	:	Department of Environment and Natural Resources
DPWH	:	Department of Public Works and Highways
JICA	:	Japan International Cooperation Agency
LDC	:	Livestock Development Council
LWUA	:	Local Water Utilities Administration
MWSS	:	Metropolitan Waterworks and Sewerage System
NEDA	:	National Economic and Development Authority
NIA	:	National Irrigation Administration
NPC	:	National Power Corporation
NSO	:	National Statistics Office
NWRB	:	National Water Resources Board
PTFWRM	:	Presidential Task Force on Water Resources Management
PWRA	:	Philippine Water Resources Authority

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

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
CAR	: Cordillera Administrative Region
CPI	: Consumer Price Index
CIS	: Communal Irrigation System
DD	: Diversion Dam
GDP	: Gross Domestic Product
GNP	: Gross National Product
GRDP	: Gross Regional Domestic Product
GVA	: Gross Value Added
IOSPs	: Irrigation Operation Support Projects
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-Revenued Water

NSDW	: National Standard for Drinking Water
NWIN	: National Water Information System
O&M	: Operation and Maintenance
OMR	: Operation, Maintenance and Repair
PD	: Presidential Decree
PDP	: Power Development Plan
SRIP	: Small Reservoir Impounding Project
STWs	: Shallow Tube Wells
SWIMs	: Small Water Impounding Management Projects
USA	: United States of America
WD	: Water District
WRDP	: Water Resources Development Project
WRR	: Water Resources Region

EXECUTIVE SUMMARY

S1. INTRODUCTION

S1.1 Objective and Framework of the Study

The objectives of the Study are stipulated in the Implementing Arrangement agreed on September 25, 1996 by the Japan International Cooperation Agency (JICA) and the National Water Resources Board (NWRB), the counterpart agency assigned by the Government of the Republic of the Philippines, 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 targeted area is the entire land of the Philippines of about 300,000 km^2.

The Study looked into the water demand and supply balance of each water resources region and major river basin. In case that the balance study discloses a possible water shortage in a region of a watershed area, the measures to suffice the demand and to eliminate the water deficit were studied from the social well-being viewpoint. The compilation of such measures as the national frameworks in terms of scale and time frame constitutes the substance of the water resources master plan.

The water use by irrigation, industry, service and domestic sectors are the major components of the water demand as well as river maintenance flow. The Study projected water demand by sector and by region and major river basin. The projection was conducted up to the year 2025 that is defined as the target year of the Study.

The substantial sources of water are surface water and groundwater. In addition, saline water from the sea could be an alternative source with a desalination facility. The development potential of such water sources was assessed for each region and watershed area. The Study proposed the conceivable development schemes for each to suffice the projected water demand.

In addition to the study on the water resources regions and the catchment area of the major river basins, the Study examined the balance of the water demand and supply in specific local areas namely major cities, where intensive water use is foreseeable due to high population density or economic activities. The plans of preparation to the impending water crisis in these areas were studied and proposed.

The Study allocated water resource development schemes thus proposed on the time-table and location maps to formulate the master plan. The Study selected several schemes

among those proposed in view of the significance of water shortage as the priority projects. The economic viability of the selected priority projects was preliminarily examined with respect to their urgencies to formulate the short-term strategy.

The various previous studies pointed out the necessity to improve the water management. In consideration of the policies established in the previous studies, the Study looked into method to improve the water management from legal and institutional aspects. The proposed improvement strategy constitutes an important element of the frameworks of the contemplated master plan.

The Study developed a database in the course of the study in order to support the works to formulate the master plan. The other objective thereof is to enhance the management capability of NWRB through furnishing it with a sophisticated system which is expected to afford a water related information without delay.

The Study was carried out substantially during a period of 13 months from March 1997 to March 1998 by the Study Team of 15 experts of various disciplines and the counterpart personnel thereof except for the third stage investigation. The substantial study period comprises four main phases, namely first field investigation work, first home office work, second field investigation work and second home office work. During the course of the Study, the Inception Report, Interim Report and two Progress Reports were prepared and discussed in the respective Steering Committee Meetings. The Study reflects the conclusions of the Steering Committee Meeting.

The expert of the Study Team worked together with relevant counterpart officers of each discipline. In the course of the study, technology transfer was performed by the experts to the counterpart personnel by means of the on-the-job training. The seminars and workshops held during the field study stages were the other opportunities for transfer of knowledge to the staff of the Government for various subjects. In addition, JICA granted the chances for to two counterpart personnel to participate in its special training course in Japan for water resources management.

S1.2 The Report

All outcomes of the Study are compiled and presented in the Draft Final Report. The Draft 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
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Volume III-3	Supporting Report	:	Part-H	Surface Water Resources Planning
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			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 Volume I: Executive Summary presents the outline of the Master Plan briefing the results and conclusions of the Study. The main contents are the summary of the study results on the future water demand and supply balance and the necessary actions to cope with the foreseeable water deficit within a convenient time.

The Volume II: Main Report presents not only the results and conclusions together with the basic concepts and procedures leading to the conclusions, but also the methods applied to data collection and analyses as well as the standards and assumptions adopted in formulating the master plan study. The Report also proposes the effective recommendations to realize the master plan.

In addition to the Main Report, the Supporting Report consisting of 3 volumes was prepared to explain the procedures and the results of the Study in detail by each of 12 disciplines and those for water demand by administrative region. The Supporting Report supplements the descriptions of the Main Report.

The Volume IV: Data Book compiles the meteor-hydrologic data, and data on irrigation and main storage type dam projects in the Philippines.

S1.3 Workshop Using Project Cycle Management (PCM)

The workshop for the Master Plan on water resources development and management was held in the second stage field investigation. This project dialogue facilitated the JICA Study Team to formulate the master plan by means of furnishing the Study Team with information and opinions which sometime conflict among the various agencies with different views.

The main objectives of the workshop were as follows:

i) to scrutinize the problems on the project,

ii) to discuss the establishment of strategic approach to solve the problems, and
iii) to collect various opinions on the master plan to be formulated through the dialogue.

In order to hold the workshop, since the method is quite a new approach for this sort of water resources master plan study, the following preparatory works were conducted during the PCM expert assignment period from the middle of December 1997 to the middle of January 1998:

- Preparatory works for holding the workshop
- Guidance on PCM method
- Orientation for moderators nominated

In cooperation with the National Water Resources Board (NWRB), the JICA Study Team conducted a one-day Workshop using Project Cycle Management (PCM) method for the master plan study on January 15, 1998. In the PCM workshop, the 45 participants were grouped into three parties, who were assigned to the discussion on the specific issues relating to the water resources management, municipal water supply and irrigation demand, respectively.

Before starting the group works, an overall discussion on participation analysis and problem analysis was conducted in accordance with the procedures of the PCM in order to identify the participants which belong to and related to the project and problems they have. The overall participation analysis identified the agencies that have the right of water. Further detailed participation analysis was performed by each group to determine the participants and to decide the target organization. The target organization of each group is shown below:

Group in Workshop	Target Group
(i) Water resources management group	Water-related organizations
(ii) Water supply group	MWSS
(iii) Irrigation water demand group	Farmers in the nation

In the detail participation analysis, the population of each target organization that is expected to be the target of the source of the project was identified from various viewpoint through the dialogue. In addition, the specific issues of the target organization such as differing needs, demands and absorptive capacities were extracted through the group works. The results of participation analysis of each group are presented in Part-L of the Supporting Report.

Based on the results of the successive analysis such as problem analysis, objectives analysis and alternative analysis, the Project Design Matrix was developed by the participants of workshop held on June 26,1998 during the third stage field investigation. Finally, three PDMs by three groups were integrated into unique PDM through workshop as shown in Table L-14 in Part-L of the Supporting Report. The project purpose in the integrated

PDM is identified by the participants of the workshop to be not only the safe and adequate drinking water supply to Metro Manila Residents but also reliable irrigation water supply for farmers in the basin. In order to achieve the project purpose, the project dialogue among the participants concluded that the following issues need to be solved;

Conditions to Achieve the Project Purpose on Integrated PDM

Institutional Aspect	Water Resources Development Aspect	Irrigation Aspect
Master Plan on water supply for Metro Manila is formulated.	Water resources are developed adequately.	Adequate irrigation water is supplied to farmers.
Strong institutional framework is legally established.	Water delivery service is improved to high level.	Proper irrigation water management is established.
Institutionalized authoritative (APEX) body, WRAP is established	Water quality is maintained well.	Source of water supply is improved.
Water-related institution (NWRB) is strengthened	Over-exploitation of groundwater ceases.	Operation and maintenance of irrigation system is improved.
Hydrological data collection network is established and improved.	Less saline water intrusion into aquifer.	Sediment inflow into reservoir is reduced.

The expected outputs identified in the PDM seem to be an eligible project independently. Based on the urgency, degree of importance and the availability of the resources, those conditions will be scheduled and implemented in harmony with the growth of the national economy. The PDM finalized at this master plan is subject to modification in compliance with the new findings and situations to achieve the project purpose set up in this stage.

