社会開発調査部報告書

No. 5

JAPAN INTERNATIONAL COOPERATION AGENCY

THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
MINISTRY OF DEVELOPMENT

THE STUDY
ON
INTEGRATED WATER RESOURCES DEVELOPMENT AND MANAGEMENT MASTER PLAN
IN
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA

FINAL REPORT

VOLUME II
EXECUTIVE SUMMARY

MAY 1999

NIPPON KOEI CO., LTD.
IN ASSOCIATION WITH
INTERNATIONAL COOPERATION

JAPAN INTERNATIONAL COOPERATION AGENCY

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THE STUDY
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COMPOSITION OF FINAL REPORT

EXCHANGE RATES

The exchange rates used in this Study are:
US Dollar (US$)1.00 = Macedonian Denar (MKD) 52.00
Deutsche Mark (DM) 1.00 = Macedonian Denar (MKD) 30.98
as of Jan.1999

PREFACE

In response to the request from the Government of the Former Yugoslav Republic of Macedonia, the Government of Japan decided to conduct the Study on the Integrated Water Resources Development and Management Master Plan in the former Yugoslav Republic of Macedonia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Kazuharu Hashimoto of Nippon Koei Co., Ltd., and composed of staff members of Nippon Koei Co., Ltd. and KRI International Corporation to Macedonia, four times between December 1997 and May 1999. In addition, JICA set up an advisory committee headed by Mr. Yoshiyuki Kawakami, Senior officer, Reservoir Area Development Measures Section, Development Division, River Bureau, Ministry of Construction between December 1997 and March 1999, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Macedonia, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Macedonia for their close cooperation extended to the study.

May, 1999

Kimio Fujita
President
Japan International
Cooperation Agency

May 1999

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

Dear Sir,

Letter of Transmittal

We are pleased to submit to you the Final Report on Integrated Water Resources Development and Management Master Plan in the Former Yugoslav Republic of Macedonia (FYROM). This Report presents the results of all the works performed in both Macedonia and Japan during a total period of 18 months from December 1997 to May 1999.

The Master Plan, formulated on the purpose of giving the comprehensive scope of effective and sustainable development in FYROM setting the target year 2025 consists of the two components. The water resources development plan proposes the development strategy and projects as well as rehabilitation projects. The water resources management plan proposes reinforcement and establishment of an efficient and effective management system for not only the development projects but also commissioned projects to bring out the best of the projects effects.

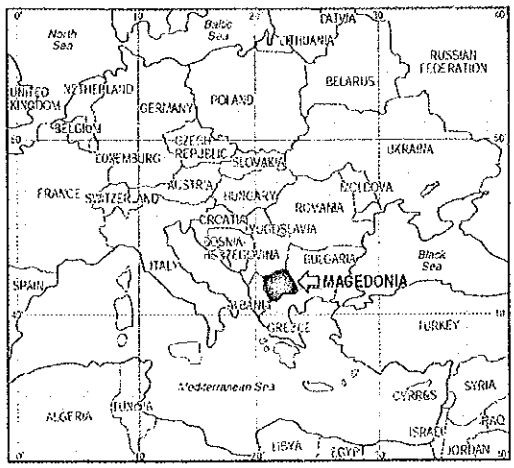
We are confident that the Master Plan will contribute to the integrated approach with environmental aspects required for dealing with water-related problems now being faced and for the optimum utilization of the limited water resources in Macedonia. Hence, we recommend to promote the Master Plan as early as possible.

We wish to take this opportunity to express sincere gratitude to your Agency and the Advisory Committee for the Study. We also wish to express our deep gratitude to the Government of Macedonia, the Embassy of Japan in Vienna, the JICA Austria Office for close cooperation and assistance extended to our Team during field investigations and studies in Macedonia.