S1.4 Acknowledgement

The Government of the Philippines has extended its assistance and cooperation to the Study Team throughout the study period. The Steering committee formed by the representatives of the relevant authorities and chaired by Mr. Luis M. Sosa, the executive director of the National Water Resources Board, has guided well the JICA Study Team well through the discussion in the Steering Committee Meetings. The Study Team wishes to acknowledge that all the comments given to the Study from the committee were useful to guide the Study to the proper goal.

The data collection was successfully done although the available time to spend on it was limited. It could not have been achieved without the assistance and support extended to the Study Team by all the concerned agencies of the Philippines. The Study Team appreciates highly for those agencies with respect to their cooperation during the field investigation.

Hearty gratitude of the Study Team is addressed to the NWRB led by Mr. Luis M. Sosa, the Executive Director. The activities of the staff of the Board, as the counterpart officers, complied sufficiently with the requirement. The Study Team members were impressed by

the enthusiasm shown by the staff of the NWRB to overcome the hectic schedule.

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The Ministry of Construction assigned a staff to the chairman of the advisory committee. The experiences in the master planning for water resources development and management of the Ministry were transferred to the Study through the advisory committee and gave valuable information for the Study. The JICA Experts to DPWH dispatched from the Ministry took care of the Study Team during the third stage field investigation and give advice from time to time. All of those were useful and helpful to the Study Team.

The Water Resources Development Public Corporation, Japan assigned its staff to a member of the advisory committee. Suggestions based on the experiences in the various water resources development in Japan were given from time to time to the Study Team. All the suggestions were effective to formulate the Master Plan .

Among others, special acknowledgement is expressed to the JICA headquarter in Tokyo and JICA Philippines office for their good arrangement and support given to the Study Team in the course of the Study.

S2. NATURAL AND SOCIO-ECONOMIC CONDITION

S2.1 Land and River System

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 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 size. The rest, consisting of small coralislets, are 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.

The independent 343 principal river basins that have at least 40 km^2 of basin area each are 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-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.

S2.2 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-1.

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

municipalities. The smallest administrative unit is the barangay. The provinces included in each of the administrative regions are shown in Figure-3.

S2.3 General Meteoro-hydrology

The following specific four types represent the climate of the Philippines ;

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

ii) Type II: No distinct 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 well throughout the year.

Figure-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 and local thunderstorms. The significance of each of these climatic influences varies with the time of year.

Since the country is composed of comparatively small mountainous islands, their river basins in general occupy small catchments with short river length. Accordingly, the rivers are generally characterized by steep riverbed slopes and the coefficients of runoff mostly fall within 0.6 to 0.7. Recently, the degradation of the river basins is becoming serious, causing floods with short time of concentration and significant increase of sediment inflow as experienced in the existing Magat reservoir. In the country, therefore, water resources development associated with watershed management has been become necessary.

S2.4 Groundwater Development Potential

Preliminary Assessment of Groundwater Potentials in the Philippines

The results of previous studies on groundwater potentials were reviewed and referred to in the Study as much as possible. In the Study, the available groundwater recharge was estimated by using the isohyetal maps prepared based on recent rainfall data and applying the groundwater recharge rate of 5 % which corresponds to the annual recharge of 150 mm assuming the annual precipitation depth of 3,000 mm. The available groundwater recharge rate of 5% is conservative with reference to the results of the previous studies

based on the measured data for various regions of the country. In order to identify the groundwater exploitable areas where it is possible to successfully develop a shallow or deep well, groundwater availability maps were prepared by the water resources region as illustrated in Figure-5 through Figure-16.

In general, it is considered that the urbanization reduces the amounts of groundwater recharge due to the covering of the land with concrete, asphalt and other impervious materials, while the development of new irrigation area may bring the increase of groundwater recharge. The future incremental amounts of groundwater recharge were predicted based on the irrigation areas to be newly developed and the projected future urbanization.

The groundwater development potentials in the country were estimated on a provincial basis, which were summed up to estimate the regional potential of the water resources as shown in Table-1.

Present Problems

The recent increase of groundwater use in the country has highlighted the issues and problems in the subsurface zone that include the intrusion of saline water into aquifer, pollution of groundwater and subsidence of ground.

The saline water intrusion can be observed along any seashore. This phenomenon is attributable to the insufficient and/or declining groundwater recharge rate, and geological conditions. In particular, Metro Manila and Metro Cebu encounter serious saline water intrusion problems as shown in Figure-17 and Figure-18, respectively. Over-exploitation of groundwater is the common cause of the problems.

Meanwhile another problem is the contamination of groundwater. The major pollutants might be domestic sewage, factory wastes and agricultural chemicals (fertilizer). Accordingly, all of the densely populated and industrial and agricultural areas have the possibility of groundwater pollution. Ground subsidence is observed mainly in alluvial plain areas. However, densely populated areas in a seashore belt such as Metro Manila and Metro Cebu are located on consolidated sediments or on firm ground with thin unconsolidated sediments. Hence, any significant subsidence of ground in those areas has not yet been reported.

Recommendation on Subsequent Groundwater Survey Groundwater Monitoring

It is found out through the Study that, in the Philippines, detailed studies on groundwater recharge and/or potentials have been carried out by the concerned agencies for a limited number of areas where groundwater shortage occurred or was likely to occur. To enable more accurate and fruitful review of the water resources management master plan in the future, a detailed groundwater survey and study should be performed for more wide areas from now on.

The White Paper of the country didn't describe anything regarding the present environmental problems related to groundwater. It is recommended that a nation-wide

monitoring program for groundwater problems be established immediately so as to take the countermeasures in the future when necessary.

S2.5 Present Socio-Economic Condition

Population

During 35 years from 1960 to 1995, the population of the Philippines has increased from 27,090 thousand in 1960 to 68,612 thousand in 1995 at an annual average growth rate (AAGR) of 2.7%. Out of the administrative regions, the population of Southern Tagalog (Region IV) increased at the highest AAGR of 3.5% for the five years from 1990 to 1995, followed by National Capital Region (NCR). Southern Tagalog (Region IV) occupies the highest share of 14.5% of the national population, followed by 13.8% of NCR.

Gross Domestic Product (GDP) and Gross Regional Domestic Product (GRDP)

During the past eleven years from 1985 to 1996, the gross domestic product (GDP) has grown from 571,883 million pesos to 848,451 million pesos at an AAGR of 3.7% at the constant 1985 price level. The per capita GDP at current prices and at constant 1985 prices grew at an AAGR of 10.0% and 0.9%, respectively.

NEDA has assessed the updated Medium-Term Philippine Development Plan (MTPDP) covering the period from 1996 to 1998 and concluded that economic recovery was attained in 1993 and sustained throughout 1994 and 1995. As a result of the economic growth accelerated in 1994 by the resolution of the power supply problem, the GDP expanded by 4.4% as targeted. The strong domestic production, as well as substantial inflows of income from remittances of overseas contract workers, raised the GNP growth rate to 5.3% in real terms, exceeding the target rate of 3.5 % to 4.5% in the MTPDP. The growing confidence in the economy and the implementation of market-friendly policies led to the improved performance of all production sectors, except for the agricultural sector. The AAGRs of GVA by sector for the period from 1985 to 1996 are 2.2%, 3.8% and 4.3% in the agricultural, industrial and service sectors, respectively.

With regard to the gross regional domestic product (GRDP) at constant 1985 price, CAR grew at the highest AAGR of 4.5% for the period from 1985 to 1995, followed by Central Luzon (Region III). In 1996, NCR accounted for the largest share of 30.3% in the Philippines, followed by 15.7% of Southern Tagalog (Region IV).

The per capita GRDP of NCR at the current price reached 67,894 pesos in 1995, which is ranked at the highest level of all the regions, while the lowest level of 8,630 pesos took place in ARMM. The highest AAGR of 13.1% for per capita GRDP was attained by Western Mindanao (Region IX) for the five years from 1990 to 1995.

Labor Market

The total labor forces have increased from 18,467 thousand in 1982 to 28,040 thousand in 1995 at an AAGR of 3.3% and the ratio of number of employed labor force to total number of labor force reached 91.6% in 1995. The agricultural sector still occupies the highest share of 44.1%. The Philippines' labor market is expected to be improved from now on

through the recovery of the national economy attained for the period from 1993 to 1995. The labor forces grew at an AAGR of 2.6% for the period of 1993 to 1995 and the economic recovery of the industrial and service sectors led to higher job creation in 1994 and 1995. With regard to the regional employment ratios in 1995, the highest ones in the agricultural, industrial and service sectors were 76.3% in ARMM, 26.8% in NCR and 71.7% in NCR, respectively.

Price Level and Inflation

The nation's annual inflation rate has moderated from 12.2% in 1988 to 8.4% in 1996. The annual average inflation rate during the period is derived to be 10.8%. In 1997,the economic crises prevailing in the Asian countries has gradually being affecting the social and economic conditions of the country.

Government Finance

The cash balance of the Government finance had continued to be deficit since 1970 but turned to be surplus after 1994. In 1996, the tax revenue accounts for 89.6% of the total revenue through the introduction of the improved collection system by the Bureau of Internal Revenue (BIR). The Government is striving to prepare the comprehensive tax reform acts to strengthen the basis of tax revenues. According to government expenditure program for recent three years from 1995 to 1997, the expenditure was planned to increase by 28% from 372,081 million Peso to 476,170 million peso. The expenditure for water resources development and flood control accounts for only 1% of the total expenditure in these three years.