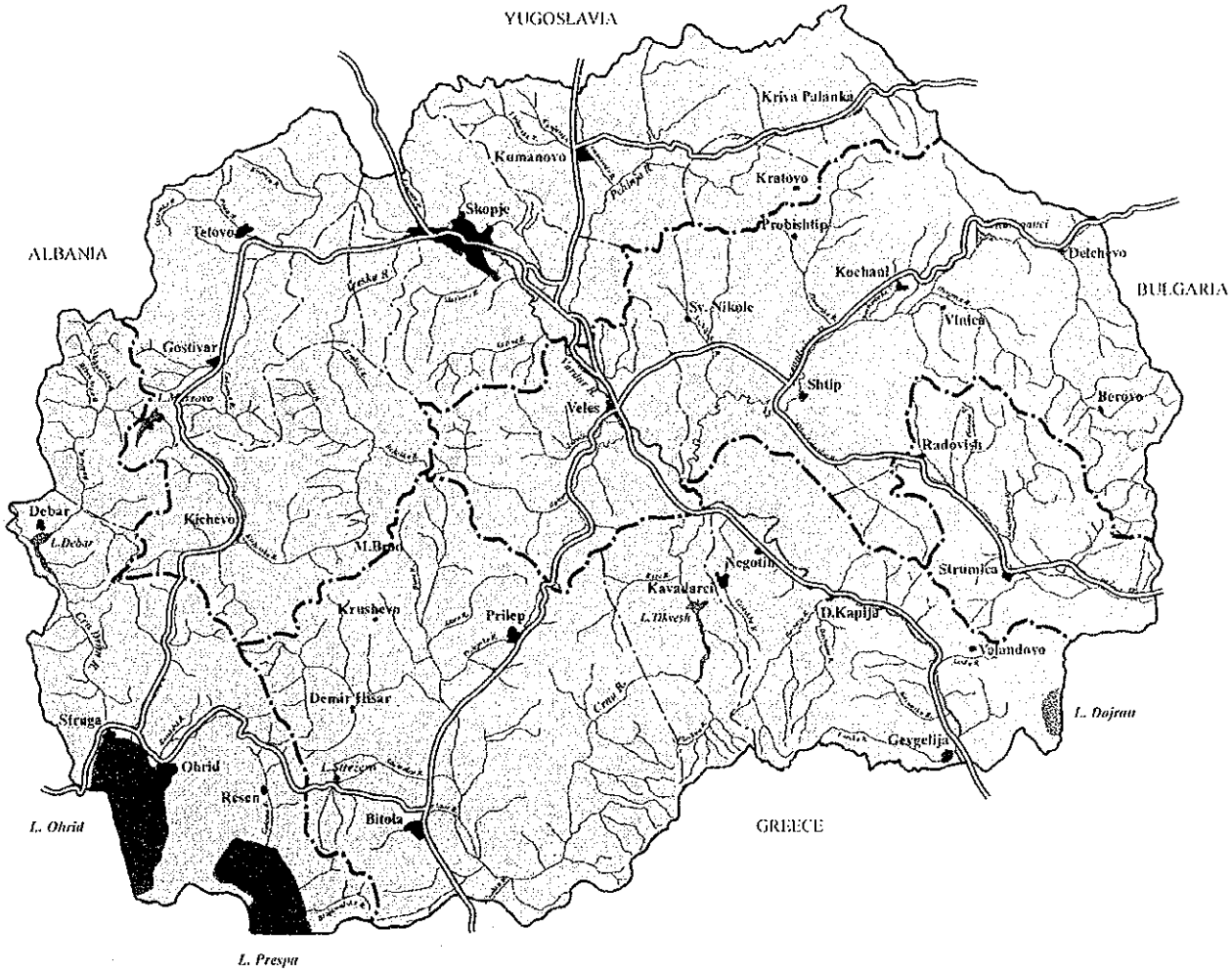
Very truly yours,

K. Hashimoto

Kazuharu HASHIMOTO
Team Leader
Study on Integrated Water
Resources Development and
Management M/P in FYROM



KEY MAP



SCALE

0 10 20 30 40 50 km

Location Map

OUTLINE OF THE STUDY

1. Purpose of the Study

The Former Yugoslav Republic of Macedonia (FYROM), which is located in the central part of Balkan Peninsular, has limited rainfall ranging from 400 to 1,000 mm per annum with a rather high difference among each region. In the 10 years from the end of the 1980s to 1990s, people experienced droughts almost every year, facing seasonal water shortage of drinking water in the urban areas and also in rural areas where there are problems of poor hygiene. Rather high occurrence of waterborne diseases among infants and schoolchildren in the communities indicates that the water sources have been polluted by untreated municipal water and no guideline for safety standards has been established, and so on. Population living in the mountain and border areas suffer from poor accessibility to safe drinking water.

Furthermore, the three major rivers of the Vardar, Crn Drim and Strumica in the country are international rivers flowing down to the neighboring countries. Harmony with environment is essential in implementing development projects in Macedonia, and it is also important to take countermeasures for reduction of pollutant load which will be increased with development projects and influenced to three countries located downstream of Macedonia. Consequently, establishment of water resources management system considering harmony with environment is urgently required to keep good diplomatic relations with these neighboring countries.

Under these circumstances, the Study on Integrated Water Resources Development and Management Master Plan in the Former Yugoslav Republic of Macedonia has been carried with the following two objectives:

1) To formulate an integrated water resources development and management master plan for the target year 2025 in the whole area of FYROM, and

2) To transfer technology to the counterpart personnel in the course of the Study

2. Basic Courses of the Study

The Study was carried out, being divided into two phases. In the first half, Phase 1 from December 1997 to September 1998, basic investigations, water demand projection, study on water resources development potential, and so on were carried out to clarify the issues on water resources development and management and to evaluate water resources development potential. In parallel with the above, the socioeconomic frame was formed, and balance between water supply and demand in the future was studied based on water demand projection. In the

second half, Phase 2 from September 1998 to May 1999, the Master Plan on the integrated water resources development and management was formulated based on the fruits in Phase 1 as well as for the targets set in the Study.

Some of the field investigations were carried out on a subcontract basis.

To transfer technology to the counterpart personnel was carried out through seminars held at the end of both phases and through a training courses in Japan.

3. Socioeconomic Frame

The socioeconomic frame, which provides the population projection and the development scenarios for agricultural, industrial and tourism sectors, was formed through downward revision of the development target given by the National Development Strategy with the agreement of Macedonian side as follows:

1) Population : 1,974,000 (1996) to 2,304,000 (2025)

2) GDP per capita : .US$1,580 (1996) to US$4,000 (2025)

3) Average growth rate during 1998 – 2025
   - Per capita GDP : 3 – 4 %
   - Industry sector : 4 – 5 %
   - Agricultural sector : 5 – 6 %

4. Basic Concept of The Master Plan

1) Guidelines for Formulation

The Master Plan, covering the entire the country, has the objectives improvement of the living environment, activation of activities in the economic sector, satisfying Basic Human Needs (BHN), and alleviation of the regional disparity through realization of effective and efficient development and management of the water resources. In addition, the Master Plan aims at establishment of a sustainable development and management system with basic concept of respecting environment conservation and effective use of water resources, considering negative environment impacts which are expected to increase with the development progress.

The Master Plan consists of two components; a water resources development plan, and a water resources management plan. The final target was set as the year 2025. The 27-year period from 1999 to 2025 was divided into the three phases; (1) PHASE I from 1999 to 2005, (2) PHASE II from 2006 to 2015, and (3) PHASE III from 2016 to 2025.