Peso Per US$ Rate

The conversion rate of the Philippines Peso to US$ depreciated by around 4 times between 1976 and 1997, changing from 7.440 in 1976 to 28.771 Pesos per US$ in 1997. Peso was relatively stable in 1996. But after July 1997, the peso began to depreciate and the conversion rate became around 40 pesos per US$ in January 1998.

S3. PRESENT CONDITION OF WATER RESOURCES DEVELOPMENT AND USE

S3.1 Municipal and Industrial Water

Existing Water Supply System

The water supply system in the country is largely classified into either public or privately owned water supply facilities. The public water supply systems are further categorized into three different levels of systems according to the service level, namely Level-III and Level-II systems and Level-I facility as follows:

i) Level-III system: Individual house connection system usually operated by the respective water districts under the technical and financial assistance of LWUA. At present, the total number of the Level-III systems managed by the WDs in the country amounts to 404.

ii) Level-II system: Communal faucet system, usually to cater for the Barangay level water supply with a limited service coverage and supply capacity as compared with those of Level-III system.

iii) Level-I facility: Point-tap system installed in rural areas of Barangay, which utilizes groundwater in a well equipped with hand-pump or spring as the source.

The present service coverage of those public water systems in urban and rural areas of each water resources region is shown in the following table:

Service Coverage of Public Water Supply by Water Resources Region (WRR)

(Unit: %)

WRR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Urban	74	64	64	66	67	69	69	69	69	69	84	69	68
Rural	75	67	67	69	79	80	77	80	76	78	77	74	75
Total	74	67	67	66	76	73	73	77	73	74	80	72	72

In the country, about 28% of the population were not covered by the public water supply systems. The overall existing service coverage is summarized by the service level and area classification in the following table and Figure-19:

Overall Service Coverage

(Unit: %)

Service Level	Urban Area			Rural Area	Total
	Metro Manila	Other Area	Sub-total		
Level-III	62%	30%	39%	5%	22%
Level-I & -II	-	40%	29%	70%	49%
Total	62%	70%	68%	75%	72%

Present Water Demand

The present water demand for the Level-III system was estimated based on the data

collected from MWSS and LWUA, while that for the Level-I facility and Level-II system was based on the population served thereby and assumed average per capita consumption.

The amount of granted water rights, which are registered in the NWRB's database, indicates the present industrial water demands. The estimated present municipal and industrial water demands are shown by the water resources region in Table-2, and Figure-20 and Figure-21and summarized below:

Present Municipal and Indostrial Water Demand in the Philippines (As of 1995)

(Unit: MCM/year)

Municipal	Industrial	Total
2,178.7	2,233.6	4,412.3

Issues and Problems of Water Supply Systems in Major Cities

The Study has found that at present the three major cities, namely Metro Manila, Metro Cebu and Baguio City, are in the condition of the most critical water supply and demand balance. The present situation as well as issues and problems of municipal water supply in these three cities are summarized below.

a. Metro Manila: The water shortage in Metro Manila, at present, is critical because of the enormous water demand by the high population increase and brisk economic activities. Further, the unaccounted-for water is significant having a share of more than half of the total water production as shown in Table-3. The operation and management of the water supply system of Metro Manila has been just turned over to the private sector from MWSS. To meet the increasing water demand in Metro Manila, priority water resources development projects for municipal water supply as well as rehabilitation of existing water supply facilities urgently need to be studied and implemented.

b. Metro Cebu: According to the annual report of the Metro Cebu Water District (MCWD), as of December 1995, MCWD was able to serve 36% of total demand and produced 11,220 m^3/day of water on an average. The unaccounted for water is a serious issue for MCWD as well. Hence, a series of water resource development projects and measures to manage water need to be studied and implemented to reduce the gap between the supply and demand.

c. Baguio City: The water supply situation is serious. On an average, 80% of the total number of service connections of 21,500 is provided with water on a basis of a four-hour thrice a week schedule according to the results of hearing at the site. Further, no running water is available due to low water pressure especially in the elevated areas. The Baguio City WD has been facing the problems caused by the deteriorated water supply system as well as insufficient water supply capacities.

S3.2 Irrigation Water

As of December 1996, there are 11,089 irrigation systems all over the country, which are classified into five schemes, namely NIS, CIS, SWIM, diversion dams and STW as summarized in the following table:

Existing Irrigation Systems in the Philippines as of December 1996

No.	Classification	Number of Schemes	Total Service Area (ha)	Service Area per Scheme (ha)
1.	National Irrigation System (NIS)	173	651,812	3,767.7
2.	Communal Irrigation System (CIS)	9,107	670,018	73.6
3.	Small Water Impounding Management (SWIM)	256	15,762	61.6
4.	Diversion Dam	569	21,233	37.3
5.	Shallow Tube Well (STW)	984	2,878	1.9
	Total	11,089	1,361,703	122.8*

Note : * shows weighted average of service area per scheme.

As a whole, the present irrigation systems cover a total irrigation service area of about 1.36 million ha or about 43 percent of potential irrigable area of the 3.2 million ha, devoted to rice cultivation. The service area of STW which relies on groundwater accounts for only 0.2% of the total area of the country. As shown in a table above, on the other hand, NIS and CIS occupies a dominant part thereof, accounting for about 97 %. The status of irrigation development under NIS and CIS as of December 1996 is presented by province and water resources region in Table-4 and Table-5, respectively. Figure-22 through Figure-33 show the locations of the existing and proposed irrigation development schemes in each water resources region.

S3.3 Surface Water and Hydropower Development

(1) Present Situation of Existing large-scale Dams

The dams provided in the Philippines so far are largely divided into two types, the large-scale dam and small-scale dam under such projects as SWIM. Several agencies have planned and implemented dams mainly to generate hydropower or to supply irrigation water. The number of the completed dams with a height of more than 15 m per unit population of million persons of 0.24 in the country is still considerably low as compared with 19.7 in Japan and 24.5 in USA.

There exist five major dams in the Philippines. These are Angat dam, Magat dam, Pantabangan dam, Ambuklao dam and Binga dam, all of which lie in Luzon island. These were the multipurpose dams, not exclusively for the purpose of hydropower generation. In the Philippines, it is expected that new large scale impounding dams will be formulated as muti-purpose dams with the purpose of hydropower generation in addition to those of irrigation and municipal water supply, and flood control. The other existing reservoir type schemes with comparatively large regulation capacities are those developed hydropower projects on the Agus river in series in Mindanao island. The scheme harnesses the Lanao

lake for the reservoir and the head along the Agus river.

Out of the five existing major dams, the sedimentation on the Magat and Pantabangan reservoirs have been investigated by the joint team of NPC and NIA. According to the latest information obtained by the joint team, the Magat reservoir is affected by a significant increase of sediment inflow after July 1990 when an earthquake took place.

The report states that the extraordinary high sedimentation rate observed between 1990 and 1995 is attributable primarily to the 1990 earthquake which led to the massive landslides and slope failure in the upper basins of the Magat reservoir. It emphasizes that the degradation of the watershed area also results from the man-made activities such as uncontrolled forest fires, illegal logging, unmanaged grazing, shifting cultivation and other improper land management practices. The estimated remaining reservoir life is about 43 years, should the present sedimentation rate continue. To improve and cope with the aggravated basin condition, the concerned governmental agencies recommended to rehabilitate more than 50 % of the catchment area that is the most seriously damaged through the implementation of effective forest protection schemes, massive reforestation, as well as adoption of other erosion control measures/practices in cooperation with the DENR and concerned provincial government.

(2) Necessity of Watershed Management

As mentioned above, the actual sediment inflow rate exceeds the design value for some of the existing reservoirs in the Philippines. The sedimentation is shortening the reservoir life to a considerable extent. Besides, the sediment inflow into existing irrigation facilities has become significantly large in recent years, as stressed in the WRDP's report. It has raised the necessary budget to dredge the sediment deposited in those irrigation facilities. Therefore, the appropriate actions are necessary to remedy the situation.

To cope with the sedimentation problems in the existing reservoirs, first of all, it is recommended that the watershed management plan contemplated for the Magat reservoir be implemented at an early stage in coordination with the concerned agencies and regional governments. In planning the new reservoir schemes for water resources development, to couple the watershed management plan to the favorable water resources development plan is recommendable.

(3) Hydropower Development by NPC

To date, most of the development plans with impounding reservoir projects have been worked out with the initiative of NPC, placing the first priority on hydropower development. NPC intends to implement those promising hydropower projects proposed in the previous studies, sooner or later, with funds from international financing sources or by BOT in order to meet the increasing power demand with the indigenous resources as much as possible.

There are 245 promising hydropower potential sites in the entire Philippines, amounting to 12,308 MW in total as shown in Table-6. These potential sites include the 2,278 MW of existing hydropower plants. Thus, a total hydropower potential of about 10,000 MW are

left undeveloped over the country. The hydropower potentials remained for the development in the future in the respective major grid systems are summarized as follows:

Hydropower Potentials Remained Undeveloped

(Unit: MW)

Major Grid			Philippine
Luzon	Visayas	Mindanao	
7,316	417	2,297	10,030

According to the 1996 Power Development Program (the 1996 PDP) prepared by NPC, the estimated power demand and energy sales are 16,256 MW and 93,313 GWh in 2005, respectively. This shows that the power demand and energy sales in the entire Philippines would increase at annual average rate of 11.9 % for the period. The hydropower development would play an important role in meeting the future power demand.