2) Outline of Water Development Plan

The water resources development plan proposes the development strategy for the facility construction and rehabilitation as well as the development projects allocated into the three phases with dividing the country into five regions of (1) the Vardar River Upper Reach, (2) the Vardar River Middle Reach, (3) the Vardar River Lower Reach, (4) the Crn Drim River basin, and (5) the Strumica River basin.

For identification and selection of development projects, the development directions were set by regions, and the development curves by regions and by water use were prepared taking development needs and environmental issues by regions into consideration.

Selected projects were tentatively divided into phases, and final prioritization of the projects were carried out based on the project evaluation, which results were duly incorporated in the action plans.

Number of the development projects are summarized below by regions and by phases:

Number of the Development Projects by Regions and by Phases

Region/Basin	PHASE I	PHASE II	PHASE III	Total
1. Vardar River Upper Reach (including the Treska and Pchinija)	7	6	2	15
2. Vardar River Middle Reach (including the Bregalnica)	1	4	1	6
3. Vardar River Lower Reach (including the Crna)	2	4	7	13
4. Crn Drim River	1	2	–	3
5. Strumica	1	2	1	4
Total	12	18	11	41

(In addition to the above, a nationwide rural water supply extension/improvement project is proposed in PHASE III)

3) Outline of Water Management Plan

The water management plan consists of six plans: (1) Water quality conservation plan, (2) Watershed conservation plan, (3) Surface water and groundwater monitoring Improvement plan, (4) Water-related facilities operation and maintenance Improvement plan, (5) Institutions and legal system strengthening plan, and (6) Human resources development plan.

The water quality conservation plan provides the environment conservation plan to deal with the development strategy and development projects which are proposed for each region by the development plan. Other plans included in the management plan are proposed to realize an efficient and effective management system.

5. Project Evaluation

The selected projects were evaluated from the six aspects: the economic, financial, technical, social, and institutional aspect as well as the project priority previously given by the Macedonian side through PIP. Then, the comprehensive evaluation was conducted to understand the general trends.

Major indicators for the economic and financial aspects are each of internal rate of return. The indicator for the technical aspect is difficulty of technique to be adopted in construction considering the balance between present techniques in Macedonia and techniques required for construction. Those for institutional aspect are current organization, reinforcement, new organization, combination of organization, expected improvement effect with implementation in institutional rearrangement. Those for social aspect are social contribution, satisfaction of development needs, satisfaction of BHN for the rural water supply projects in particular. That for the project priority in Macedonia is position of projects if listed up in PIP. The selected projects were tentatively prioritized based on the results of the comprehensive evaluation.

The tentative prioritization was reviewed, considering the results of IEE (Initial Environmental Examination: Necessity of further environmental impact study in implementation of the projects was examined), consistency with the output from the PCM workshop, further referring to the water quality/watershed conservation plans to harmonized with the environment for sustainable water resources development. The phasing of the development projects in the development plan was determined finally, and duly incorporated in the action plan for PHASE I.

6. The Master Plan

The Master Plan proposes 42 development projects (See Figure S-1).

The following are 12 projects for the PHASE I (1999 to 2005) (See Figure S-2):

Projects Proposed in PHASE I

River Basin	Project	Purpose	Cost (10^6xUS$)
1. Vardar River Upper Reach	1) Water Supply Project for Tetovo – River Pena Intake	M&I	3.2
	2) Kichevsko Pole Area Irrigation Rehabilitation Project	RI	2.9
	3) Patishka Reka Water Supply Project	M	3.2
	4) Slupchanka Dam Project	M	7.3
	5) Treska River Upper Reach Rural Water Supply Project	RS	19.3
	6) Skopje Circle Rural Water Supply Project	RS	21.3
	7) Kriva Palanka/Kumanovo Circle Rural Water Supply Project	RS	29.3
2. Vardar River Middle Reach	1) Zletovica Multipurpose Dam Project,Phase I	M&I	68.2
3. Vardar River Lower Reach	1) Valandovo Area Irrigation Rehabilitation Project	RI	7.3
	2) Pelagonija Circle Rural Water Supply Project	RS	35.4
4. Crn Drim River	1) Irrigation System Betterment Project in Resen	RI	7.0

5. Strumica River	1) Oraovica Dam Project	M&E	21.7
Total			226.1

(M : Municipal Water, I : Industrial Water, RI : Irrigation Rehabilitation, RS : Rural Water Supply, E : Environmental Water)

Of them, a feasibility study (F/S) and/or basic design (B/D) were finished except for estimation of internal rates of return to indicate economic and financial viability for the Patishka Reka water supply project and Irrigation system betterment project in Resen. It has passed some time since such study and design, and therefore it is proposed to review and update them and to estimate the internal rates of return for the next step as soon as possible.

The feasibility study and detailed design of the Zletovica multipurpose dam project were finished by 1996, and the works started partly. Some review and updating of the design by 1996 will be required.