S3.4 Groundwater

S3.4.1 Groundwater for Municipal Water Supply

(1) Level-III Water Supply System

The service areas of existing Level-III water supply systems which rely on groundwater may be largely divided into the service area of MWSS in and around Metro Manila and other service areas of regional water districts under LWUA. In case of the former, MWSS owns a total of 265 wells, of which 156 wells or about 59% were abandoned due to the intrusion of saline water, lowering of groundwater table or the deterioration of the facilities.

In the other areas, about 86% of the Level-III water supply systems relies on groundwater source.

(2) Groundwater Production by Water Supply System

The other groundwater uses for municipal water supply, excepting the Level-III system, are the Level-II system, public and privately owned Level-I facilities and commercial facilities.

Groundwater production in 1995 is tabulated by water resources region in accordance with the categories in the following table:

Present Production of Groundwater for Municipal Water Supply in 1995

(Unit: MCM/year)

WRR	Level-III		Level-II	Level-I		Commercial	Total
	MWSS	LWUA		Public	Private		
I	-	24.7	2.7	11.8	6.6	0.2	46.0
II	-	7.2	3.5	17.4	11.2	-	39.3
III	-	135.8	7.0	43.7	28.6	0.4	215.5
IV	26.9	99.4	11.3	37.1	71.5	8.9	255.1
V	-	32.8	4.3	26.1	11.6	0.0	74.8
VI	-	45.7	5.4	34.8	15.4	2.4	103.7
VII	-	70.4	4.5	30.1	14.7	0.5	120.2
VIII	-	6.3	3.8	20.8	8.7	0.6	40.2
IX	-	30.4	3.7	19.8	10.4	-	64.3
X	-	44.6	3.7	20.5	11.3	-	80.1
XI	-	47.0	3.0	18.6	8.3	0.3	77.2
XII	-	15.8	4.5	31.4	15.1	1.7	68.5
Total	26.9	560.1	57.4	312.1	213.4	15.0	1,184.8

According to the granted water rights data of NWRB, the source of irrigation water is predominantly surface water. Groundwater accounted for only 1.2 % of the total amount.

S3.4.2 Total Groundwater Use in the Philippines

The data on granted water rights registered in the NWRB's database indicates the amount of groundwater production for industrial, irrigation and other purposes. The present groundwater production in the country was estimated approximately at 2,518 MCM/year as follows:

Present Production of Groundwater in the Philippines

(Unit: MCM/year)

WRR	Municipal	Industrial	Irrigation	Others	Total
I	46.0	5.3	64.0	0.0	115.3
II	39.3	0.7	29.2	0.2	69.4
III	215.5	83.7	120.1	4.3	423.6
IV	255.1	202.2	46.1	20.1	523.5
V	74.8	1.6	25.6	0.6	102.6
VI	103.7	45.6	110.6	34.9	294.8
VII	120.2	88.0	64.0	29.5	301.7
VIII	40.2	20.4	9.4	0.2	70.2
IX	64.3	1.4	19.9	0.2	85.8
X	80.1	43.3	40.6	4.1	168.1
XI	77.2	16.0	41.1	26.5	160.8
XII	68.5	6.3	125.1	2.5	202.4
Nation	1,184.8	514.4	695.6	123.1	2,517.9

S3.5 Flood Control

Flooding is common in the Philippines and has brought about severe damages almost every year. Flood damages have been exaggerated by typhoons which pass over islands of the Philippines during the period from April to November due to the heavy rainfall and strong wind except for the central and southern Mindanao. In general, there are only a limited number of the major rivers that have sufficient carrying capacity to pass down the concentrated runoff of rainstorm in the areas affected.

DPWH is responsible for planning and implementation of the flood control and drainage projects in the country. Out of the total budget of 13.9 billion Pesos allocated to the basic infrastructure program in 1994, about 1.9 billion pesos or 14 % of the total budget is disbursed to the flood control sector.

The nationwide flood control plan was established through the previous study on river dredging. The study contemplated a flood control plan for each of the 12 major river basins. These river basins are the Laoag, Agno, Cagayan, Pampanga, Bicol, Amnay-Patrick, Panay, Jalaur, Ilog, Agusan, Tagaloan and Mindanao river basins. The Study proposed mainly river improvement works to expand the river carrying capacity in order to solve the flood problems in the downstream low-land areas. The proposals should,however, be reviewed reflecting present land use especially in the riparian areas.

After the nationwide flood control plan, several studies on flood control and drainage improvement have been carried out for specific basins at a study level of master plan and/or feasibility. According to the Medium Term Infrastructure Program prepared by DPWH (DPWH-MTIP), the Government intends to implement the flood control and drainage projects placing a priority on the 12 major river basins and Metro Manila.

The total budget for these projects is estimated to be about 21 billion Pesos so as to attain the target of flood control plans nominated in the DPWH-MTIP. In the DPWH-MTIP, the majority of the flood control plans are proposed to be of the flood protection dikes or flood walls. However, it is recommended to adopt a multi-purpose dam with the function of flood control as an alternative plan, as far as possible, in formulating a new reservoir type dam for the water resources development. In the Master Plan Study on the Cagayan River Basin Development which was carried out in 1987, the comprehensive flood control plan which consists of river dredging works and provision of multi-purpose dam in the upper reaches was formulated to mitigate the flood damages in the lower reaches.

S3.6 Water Quality

The Philippines government has performed vigorous monitoring on water quality of the rivers in and around Metro Manila, such as the Pasig River, the Markina River, the Sun Juan River, the Paranaque River and the Tullahan-Tinajeros River. Results of monitoring show very high BOD values and low DO values. The facts indicate contamination of river

water with non-treated municipal sewage. In addition, some monitoring has been performed on the downstream reaches of the rivers in Luzon outside Metro Manila and other rivers in Visayas and Mindanao. These results also show contamination with domestic, industrial and agricultural effluents.

According to the quality classification standard a river rated at class-AA or class-A is judged to be suitable for municipal water supply. The results of the classification show that almost half of the rivers could still be tapped for drinking water, requiring only approved disinfection to meet the National Standards for Drinking Water (NSDW).

S3.7 Present Institutional Issues on Water Use and Water Resources Development

The Government of the Philippines recognizes the fact that a major constraint in the water resources sector is institutional : absence of a national water resources master plan to guide water resources development and management; multiplicity of agencies engaged in water management responsibilities; weak enforcement of the Water Code; lack of reliable water resources data.

NWRB, the agency mandated to integrate and coordinate as well as regulate and manage the water resources sector, has very limited funds and staff and is unable to effectively enforce the provisions of the Water Code. There are no updated water resources master plans to integrate water and land use activities. Agencies in each sub-sector of the water resources sector largely depend on their own strategies and programs for water resources development resulting in water use conflicts with negative effects from excessive or unregulated water withdrawals and regulated waste water discharges.

S4. REGIONAL WATER DEMAND PROJECTION AND GROUNDWATER DEVELOPMENT

S4.1 General Procedures Adopted for Water Demand Projection

The future water demand for the entire Philippines was projected in accordance with the following procedures:

(i) The water demand projection was made for each of municipal and industrial and agricultural sectors in accordance with the socio-economic framework set up in the Study.

(ii) The base year for the projection was set at 1995, while the target year at 2025. In addition, the projection was made for the intermediate years of 2000, 2005, 2010, 2015 and 2020.

(iii) The adopted are two socio-economic framework corresponding to the assumed two different cases, namely the low and high economic growth scenarios.

(iv) The water demand projection was made for each water resources region and major river basin in addition to the nation-wide projection.

S4.2 Set-up of Socio-Economic Framework

The future socio-economic framework was set up for population, gross domestic product (GDP) and labor employment based on the data collected from NEDA. With regard to the GDP, the two different scenarios of the low and high economic growth scenarios were worked out in the Study.

Population

Concerning the national population projection, the Study adopted the medium level of future population projected by NSO for the period from 2000 to 2025. In the NSO's projection, the national population is estimated to reach 111 million in 2025, increasing at an annual average rate of 1.6% for the period. The nationwide population thus projected by NSO was used as the control total in projecting the future regional and provincial populations in the same years. NSO projected the regional population up to the year 2020. The Study extended the projection up to the target year 2025 through the same method as that adopted in the NSO's projection. The provincial population projection also was made by means of the same methodology as that applied to the regional projection, since the results of NSO's provincial population projection have not yet been figured out. The projected population and population density for the respective water resources regions are depicted in Figure-34 and Figure-35, respectively.

Gross Domestic Product (GDP)

(i) Higher Economic Growth Scenario

The GDP of the Philippines in the high economic growth case was projected for the period from 1997 to 2025 based on the annual growth rates presented in the updated Medium-

Term Development Plan (1997 to 2001) and the tentative Long-Term Development Plan, which were prepared by NEDA. It is considered that the growth rates in the NEDA's tentative plan are still applicable judging from the past high AAGRs of GDP in the Philippines. In the Study, the economic features projected based on the NEDA's plans were adopted for the higher economic growth scenario, while those in the lower economic growth scenario were projected with reference to the economic projection made by the international organization.