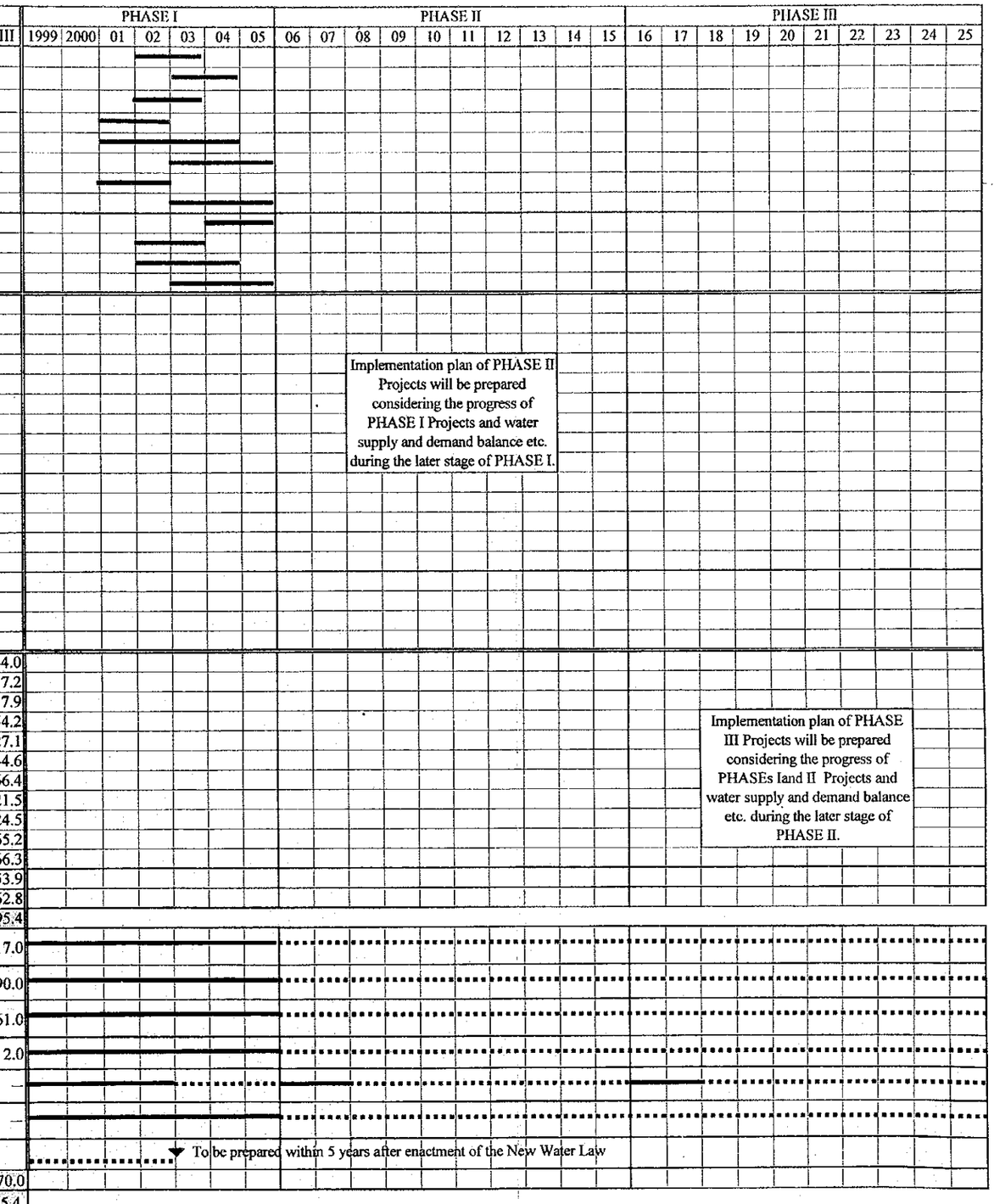
For other projects than the above three, it is proposed to carry out further study on the feasibility level and to estimate the internal rates of return for the next steps as soon as possible.

The investment cost and internal rates of return in the Master Plan have been estimated based on general figures, maps, references and data obtained through formulation of the Master Plan.

The investment cost required for PHASE I is estimated at 226.1 million US$ (averaged at 45 (=226.1/5) million US$ per a year), summing up the annual investment costs of 5 years from 2001 (20.8 million US$) to 2005 (29.5 million US$). In the meanwhile, the public investment relating to water supply and irrigation was about 20 million US$ among the national budget of 750 million US$ in 1996, and about 16.5 million US$ was provided annually on an average according to a report of ACU, resulting in 36.5 (=20+16.5) million US$ per a year combining those for public investment for the water supply and irrigation. That means further 8.5 (=45-36.5) million US$ per a year will be required, being compared with the current annual investment, in case implementation of the projects as proposed in PHASE I.

To deal with this, it is strongly recommended in the early time to carry out further investigation and study on the feasibility level and to estimate the investment cost and internal rates of return of each project with a certain accuracy so as to formulate a fund raising plan incorporating the fund sources of the projects of foreign currency (aids), domestic currency (local budget), BOT/PFI, and so on.

	Project Name	Purpose	Project Cost (US$mil.) PHASE I	PHASE II	PHASE III
Water Resources Development Plan	1. Water Supply Project for Tetovo - River Pena Intake	M & I	3.2		
	2. Kichevsko Polc Area Irrigation Rehabilitation Project	RI	2.9		
	3. Patishka Reka Water Supply Project	M	3.2		
	4. Slupchanka Dam Project	M	7.3		
	5. Zletovica Multipurpose Dam Project (Phase I)	M & I	68.2		
	6. Valandovo Area Irrigation Rehabilitation Project	RI	7.3		
	7. Irrigtion System Betterment Project in Resen	RI	7.0		
	8. Oraovica Dam Project	M & E	21.7		
	34. Treska River Upper Reach Rural Water Supply Project	RS	19.3		
	35. Skopje Circle Rural Water Supply Project	RS	21.3		
	36. Kriva Palanka/Kumanovo Circle Rural Water Supply Project	RS	29.3		
	37. Pelagonija Circle Rural Water Supply Project	RS	35.4		
	9. Studena Voda Groundwater Development Project	M		1.0	
	10. Paligrad Multipurpose Dam Project	M & I, A, P		48.1	
	11. Lipkovo-Glaznja Area Irrigation Rehabilitation Project	RI		21.6	
	12. Kiselichka Dam Project	M & I, A		46.4	
	13. Vakuf Multipurpose Dam Project	M & I, A, P		164.3	
	14. Razlovci Dam Project	M & I, A		42.3	
	15. Rechani Multipurpose Dam Project	M & I, P		50.3	
	16. Construction of Irrigation Sub-system "Shtipsko Pole", left side	A		13.9	
	17. Studencica Supplemental Water Supply Project	M & I		2.5	
	18. Kovanska Dam Project	A		31.9	
	19. Konsko Dam Project	M & I, A		66.1	
	20. Ohrid Area Irrigation Rehabilitation Project	RI		8.2	
	21. Mantovo Area Irrigation Rehabilitation Project	RI		11.2	
	22. Strumica Area Irrigation Rehabilitation Project	RI		24.4	
	38. Vardar River Upper Reach Rural Water Supply Project	RS		15.6	
	39. Bregalnica River Basin Rural Water Supply Project	RS		29.8	
	40. Vardar River Lower Reach/Strumica River Basin Rural Water Supply Project	RS		21.4	
	41. Southwest Mountains Area Rural Water Supply Project	RS		7.5	
	23. Construction of Bypass Channel Raven- Rechica	A			44.0
	24. Pelince Dam Project	A			57.2
	25. Blatec Dam Project	M & I, A			37.9
	26. Krapa Dam Project	M & I, A			54.2
	27. Zhvan Dam Project	A			127.1
	28 Obednik Dam Project	A			44.6
	29. Kochishte Dam Project	A			66.4
	30. Zhurche Dam Project	A			21.5
	31. Konjarka Dam Project	A			24.5
	32. Petrushka Dam Project	A			65.2
	33. Podares Dam Project	M & I, A			66.3
	42. Nationwide Rural Water Supply Extention/Improvement Project	RS			53.9
	Subtotal by PHASE		226.1	606.5	662.8
	Subtotal of Water Resources Development Plan				1,495.4
Water Resources Management Plan	Water Quality Conservation Plan by River Basin	PHASE I to III			217.0
	Watershed Conservation Plan by River Basin				190.0
	Surface Water and Groundwater Monitoring System Improvement Plan				61.0
	Water-related Facilities Operation and Maintenance Improvement Plan				2.0
	Institutions and Legal System Strengthening Plan				–
	Human Resources Development Plan				–
	New Water Economy Base Plan to be prepared by GOM				
	Subtotal of Water Resources Management Plan				470.0
		Grand total			1,965.4



Remarks, M: Municipal, I: Industrial, A: Agricultural, P:Power, E: Environmental, RI: Irrigation Rehabilitation, RS: Rural Water Supply

Figure S-1 Overall Implementation Plan

No.	Project Name	Purpose	Project cost (US$ mil.)	PHASE I						
				1999	2000	2001	2002	2003	2004	2005
1	Water Supply Project for Tetovo - River Pena Intake	M & I	3.2			RE				
							1.6	1.6		
2	Kichevsko Pole Area Irrigation Rehabilitation Project	RI	2.9				NP			
								1.4	1.5	
3	Patishka Reka Water Supply Project	M	3.2			RE				
							1.6	1.6		
4	Slupchanka Dam Project	M	7.3		RE					
						3.7	3.6			
5	Zletovica Multipurpose Dam Project	M & I	68.2		RE					
						13.6	20.5	20.5	13.6	
6	Valandovo Area Irrigation Rehabilitation Project	RI	7.3				NP			
								2.3	2.7	2.3
7	Irrigation System Betterment Project in Resen	RI	7.0		RE					
						3.5	3.5			
8	Oraovica Dam Project	M & E	21.7			NP				
								6.5	8.7	6.5
		Subtotal	120.8	0.0	0.0	20.8	30.8	33.9	26.5	8.8
34	Treska River Upper Reach Rural Water Supply Project	RS	19.3					NP		
									9.6	9.7
35	Skopje Circle Rural Water Supply Project	RS	21.3			NP				
							10.6	10.7		
36	Kriva Palanka/Kumanovo Circle Rural Water Supply Project	RS	29.3			NP				
							8.8	11.7	8.8	
37	Pelagonija Circle Rural Water Supply Project	RS	35.4				NP			
								11.7	12.7	11.0
		Subtotal	105.3	0.0	0.0	0.0	19.4	34.1	31.1	20.7
		Total	226.1	0.0	0.0	20.8	50.2	68.0	57.6	29.5

Remarks: · For purpose of project; M: Municipal, I: Industrial, E: Environmental, RI: Irrigation Rehabilitation, RS: Rural Water Supply
· For works before implementation of Projects; RE: Review of existing plan/design, NP: New planning, study and survey

Figure S-2 Implementation Program of PHASE I Projects

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FINAL REPORT

ABBREVIATIONS AND ACRONYMS

ACU	-	Aid Coordination Unit
a.s.l	-	above sea level
BOD	-	Biological Oxygen Demand
CE(s)	-	Communal Enterprise(s)
DO	-	Dissolved Oxygen
EBRD	-	European Bank for Reconstruction and Development
ECM	-	Electric Power Company of Macedonia
EC	-	European Community
EL	-	Elevation
EU	-	European Union
FRY	-	Federal Republic of Yugoslavia
FYROM	-	The Former Yugoslav Republic of Macedonia
GDP	-	Gross Domestic Product
GEF	-	Global Environment Facility
GNP	-	Gross National Product
GOJ	-	Government of Japan
GOM	-	Government of Macedonia
GTZ	-	Deutsche Gesellschaft für Technische Zusammenarbeit
HMI	-	Republic Hydrometeorological Institute
I/R	-	Interim Report
IEE	-	Initial Environmental Examination
IBRD	-	International Bank for Reconstruction and Development
IDA	-	International Development Association
IMR	-	Infant Mortality Rate
JICA	-	Japan International Cooperation Agency
JUS	-	Jugoslavian Standards
MAFWE	-	Ministry of Agriculture, Forestry and Water Economy
MCIC	-	Macedonian Center for International Cooperation
MKS	-	Macedonian Standards
MOD	-	Ministry of Development
MOE	-	Ministry of Economy
MOH	-	Ministry of Health
MUPC	-	Ministry of Urban Planning and Construction
MOEn	-	Ministry of Environment
MOS	-	Ministry of Science
MOFA	-	Ministry of Foreign Affaires
NDS	-	National Development Strategy 1997
NEAP	-	National Environmental Action Plan 1997
NEHAP	-	National Environmental Health Action Plan
NGO(s)	-	Non Governmental Organization(s)