In the high economic growth scenario, the total GDP of the Philippines was projected to increase from 803,450 million pesos in 1995 to 6,849,796 million pesos in 2025 at a high AAGR of 7.4%. As for the sectoral growth rates for the period, the highest growth rate is expected to be 8.7% in industrial sector, followed by 7.2% in service sector and 4.4% in agricultural sector.

The projected gross value added (GVA) and per capita GVA for the respective water resources regions are depicted in Figure-36 and Figure-37, respectively, in place of GDP.

(ii) Lower Economic Growth Scenario

The low economic growth scenario was assumed mainly in consideration of the uncertainty of the high economic growth represented by the recent drastic depreciation of Peso currency. The seriousness of the water constraint will emerge in the assumed low growth scenario which contemplate smaller water demands. With reference to the long-term economic projections made by the international organizations such as World Bank, ADB, PECC (Pacific Economic Cooperation Council) as well as the historical growths of GDP in developed countries like Japan, the annual average growth rate of GDP was set at 5% for the period from 2000 to 2025 and 4.8% for the period from 1996 to 2025. The annual average growth rate of 4.8% in the low economic growth scenario is about 2.6% lower than that in the high economic growth scenario.

Employment

The nationwide employment rate for the period from 1995 to 2025 has been projected taking into consideration: I) the past tendency of total employment after 1987, ii) the Updated Medium-Development Plan (1996-1998), iii) annual increase rates of population until the year 2025. The projected total employment of the Philippines would increase from 26 million in 1995 to 49 million in 2025 at an annual growth rate of 2.1%. As for the sectoral annual growth rates for the period, industrial and service sectors are 3.1% and 2.7%, respectively. The agricultural sector is the lowest of 1.1% as the result of the employment projection.

S4.3 Municipal Water Demand Projection

The municipal water demand for public water supply level depends on population, per capita water consumption, service coverage and unaccounted-for water ratio.

The future population projected through the set-up of the socio-economic framework was applied to the domestic water demand projection. The per capita water consumption for the Level-III water supply systems was projected for the service areas of MWSS and regional Water Districts based on the previous master plan and provincial plans, respectively. In the service area of MWSS, the projected per capita water consumption increases from 159 lpcd in 1995 to 258 lpcd. While, consumption in other water districts increases to 169 lpcd to 269 lpcd in 2025. Concerning the Level-I and Level-II water supply systems, it is projected that the present per capita water consumption of 30 lpcd will increase to 40 lpcd in 2025 with an increment of 2 lpcd for every five year.

The overall service coverage of the public water supply system as the model case with reference to those in the provincial plans was assumed as follows:

Overall Service Coverage (Model Case)

Classification	Year						
	1995	2000	2005	2010	2015	2020	2025
Urban	69%	75%	80%	85%	90%	93%	95%
Rural	73%	79%	85%	91%	93%	95%	95%

The Study assumed that the service coverage will expand in the urban area through the installation of the Level-III water supply system. In the rural area, on the other hand, the Level-I and Level-II water supply systems will continue to reach the target service coverage, while the present service coverage of the Level-III water supply system in the rural area will remain unchanged until 2025. The unaccounted-for water ratios will decrease to 30% in Metro Manila and 20% in other water districts with reference to the said master plan and provincial plans.

Based on these procedures and assumptions, the water demand for public water supply was projected by water resources region, province and major river basin for the period until the year 2025. Consequently, the total water demand for public water supply system in the year 2025 was estimated to be 7,289 MCM/year, which corresponds to 3.7 times of the present water consumption. Finally, the total amount of municipal water demand including privately owned water source was projected to be 7,430 MCM/year in the target year of 2025.

S4.4 Industrial Water Demand Projection

The Study developed the following regression formula showing a relationship between GDP of industrial sector and total water amount for water rights granted to industrial sector in order to estimate the industrial water demand since a high correlation index of 0.88 between two factors was derived:

$$WD = 0.00485 \times GDP + 525.275$$

Where,

WD	; Water Demand (MCM/year)
GDP	; GDP for Industrial sector (Million Pesos)

The projected industrial water demands were obtained working out the formula applying the projected industrial GDP.

Regarding the sources of industrial water, it was assumed that the surface water supply would be unchanged from the present supply level, since a lot of mining companies which are main users of surface water in the industrial sector are ceasing or suspending their activities at present.

In addition, it was assumed that about 30% of groundwater to be supplied for the industrial purpose could be reused for the same purpose until 2025. More intensive recycling use of 3 times was contemplated for Metro Cebu and the Pasig-Laguna Bay basin inclusive of Metro Manila taking into account the severe water shortage foreseen there in the future.

As mentioned above, the industrial water demand was estimated by applying two kinds of industrial GDP; namely GDPs, resulting from the high and low economic growth scenarios. In the scenario of high economic growth, the estimated industrial water demand is 4,997.6 MCM/year in 2025, which corresponds to 2.24 times of the present consumption. In the low economic growth scenario, the estimated industrial water demand is 3,310.1 MCM/year, which corresponds to 1.48 times of the present water consumption.

S4.5 Agricultural Water Demand

S4.5.1 Available Data and Present Agricultural development

The source of the data and information used in the study, are NIA and BSWM. The majority thereof is data on existing irrigation systems, 10-year irrigation development plan of NIA and BSWM and previous study reports on irrigation development. Also gathered from BAS are the inventory of livestock, poultry and fisheries. The information on development of livestock and poultry industries and fisheries was gathered from DA, LDC and BFAR.

The prime agencies responsible for the irrigation development in the country are the National Irrigation Administration (NIA) and Bureau of Soils and Water Management (BSWM). NIA, a government-owned corporation, implements large-scale irrigation projects, while BSWM is entrusted by the Department of Agriculture to handle the small-scale irrigation projects. The significant investment in the irrigation sector during the past three decades has resulted in considerable success as indicated by the increased agricultural production after the development of the irrigation systems amounting to a total area of 1.36 million ha as of 1996, or about 43% of the potential irrigable area of 3.16 million hectares in the country.

The database of NWRB on water rights grants shows that there are 1382 approved water permits to appropriate groundwater source for irrigation use. The estimated service area, based on a unit water requirement at 1.5 lps/ha is approximately 14,400 hectares, because the water withdrawal rate was 21,200 lps.

The performance of many irrigation systems in the Philippines does not reach the expected level in terms of the actually irrigated area. The performance of the irrigation systems is affected not only by the delayed onset of rainy seasons, droughts, floods and pests, but also for the following reasons:

(i) Inclusion in the service area of some elevated farms that are very difficult to irrigate, and some low-lying areas,
(ii) Deteriorated canals and canal structures, neglected drainage systems and unmaintained service roads,
(iii) Degradation of watersheds,
(iv) Unsatisfactory water management practices or operation modality being adopted,
(v) Inadequate funds for the operation and maintenance (O&M) of the irrigation systems that need to be improved and rehabilitated, and the inadequacy of O&M capability of some field personnel as well as the IAs.

In order to improve the operational performance of the irrigation systems, physical and institutional interventions should be undertaken.

The development of livestock, poultry and fisheries is now the unflinching endeavor in the Philippines. In 1996, out of the total livestock population of 13.6 million heads, 8.37 million heads were slaughtered producing 1.53 million metric ton of meat. For poultry, the total population reaches 100.273 million heads, producing 0.947 million metric ton. It is noted that in the Study, livestock includes only cattle, carabao and hogs. For poultry, only the broiler chicken is considered. With regard to fisheries, bangus (milkfish) and sugpo (prawn) industries are further examined from point of view of the water use. The total fishpond area for bangus and sugpo raising in 1996 is estimated to be 139,832 ha.

S4.5.2 Agricultural Development Plan

The 10-year development plan of NIA covering the period from 1997 to 2006, looks at to developing a total of new irrigation area of 373,845 ha under the national and communal irrigation projects and rehabilitating the existing irrigation areas of 882,056 ha. Besides, it includes the reforestation in the Magat watershed and the improvement of the relevant facilities and access roads of the existing irrigation facilities. Sixty-seven SWIM projects would also be implemented within the period. BSWM is also planning to develop new irrigation area of 310,016 ha for the period from 1997 to 2006. Although NIA is mandated to continue the country's irrigation development program, at present, there is no concrete irrigation development plan beyond year 2006. However, the Study attempted to project new irrigation areas to be developed for the period from 2010 to 2025 observing the

policy of NIA. The projection was made on the assumption that the future irrigation development program for the period would follow the same rate of new irrigation area as that in the current ten-year program. As a conclusion, it was estimated that a total of 1.5 million ha of new irrigation areas would developed within the period of 1997 to 2025.

The target of the Medium-Term on Livestock Development Plan covering the period until 1998 is to increase the population of cattle, carabao and hog to 3.0 million, 2.5 million and 10.8 million, respectively and chicken population to more than 100 million. For fisheries, the Medium-Term Fisheries Management and Development Program for the period from 1993 to 1998 aims to achieve aquaculture productivity of 2.4 tons per ha per year by 1998. Recently, the Republic Act (RA) No. 8435 was signed for conservation, protection and improvement of productivity of aquaculture. Beyond 1998, there is no available plan both for development of livestock and fisheries. Hence, the Study presented a projection on livestock and poultry population and fishpond areas for the period from 1998 to 2025 based on the framework for major agricultural commodities in terms of GDP and production estimated in the socio-economic analysis. Until the year 2025, the livestock and poultry population are estimated to increase to 44.7 million heads and 2,517 million heads, respectively. For fisheries, the total projected fishpond area for bangus and sugpo is 210,038 ha.

S4.5.3 Agricultural Water Demand

The agricultural water demand in the year 2025 was estimated for each of the two scenarios, Case 1 for high economic growth scenario and Case 2 for low economic growth scenario. The estimate was made by province, water resources region and major river basin.

The total present agricultural water demand nationwide in 1996 is estimated to be 25,533 MCM or 69.95 MCM/day. About 18,527 MCM or 72.6 percent of the total agricultural water demand is occupied by irrigation sub-sector. The livestock/poultry sub-sector accounted for 107 MCM or 0.42 percent of the total agricultural water demand. For the fishery sub-sector, the water demand is estimated at 6,899 MCM or 27 percent of the total agricultural water demand.

The total irrigation area to be irrigated in Case 1 is 2.86 million ha, which includes the existing areas and new areas to be developed for the period from 1997 to 2025. In Case 2, it is assumed that there will be no development beyond 2006. The cropping intensity is assumed at 175% for the existing irrigation areas and 200% for new irrigation areas. With the assumption that production yield will increase at 5.5 MT/ha/year, the estimated palay production is 29.8 million MT/year in Case 1 and 18.8 million MT/year in Case 2 in 2025. The irrigation water demand was determined by multiplying the irrigated area with the ten-day irrigation water requirement.

For livestock and poultry, the water demand was estimated based on the water requirement of 2.4×10^{-4} lps per head for livestock and 1.46×10^{-6} lps per head for poultry. For

fisheries, the water requirement for bangus fishponds is 0.9259 lps/ha and for sugpo fishponds is 3.15 lps/ha. All these criteria were quoted from the NWRB's standard values used for the water rights evaluation.

In Case 1, the agricultural water demand is expected to reach 72,973 MCM or 200 MCM/day in 2025. About 59,884 MCM would be required for irrigation. Livestock and poultry would require 434 MCM and fisheries would need 12,655 MCM. Likewise, in Case 2, the total agricultural water demand nationwide is expected to reach 51,925 MCM or 100.24 MCM/day in 2025. Irrigation would require 38,836 MCM and 218 MCM for livestock and poultry. About 10,806 MCM would be needed for fisheries.

The agricultural water demand to be shared by groundwater was estimated to be 4,694 MCM in year 2006 and it was assumed to remain constant until year 2025. Thus, the projection assumed that there would be no new areas to be irrigated by groundwater source beyond 2006.

S4.6 Groundwater Development Plan

The future water demand to be shared by groundwater was estimated with the following assumptions:

(i) With respect to the Level-III water supply system of the three different water supply systems, the water districts whose water supply entirely depends on groundwater resources at present will continue to develop ground water in the future as far as it is exploitable. Concerning the water districts whose service area is provided by surface water, they will seek for the development of surface water in order to meet the future water demand. The Level-II and Level-I water supply systems would rely on groundwater resources in the future as they do at present

(ii) The additional industrial water demand until 2025 could be sufficed by groundwater, since the production of the mining sector, which has consumed a large part of surface water is projected not to grow in the future.

The groundwater development plans were preliminarily formulated for each of the water resources regions and for the major river basins so as to meet the future water demands to be shared by groundwater which were estimated under the above assumptions. The requirement of new groundwater development was clarified for each of the water use sectors and the different water supply systems of the Level-I, Level-II and Level–III. The procedures, methodologies and assumptions applied to the formulation of the nation-wide groundwater development plans are described in detail in Part-G of the Supporting Report.

In the Study, the typical deepwell structures were designed with reference to the design standards utilized in this country as shown in Figure-38. In addition, the life of the

facilities as well as the annual reduction of groundwater production were taken into account in determining the requirement of the future groundwater development. Likewise, the hydrogeological conditions which differ by region were reflected in the estimate of the new groundwater requirement.

Water volume to be developed through the construction of new deepwells until the year 2025 is shown in Figure-39 for each region. As seen in this Figure, the water resources regions III and IV require the largest numbers of new deepwells for the Level-III water supply systems.

The construction cost estimate for the new groundwater development was made in consideration of the necessity of the relevant structures such as water transmission facilities, and treatment facilities mainly for chlorination and distribution facilities. The typical water supply systems referred to the construction cost estimate are depicted in Figure-40. The consequent estimates of investment required for new groundwater development in the country are presented below at 5-year intervals :

Cost for Groundwater Resources Development (Well Construction)

(Unit: Billion Pesos per 5 years)

Economic Growth Scenario	Year					
	2000	2005	2010	2015	2020	2025
High	47.5	54.1	49.9	57.0	46.0	51.7
Low	47.3	53.4	48.9	55.5	44.2	48.9

The regional breakdown thereof can be found in Figure-39,onece referred to in the preceding paragraph, together with the development volume.

S5. SURFACE WATER DEVELOPMENT PLAN FOR MAJOR RIVER BASINS

S5.1 Water Balance in Each Water Resources Region

The future water demands were projected by water resources region and by sectoral water use for the period up to the target year 2025 at 5 year intervals. The attached Table-07 presents such projected water demands for the target year of 2025. The projected water demands in the year 2025, of which the principal demand is diversion requirements of irrigation with the assumed crop intensities, were compared with the respective water resources potentials to examine the water demand and supply balances preliminarily. In this simple examination, the water resources potentials are assumed to be the sum of the potentials of groundwater and surface water estimated on the condition that the maximum available discharge is a daily discharge with 50 % dependability. The following table shows the results of the examination:

Water Balance by Water Resources Region

WRR No.	Total Water Resource Potentials (Dependability of Surface Water: 50%) (1)	Water Demand in 2025		Ratio of Potential to Demand	
		Case-1 (2)	Case-2 (3)	Case-1 =(1) / (2)	Case-2 =(1) / (3)
I	11,348	3,041	2,874	3.78	3.95
II	19,625	12,466	7,618	1.57	2.58
III	12,521	18,168	14,618	0.69	0.86
IV	21,110	10,052	7,368	2.10	2.87
V	11,045	4,167	2,841	2.65	3.89
VI	20,644	7,595	6,206	2.72	3.33
VII	4,649	2,729	2,226	1.70	2.09
VIII	18,457	1,956	1,644	9.44	11.22
IX	17,282	4,598	3,616	3.76	4.78
X	44,216	3,682	2,253	12.01	19.63
XI	18,675	4,141	2,390	4.51	7.81
XII	26,858	12,806	6,946	2.10	3.87

Note: Case-1; High economic growth scenario
Case-2; Low economic growth scenario

As seen in Table-7, the agricultural water demand is still dominant out of the total water demand in 2025 for every water resources region, except for the WRR IV where the municipal and industrial (M&I) water demands in Metro Manila occupy the relatively large part of the total water demand in the WRR IV. As far as the municipal and industrial water demands are concerned, it appears that the M&I water demand can be met under the present condition without provision of new large scale storage type dams, except for specific cities such as Metro Manila and Metro Cebu whose water demands are projected to largely expand in the future.

It is assessed through the comparison of the water resources potential and water demand in 2025 that the four water resources regions, WRR II, III, IV and VII, are more critical than the other regions as indicated by ratios of the potentials to the demands. Thus, it is

foreseen that more critical water deficit in the target year 2025 would come out in the water resources regions II, III and IV which are all situated in Luzon island. The most critical water deficit is projected to take place only in the water resources region III until the target year 2025. For the time being, on the other hand, some large-scale storage type projects for water resources region III are under construction or going to be implemented in the near feature. These are the Casecnan Transbasin project and San Rouqe multi-purpose dam project. It is expected that the future water deficit in the WRR III would be mitigated a lot after the completion of these storage type projects. Furthermore, the Pampanga river whose streamflow is to be augmented by the Casecnan Transbasin project could be one of the sources to meet the future municipal and industrial water demands in Metro Manila located in the WRR IV.

S5.2 Surface Water Resources Development Plans for Major River Basins Towards Year 2025

The water demand and supply balance studies for each of the major river basins were carried out applying those future water demands and the estimated present water availability in order to study the necessity of the water resources development to meet the surface water demand up to the target year 2025. In the Study, the data on the existing and proposed storage type dam projects were gathered mainly from NPC and NIA as the candidates for the water resources development. The Study proposed new storage type dams identified based on 1 to 50,000 scaled topographic maps if no appropriate dam is proposed by the previous study. The Study lined up a total of seventy-three (73) storage type dams inclusive of the existing 5 large-scale dams as listed in Table-8.

The necessity of water resources development projects to meet the water demand until the year 2025 was assessed under the following conditions:

i) The projected water demands under the higher economic growth scenario should be sufficed.

ii) The proposed BOT projects could complete the tasks on schedule.