ABBREVIATIONS AND ACRONYMS (Continued)

ODA	-	Official Development Assistance
O&M	-	Operation and Maintenance
PCM	-	Project Cycle Management
PDM	-	Project Design Matrix
PHARE	-	Pologne et Hongri Aide a Reconstruction Economique (Poland and Hungary Aid for Economic Reconstruction)
PIP	-	Program for Public Sector Investment in the Republic of Macedonia 1998-2000
P/R	-	Progress Report
PWME	-	Public Water Management Enterprise
RIHP	-	Republic Institute for Health Protection
S/W	-	Scope of Work
SS	-	Suspended Substances
SFRY	-	Socialist Federal Republic Yugoslavia
UNDP	-	United Nations Development Program
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
UNICEF	-	United Nations Children's Fund
WHO	-	World Health Organization
WDI	-	Water Development Institute
WMO(s)	-	Water Management Organization(s)
WUA(s)	-	Water Users' Association(s)

WEIGHTS AND MEASURES

Metric System

mm	-	Millimeter(s)	ha	-	Hectare (100m x 100m)
m	-	Meter(s)	l	-	Liter(s)
m^2	-	Square meter(s)	lit/sec (l/sec)	-	Liter per second
km^2	-	Square kilometer(s)	m^3	-	Cubic meter(s)
lpcd	-	litre/capita/day	m^3/sec (m^3/s)	-	Cubic meter(s) per second
			p.e.	-	population equivalent

CURRENCY

MKD	-	Macedonian Denar	DM	-	Deutsche Mark
USD	-	United States Dollar	JPY	-	Japanese Yen

CHAPTER 1 SCOPE OF THE STUDY

1.1 Background of the Study

The Former Yugoslav Republic of Macedonia (FYROM), which is located in the central part of Balkan Peninsular, has limited rainfall that ranges from 400 to 1,000mm per annum with a rather high difference among each region. In the 10 years from the end of the 1980s to 1990s, people experienced droughts almost every year, facing seasonal water shortage of drinking water in the urban areas and also in rural areas where there are problems of poor hygiene. Rather high occurrence of waterborne diseases among infant and schoolchildren in the communities indicates that the water sources have been polluted by untreated municipal water and no guideline for safety standards has been established, and so on. Population living in the mountain and border areas suffer from poor accessibility to safe drinking water.

Furthermore, the three major rivers of the Vardar, Crn Drim, and Strumica Rivers in the country are international rivers. Harmony with environment is essential in implementing development projects in Macedonia, and it is also important to take countermeasures for reduction of polluted load which will be increased with development projects and be influenced to three countries located downstream of Macedonia. Consequently, establishment of water resources management system considering harmony with environment Is urgently required for keeping good diplomatic relations with the neighboring countries.

These issues relating to water resources development and management have not been solved fundamentally, because they have not been dealt with by a middle/long term master plan, but just temporary measures and/or a master plan which does not cover the whole area of Macedonia. Under these circumstances, the Government of Macedonia (GOM) requested to the Government of Japan (GOJ) in October 1996 to extend technical cooperation programs for carrying out the Study on Integrated Water Resources Development and Management Master Plan (the Study).

In response to the official request from GOM, GOJ decided to conduct the Study. Accordingly, the Japan International Cooperation Agency (JICA), commenced the Study with dispatch of the Study Team to Macedonia on December 14, 1997.

The field works in Macedonia by the Study Team were carried out four times, the first (from December 14, 1997 to March 13, 1998), the second (from May 21 to July 25, 1998), the third (from September 10 to December 23, 1998) and the fourth (from March 10 to March 24, 1999) in good cooperation and understanding with the Macedonian side.

1.2 Objective of the Study

1) to formulate an integrated water resources development and management master plan for the target year 2025 in the whole area of FYROM

2) to transfer technology to the Macedonian counterpart personnel in the course of the Study

1.3 Study Area

The Study area covers the whole of the country as shown in Location Map.

1.4 Scope of the Study

Phase I : [Survey/investigation, water demand forecast, and analysis of water resources development potential]

The present status of water resources development and management in FYROM shall be studied through analysis of collected data/documents and field investigations.

Phase II : [Formulation of Master Plan on Integrated Water Resources Development and Management]

An integrated water resources development and management master plan shall be formulated, which includes a supplemental environmental survey for Initial Environmental Examination (IEE) and evaluation of priority projects and preparation of a preliminary implementation program and study of fund raising for the project.

The overall work schedule of the Study is shown in Figure 1.

1.5 Implementation Organization

The Ministry of Development (MOD) acts as the counterpart body to the Study Team. The Steering Committee of the Macedonian side was organized in December 1997, consisting of representatives from MOD, and other seven related organizations. The counterpart personnel team consisting of 11 member was formed to work with the Study Team.

The JICA Study Team is headed by a Team Leader who is responsible for maintaining close liaison with MOD, JICA, and other agencies concerned as well as for planning activities and monitoring progress of the entire Study for ensuring its timely and efficient completion.

1.6 Study Schedule and Activities

Phase I of the Study was conducted from December 1997 to September 1998.