The reservoir operation study was carried out applying the mean 10-day runoff data of the 5-year droughty year, since irrigation water demand accounts for a dominant part of the projected total water demand in the high economic growth scenario. Consequently, it is foreseen that the following major river basins would be subject to the water shortage for the period until the year 2025 in case of the high economic growth, if no water resources development is undertaken:

Major River Basins Likely to Cause Water-Constraint until Year 2025

No.	Major River Basin	Water Resources Region (WRR)	Location (Group of Islands)
1	Laoag	WRR I	Luzon
2	Abra	WRR I	Luzon
3	Cagayan	WRR II	Luzon
4	Abulug	WRR II	Luzon
5	Agno	WRR III	Luzon
6	Pampanga	WRR III	Luzon
7	Amnay-Patric	WRR IV	Luzon
8	Bicol	WRR V	Luzon
9	Panay	WRR VI	Visayas
10	Jalur	WRR VI	Visayas
11	Ilog-Hilabangan	WRR VI	Visayas
12	Tagoloan	WRR X	Visayas
13	Cagayan De Oro	WRR IX	Mindanao
14	Tagum Libugannon	WRR XI	Mindanao
15	Davao	WRR XI	Mindanao
16	Buayan-Malungon	WRR XII	Mindanao
17	Mindanao	WRR XII	Mindanao

As listed above, a total of seventeen (17) major river basins would require new surface water resources development in addition to the existing large scale dams and on-going and committed BOT projects in order to meet the water demands until the year 2025. Out of these 17 major river basins, the major river basins in Luzon Island would face to the serious water shortage until the year 2025.

With regard to each of these 17 major river basins, the priority projects are selected from those listed up in Table-8 in order to meet the future water demand. In this selection, following principles were used:

- The first priority is given to the impounding dam scheme which NPC and/or NIA propose to implement at an early stage,

- The impounding schemes on which higher level of study were carried out are given higher priority on implementation, as long as it is verified to be technically and economically feasible in the previous study. This implies that the impounding schemes are lined up in the development plan for the water-constraint major river basin in order of their study levels, namely definite design, feasibility study, pre-feasibility study and map study,

- The impounding schemes that are not likely to have the significant adverse effects on natural and social environments, are given higher priorities.

The selected priority projects are listed bellows:

List of Proposed Impounding Dam Projects for Major River Basins

No.	Major River Basin	Water Resources Region (WRR)	Priority Reservoir Type Projects to be Implemented up to Year 2025	
			Nos. of Priority Projects	Name of Priority Projects
1	Laoag	WRR I	2	Palsiguan-Nueva Multi-Purpose Dam Project Tina-Gasgas-Cura Multi-Purpose Dam Project
2	Abra	WRR I	1	Binongan Multi-Purpose Dam Project
3	Cagayan	WRR II	4	Mallig II Multi-Purpose Dam Project Matuno Multi-Purpose Dam Project Addalam A Hydroelectric Project Ilaguen B Hydroelectric Project
4	Abulug	WRR II	1	Agulubu Hydroelectric Project
5	Agno	WRR III	1	Balog-Balog Multi-Purpose Dam Project
6	Pampanga	WRR III	2	Balintingon Multi-Purpose Dam Project Bayabas and Massin Dam Project
7	Amnay-Patric	WRR IV	1	Amnay Multi-Purpose Dam Project
8	Bicol	WRR V	1	Talisay Multi-Purpose Dam Project
9	Panay	WRR VI	1	Panay Multi-Purpose Dam Project
10	Jalaur	WRR VI	1	Jalaur Multi-Purpose Dam Project
11	Ilog-Hilabangan	WRR VI	1	Ilog No.1 Multi-Purpose Dam Project
12	Tagoloan	WRR X	1	Tagoloan Multi-Purpose Dam Project
13	Cagayan De Oro	WRR X	1	Bulang-Batang Hydroelectric Project
14	Tagum-Libuganon	WRR XI	1	Buhonao Multi-Purpose Dam Project
15	Davao	WRR XI	1	Davao II Multi-Purpose Dam Project
16	Buayan-Malungun	WRR XI	1	Dimloc Multi-Purpose Dam Project
17	Mindanao	WRR XII	1	Pulangi Multi-Purpose Dam Project
Total			22	

Note : Two SWIM projects are proposed in the previous study.

The locations of the proposed impounding dam projects for each of the 17 major river basins are shown in Figure-41 to Figure-51. The implementation schedule of the proposed impounding dam projects are depicted in Figure-52 to Figure-71.

The disbursement schedule of the present-day construction cost for the 22 storage type dam projects selected in the foregoing Subsection 5.4.1 at 5-year intervals are tabulated below for the period until the year 2025:

Present-Day Cost for Development of Storage Type Dams

(Unit: Million US$ per 5 years)

Year	2000	2005	2010	2015	2020	2025
Present-Day Cost	383	3,077	714	445	1,602	389

S6. SURFACE WATER RESOURCES DEVELOPMENT PLANS FOR SELECTED MAJOR CITIES

S6.1 Selection of Water-Constraint Major City

Water demand and supply can be balanced for each region and each major river basin through the provisions of water resources development schemes discussed in the previous Section. However, the constraint in water demand and supply balance in a confined area may not emerge in these general study. Nation-wide master plan should take care such local balances as well if they are significant in terms of national economic development or regional or basin-wide water balance. Along this line, some cities, where significant water constraints are likely to take place, were selected to study the measure to remedy the constraints. The following factors were adopted to select the cities:

i) Present groundwater extraction volume
ii) Type of water sources utilized
iii) Population
iv) Population density
v) Ratio of groundwater potential to the present water demand
vi) Ratio of groundwater potential to future water demand in 2025

Each factor has different effect on the water demand and supply balance in the relevant area and the rating standards were set up so as to reflect the significance of the effect on the constraint as shown in Table-9. The rating standards evaluate the significance in terms of points. The total point given by the evaluations of all factors indicates the seriousness of the water constraint of the city. The results of the evaluation are shown in Table-10 which lists the cities in order of the scored total points. The following nine (9) cities and municipalities were selected as the cities with anticipated serious water constraints that should be remedied:

i) Metro Manila
ii) Metro Cebu
iii) Davao City
iv) Baguio City
v) Angeles City
vi) Bacolod City
vii) Iloilo City
viii) Cagayan De Oro City
ix) Zamboanga City

S6.2 Water Demand Forecast for Selected 9 Major Cities

The water demand projections for the nine cities selected above was carried out dividing the demand into two sectoral demands, namely the municipal and industrial demands.

In the estimation of municipal water demand, population served and water demand component for each water use sector were determined with reference mainly to the

collected data from the relevant water districts. While, the unit water consumption and non-revenue water ratio were determined based on the design criteria of LWUA.

The projected water demand for the selected 9 cities are shown in Table-11 and summarized below:

Water Demand for Selected 9 Major Cities

Year	Metro Manila	Metro Cebu	Davao City	Baguio City	Angeles City	Bacolod City	Iloilo City	Cagayan De Oro City	Zamboanga City
(1) Water Demand in 1995 (MCM)	1,068	59	50	12	11	37	9	29	28
(2) Water Demand in 2025 (MCM)	2,883	342	153	87	31	111	47	98	203
Ratio ((2)/(1))	2.7	5.8	3.1	7.3	2.8	3.0	5.2	3.4	7.3

The projected water demands of the major cities in 2025 are to increase to 2 to 3 times of those in 1995, except for Metro Cebu, Baguio, Iloilo and Zamboanga cities in which a higher increase in water demand is expected to take place until 2025 because of the high increase in population and service coverage ratio of the public water supply system. In addition, a considerable growth of industrial water demand is projected in Zamboanga City.

S6.3 Estimate of Exploitable Groundwater Amount

Groundwater has been the substantial source of municipal water supply. The tendency may stand in the future municipal water supply until the exploitation of groundwater reaches to the limit. The exploitable groundwater amounts were estimated based on the data and information collected during the field investigation. The procedures and methodologies applied to the estimate are explained in detail in Part-C of the Supporting Report. Concerning the major cities for which the detailed analysis on groundwater potentials was carried out in the previous studies, the exploitable groundwater amounts estimated therein are adopted in the Study. These are Metro Manila, Metro Cebu, Metro Iloilo and Davao City.

The exploitable groundwater amounts of the other cities were estimated by means of the different two methods. One is to estimate the amount on the basis of the estimated flow in the aquifer in case that the hydrogeological data such as the transmissivity values of existing wells are available. The other is to estimate the amount from annual rainfall assuming the recharge ratio thereto and the area of aquifer, provided that there are no more available data. In this respect, 5% of the precipitation on the aquifer area is adopted as the exploitable recharge. The adopted figure is equivalent to the assumed exploitable depth of 150 mm per annum assuming the annual rainfall depth of 3,000 mm. Consequently, the

exploitable groundwater amounts for the selected major cities were derived as follows:

Exploitable Groundwater for Selected Major Cities

(Unit: MCM/year)

Metro Manila	Metro Cebu	Davao City	Baguio City	Angeles City	Bacolod City	Iloilo City	Cagayan City	Zamboanga City
191.0	60.1	84.4	14.5	137.3	103.3	79.9	34.3	53.8

S6.4 Surface Water Resources Development Plan for Water-Constraint Major Cities

The future water resources development for the nine cities are summarized below.