Phase II was conducted from September 1998 to May 1999 (See Figure 1).

The following field surveys were carried out on a subcontract basis:

1) Water utilization survey (February to March 1998)
2) Water quality survey (February to March 1998)
3) Environmental survey (1) (February to March 1998)
4) Groundwater quality survey (2) (June to July 1998 during the normal water season)
5) Environmental survey (2) (June to July 1998)
6) Groundwater quality survey (3) (September to November 1998 during the low water season)
7) Topographic survey (October to November 1998)
8) Supplemental Environmental Survey for IEE (October to November 1998)

Transfer of technology activities consist of the on-the-job-training and seminars to the counterpart personnel.

The first seminar was conducted on September 21, 1998 during the third fieldwork in Macedonia for the following subjects:

1) Explanation of the progress and general findings of the Study;
2) Planning method of the water resources development and management;
3) Planning through the PCM method and outputs of workshops in Macedonia;
4) Analysis method and findings of the groundwater study

In parallel with a series of discussion on the Draft Final Report during the fourth fieldwork in Macedonia, the second seminar was conducted on March 17, 1999 for the following subjects:

1) Key issues on the Integrated Water Resources Development and Management Master Plan (the present Study);
2) Current condition on water utilization in Japan and comprehensive water resources management in the Tone River basin;
3) Water resources development considering symbiotic relationship with natural environment and current activities of flood control in Japan

CHAPTER 2 PRESENT CONDITIONS OF THE STUDY AREA

2.1 Natural Conditions

The Former Yugoslav Republic of Macedonia (FYROM) is a land-locked country surrounded by four countries, i.e. Bulgaria on the east, Federal Republic of Yugoslavia (FRY) on the north, Albania on the west and Greece on the south, located in the central part of Balkan Peninsular. The country lies between longitudes 20°21'31'' and 23°02'12'' east, and latitudes 40°51'16'' and 42°22'21'' north, extending to east-west direction of 210 km and to south-north of 160 km with a border line of 850 km in total and an area of 25,713 km^2.

2.2 Socioeconomic Conditions

The table below outlines the socioeconomic situations in Macedonia. The detailed explanation provided in the following Sub-sections.

Summary of Socioeconomic Data of Macedonia

1	Population	1,945,932	(1994 Census)
2	Population Density (person/km^2)	76	(1994 Census)
3	Annual Growth Rate of Population	0.77%	(1994-1997)
4	% of Urban Population	59.4%	(1994 Census)
5	Main Towns	(Population in '000) Skopje Bitola Kumanovo Prilep Tetovo Veles	(1994 Census) 444.2 77.5 71.9 68.1 50.3 46.8
6	Languages	Macedonian	
7	Currency	Temporary government coupons were replaced by the denar on May 10th 1993. The National Bank of Macedonia fixes daily the exchange rate of the denar against the major currencies. Average exchange rates in 1996: MKD40 : US$1 Exchange rates as of January 15th 1999: MKD52.00 : US$1.00	
8	Fiscal Year	Calendar year	
9	Ethnic Composition ('000)	Macedonians Albanians Turks Romanies (Gypsies) Serbs	1,296 (1994 Census) 441 78 43 40
10	Infant Mortality Rate	16 deaths/1,000 live births	
11	Number of Doctors	3.2 per 1,000 of population	(1994)
12	Elementary School Enrollment Rate	Over 95%	
13	Adult Literacy Rate	94%	
14	Per Capita Nominal GDP	US$1,580 (82,850MKD)	(1997)
15	Real GDP Growth	0.8% in 1995 1.5% in 1996	

2.3 Topography and River System

The country ranges from an elevation 50m above sea level around Gevgelija in the alluvial lowland of the Vardar River near the border with Greece to the high mountainous area extending west to the border with Albania and the northwest border with FRY where the peaks range from an elevation of 2,200 to 2,700 m. The country consists of 19.1% plain area and 80.9% mountainous/hilly area.

The surface areas of these regions in Macedonia are shown below:

Surface Areas of Major River Basins in Macedonia

River/Lake	Catchment Area (km^2)	% of Total Area
1. Vardar River		
Main Stream	6,813	26.5
Treska River	2,068	8.0
Pchinja River	2,373	9.2
Bregalnica River	4,307	16.8
Crna River	4,985	19.4
Subtotal	20,546	79.9
2. Cm Drim River	3,355	13.0
3. Strumica River	1,520	5.9
Subtotal (1 to 3)	25,421	98.8
4. Minor river basin		
Lake Dojran	120	0.5
Cironska & Lebnica River	128	0.5
Juzna Morava River	44	0.2
Subtotal (4)	292	1.2
Total (1 to 4)	25,713	100.0

2.4 Meteorology

Key climate indicators in each river basin based on the data at main meteorological station in each basin are summarized below:

Key Climatic Indicators at Major Meteorological Stations

River Basin	Station	Rainfall (mm/year)	Temp-erature (°C)	Wind (m/sec)	Sunshine Duration	Cloudiness (0 ~ 10)	Humidity (%)
Vardar	MST27_Gevgelija	667	14.0	1.8	6.5	4.4	70.8
Treska	MST06_S. Glava	640	-0.9	5.6	5.6	5.6	83.3
Pchinja	MST25_K. Palanka	617	10.0	2.3	6.3	5.3	68.2
Bregalnica	MST34_Shtip	467	12.6	2.1	6.4	5.0	66.9
Crna	MST11_Prilep	535	11.1	1.6	6.3	5.0	67.5
Cm Drim	MST213_Ohrid	694	11.1	1.8	6.2	5.0	70.4
Strumica	MST04_Strumica	547	12.7	1.1	6.2	4.2	74.3

Note: Rainfall is based on annual total, and other parameters are based on average annual except sunshine duration is presented by hours/day.