(1) Metro Manila

Metro Manila suffers from the consecutive water shortage especially in the dry season. To improve the situation, the Umiray-Angat Transbasin Project is now under construction by MWSS. After that, MWSS is planning to implement the Laguna lake and Manila Water supply Project III (MWSP III).

Since it is pointed out in the previous studies that the water quality of the Laguna lake is poor and that the Laiban dam site and its reservoir area are composed of the limestone, presumably causing the water leakage problem after completion of the Laiban dam, the following alternative projects were worked out:

i) Kaliwa-Kanan Transbain Project
ii) Kanan-Umilay Transbasin Project
iii) Massim and Bayabas Dam Project
iv) Pampanga-Novaliches Water Supply Project
v) Kaliwa-Cogeo Water Supply Project

The location of these projects is shown in Figure-72. The three development scenarios were set up by combining those water supply projects as shown in Figure-73 to Figure-75. All the proposed development scenarios largely rely on the water resources of the Kaliwa and Kanan rivers, the tributaries of the Agos river. The rainy season of the Kanan river is much different from that of the Angat basin. Therefore, the development of water resource of the Kanan river for water supply to Metro Manila has an advantage over the development of other resources located in the similar climatic zone to the Angat basin. A series of several small-scale development like the Laguna lake development affords the plan with the flexibility to adapt to the economic fluctuation, although the efficiency of investment is necessarily not high. The water conveyance plan of the Kanan river to Angat reservoir lays out the main facilities in a linear series. The reliability of the system against the physical risks is lower than the plan that contemplates the other water conveyance route such as the Kanan-Kaliwa conveyance system. These three scenarios are characterized as follows:

Scenario I The scenario has a rather high flexibility to the economic change, but has a possibility to encounter a water quality problem and geologic problem in case of the Laguna lake and Laiban dam, respectively. The reliability of the system is high because the water tapped from the Kanan river is conveyed to Manila through a new southern route. The investment cost may become large because of construction of new facilities for the water conveyance and treatment.

Scenario II The reliability of the system is high because the water sources are diversified to multiple ones such as Angat dam, and the Kanan and Kaliwa rivers. With regard to the Pampanga water conveyance project, there is a possibility that a water quality problem takes place, and the high OMR cost is foreseeable. The investment may become large because of large-scale construction works.

Scenario III The adaptability to the economic fluctuation is highest because many medium-scale alternative schemes are proposed to form the scenario such as Maasim and Bayabas dams and Kaliwa weir. Those schemes allow developing water resources in stages in harmony with the increase in water demand.

(2) Metro Cebu

The Metro Cebu Water District is planning to implement the following projects in order to meet the future water demand:

- Mananga Phase II dam
- Bohol-Cebu Water Supply Project
- Desalination of sea water

The Study identified and proposed the following alternative development plans in which the comparatively large river basins are effectively developed for the purpose of municipal water supply to Metro Cebu:

- Malubog-Mananga Transbain Project (MMTP)
- Lusaran-Pulambato Transbasin Project (LPTP)

The location of those projects is shown in Figure-76. The three alternative development scenarios were set up by combining those water supply projects as shown in Figure-77 through Figure-79. A large scale water conveyance scheme such as Bohol-Cebu water conveyance scheme is indispensable to meet the water demand in the year 2025 completely, unless desalination plants are introduced. These three scenarios are characterized as follows:

Scenario I The scenario includes the Bohol-Cebu water supply project linking the two islands. The environmental and social impacts to be caused by construction of the proposed Tipolo in the Bohol island might be significant issues. The provision of submarine water conveyance pipe requires special technologies for design, construction and maintenance. The large-scale development may deprive the plan of the flexibility to adapt to the national and regional economic fluctuation.

Scenario II The concept of the scenario is the same with scenario I. The plan, however, looks for the surface water resources within Cebu island as much as possible.

Scenario III Desalination of sea water is introduced instead of surface water resource development in order not to rely on that of the other islands. The capacities of the desalination plants can be extended in accordance with the projected increase in water demand, and thereby the adaptability to the economic fluctuation may be secured. Water supply will not be affected by the climatic condition. However, a considerable amount of operation cost would be incurred due to the energy consumption.

(3) Baguio City

The Study identified the following two projects to develop water resources to supply water to Baguio city:

-Laboy Dam Project
-Laboy Weir and Ponds Project

The conceivable main water sources for meeting the future water demand are the Laboy river and Ambuklao dam. The necessary pumping-up of water might incur a considerable amount of operation cost for any alternative. These two scenarios are characterized as follows:

Scenario I The main water source is the Laboy river through the proposed Laboy dam. The necessary water lifting is about 700m. Sand flashing from the proposed Laboy reservoir may be the significant technical issue.

Scenario II The main water sources is two; the Laboy river through the proposed Laboy weir and Ambuklao reservoir. The water tapped from the reservoir is to once lifted for 200 to the proposed Laboy weir site and lifted again for 700m to Baguio city togetherwith the water withdrawn from the Laboy river. The plan may be developed in two stages in accordance with the projected increase in water demand; first, Laboy weir and water lifting facilities to Baguio city, and then water tapping facility from Ambuklao reservoir.

The locations of those projects are shown in Figure-80 and the development scenarios for Baguio City are illustrated in Figure-81 and Figure-82.

(4) Other six cities

The results of the estimation of exploitable groundwater indicate that the exploitable groundwater amounts in Angeles, Iloilo and Bacolod Cities exceed the water demands in the year 2025. On the contrary, the projected municipal water demands of Davao, Cagayan De Oro and Zamboanga exceed the estimated exploitable amounts and it is anticipated that the new surface water developments will become necessary in order to meet the water demand before the year 2025. Out of these three cities, the water districts of Davao and Cagayan De Oro Cities are planning to develop the water resources in a form of BOT. For Zamboanga city, the Study proposed the construction of Pasonaka dam. Besides, a multi-purpose dam was proposed to meet the each water demand for Davao city and Bacolod city as an alternative plan to the contemplated BOT scheme and groundwater development plan. These alternative plans might be developed as multi-purpose dams. The locations of storage type dams identified on the Davao River are shown in Figure-83.

The development scenarios for those six cities are shown in Figure-84 to Figure-91.

S6.5 Preliminary Economic and Environmental Evaluation for Priority Schemes

(1) Economic Evaluation

In the Study, the economic evaluation was carried out for the proposed water supply projects for the three major cities, Metro Manila, Metro Cebu and Baguio City, for which the preliminary design and cost estimate were carried out. The proposed main project features are summarized in Table-12 to Table-14 and their construction costs are summarized in Table-15.

On the other hand, the benefit to be accrued from the water supply was estimated applying the following values corresponding to the weighted affordability to pay at a price level of July 1997, which were estimated based on the present water tariff and average income per family:

- Metro Manila : 8.2 Peso/m^3 (0.296 US$/$m^3$)
- Metro Cebu : 15.9 Peso/m^3 (0.575 US$/$m^3$)
- Baguio City : 13.5 Peso/m^3 (0.488 US$/$m^3$)

In estimating the benefit accrued from hydropower generation, a hypothetical diesel plant is selected as the most competitive alternative thermal plant to hydropower plant. Based on the data gathered from NPC on the construction and O&M costs of diesel power plant, the kW and kWh values were determined to be 1,098.2 US$/kW and 0.0403 US$/kWh, respectively. The economic evaluation was carried out for each of the newly proposed projects with these procedures and assumptions. The derived internal rate of returns are

summarized below.

(2) Environmental Impact and Preliminary Assessment

The environmental impacts to be incurred by the implementation of those projects were preliminarily evaluated as shown in Table-16.

The following table presents the preliminary evaluation results of the proposed alternative water supply projects from the environmental viewpoints together with their internal rate of returns (EIRR) estimated above:

Results of Preliminary Evaluation of Water Supply Projects

No.	Major City	Name of Project	EIRR (%)	Item of Significant Environment Impact which may occur due to the implementation
1.	Metro Manila	Kanan-Umilay Transbasin	19.7	B & C
2.	Metro Manila	Massim and Bayabas Dam	14.9	B & D
3.	Metro Manila	Kaliwa-Cogeo Water Supply	13.4	None
4.	Metro Manila	Pampanga-Novaliches Water Supply	8.2	None
5.	Metro Cebu	Malubog-Mananga Transbasin	12.9	D
6.	Metro Cebu	Lusaran-Pulanbato Transbasin	12.5	D
7.	Metro Cebu	Bohol-Cebu Water Supply	11.1	A & B
8.	Baguio City	Laboy Dam	10.7	None
9.	Baguio City	Laboy Weir and Ponds	3.6	None

Note: Environmental impact items;
- A: Inundation of agricultural land
- B: Resettlement of inhabitant
- C: NIPAS protected area
- D: Mineral deposits or water quality
- E: Endangered rare species

As for the Metro Manila water supply, the Kanan-Umilay transbasin and Massim & Bayabas Dam Projects shows the relatively higher EIRR values as compared with ones of others, although these are associated with some environmental impacts which need to be clarified in the subsequent study stage. All three water supply projects for Metro Cebu are competitive with each other in terms of the EIRR value. On the other hand, it is noted that the IRR values of the water supply projects for Baguio City become smaller in comparison of those for other cities due to the high operation and maintenance cost, which might be incurred by mainly the high electricity cost required for the lifting water by operating pumps.