2.5 Hydrology

The discharge variation in major river basins is listed below:

Maximum, Minimum and Average Discharge at Major Gauging Stations

(Unit: m^3/sec)

River Basin	Station	Maximum	Minimum	Average
1. Vardar	ST014_Gevgelija	549.7	9.6	136.0
2. Treska	ST026_Sveta Bogorodica	91.3	4.0	23.3
3. Pchinja	ST035_Katlanovska Banja	65.9	0.3	11.9
4. Bregalnica	ST052_Shtip	130.0	0.1	11.2
5. Crna	ST065_Rasimbegov	182.6	0.9	22.4
6. Cm Drim	ST088_Lozhani	72.7	6.1	23.4
7. Strumica	ST104_Novo Selo	60.6	0.0	3.8

Duration of flow at gauging stations located at lower reaches of major rivers was estimated based on the daily discharges for 36 years from 1960 to 1996. Principal several figures with specific discharges (showing in parenthesis, $m^3/s/100km^2$) are summarized below:

Flow Duration in Major Rivers

(Unit:m^3/s)

River Basin	Catchment Area (km^2)	Average	97% (355 days)	75% (265 days)	50% (175 days)	25% (90 days)
1. Vardar	22,301	136.0 (0.61)	21.9 (0.10)	62.1 (0.28)	100.1 (0.45)	176.2 (0.79)
2. Treska	1,880	23.3 (1.24)	5.2 (0.28)	9.6 (0.51)	17.7 (0.94)	31.9 (1.70)
3. Pchinja	2,794	11.9 (0.43)	0.8 (0.03)	3.5 (0.13)	8.2 (0.29)	16.4 (0.59)
4. Bregalnica	2,897	11.2 (0.39)	1.1 (0.04)	3.9 (0.13)	6.9 (0.24)	12.9 (0.45)
5. Crna	4,526	22.4 (0.49)	1.8 (0.04)	5.2 (0.12)	13.3 (0.31)	31.2 (0.73)
6. Cm Drim	1,899	23.4 (1.23)	9.6 (0.51)	19.9 (1.05)	22.1 (1.16)	26.7 (1.41)
7. Strumica	1,401	3.8 (0.27)	0.1 (0.01)	0.9 (0.06)	1.9 (0.14)	4.3 (0.31)

2.6 Geology

The land of Macedonia is composed of bedrocks of varied ages spanning from Pre-Cambrian to Quaternary and strongly controlled by the Alpine tectonic movement of Tertiary age. It can be divided into tectonic belts of Serbo-Macedonian Massif on the east and Dinarides on the west that are elongated in the north-northwesterly direction parallel with the Adriatic coast. The Dinarides is further divided into three zones, that is, Vardar Zone, Pelagonijan Horst Anticlinorium and West Macedonian Zone, from east to west in order.

Macedonia is situated in an active seismic zone, as represented by the strong earthquake in Skopje on July 26, 1963, that caused serious damage to the capital. Its epicenter was identified at 42.00 °N/21.50°E with MSK intensity IX in

Skopje.

The land of Macedonia consists for the most part of old and hard bedrocks of Pre-Cambrian to Mesozoic that are generally strong enough to be foundation of high dams, and also manageable for treatment due to water-tightness except for karstified limestone. Generally speaking, major foundation engineering problem is rarely seen in damsites in this country, except for the question of water leakage in karst limestone areas. Foundation treatment can be performed within a reasonable cost range.

2.7 Vegetation and Soil

The vegetation in Macedonia is classified into two, that is forest area and agricultural area, which are further divided as follows:

Classified Vegetation Areas

Vegetation	Area (1,000 ha)	
1. Forest Area		
1) Pure tree stands of deciduous trees	540	
2) Pure tree stands of conifers	79	
3) Mixed tree stands of deciduous trees	271	
4) Mixed tree stands of conifers	6	
5) Mixed tree stands of deciduous trees and conifer	57	
Subtotal (1)	953	(37%)
2. Agricultural Area		
1) Cultivable area	658	
2) Pastures	633	
3) Pond, reed beds and fishponds	1	
Subtotal (2)	1,292	(50%)
3. Other	326	(13%)
Total (1 to 3)	2,571	

Areas of soils in fertility are classified into seven as follows:

Classified Areas of Soil in Fertility

Class	Area (1,000 ha)	Fertility
I	190 (7%)	Highest
II	95 (4%)	
III	369 (14%)	
IV	231 (9%)	
V	975 (38%)	
VI	314 (12%)	
VII	397 (16%)	Lowest
Total	2,571	

2.8 Groundwater

Five types of groundwater occur in the country as follows:

1) Groundwater in unconsolidated Quaternary and Neogene sand and gravel layer

i) High to medium yielding aquifers
ii) Low yielding aquifers

2) Groundwater in fault and fractured zones
   i) Practically without aquifers
   ii) Local aquifers

3) Groundwater in the karst limestone and marble

The nationwide volume of groundwater, which has been exploited amounts to 9.77m^3/sec, that is 308.2x106m^3/year, which is broken down below:

1) The exploited groundwater in unconsolidated sand and gravel layer amounts to 1.99 m^3/sec, that is 62.8x10^6 m^3/year;

2) The exploited groundwater in faults and fractured zones is as small as 0.05 m^3/sec, that is 1.6x$10^6$$m^3$/year;

3) The exploited groundwater in karst limestone and marble, almost equal to the yield of springs. amounts to 7.73 m^3/sec, that is 243.8x10^6 m^3/year.

2.9 Watershed Management

The total forest area was 953,322 ha in 1996 (Statistical Year Book 1997) sharing 37 % of the national territory.

Most of the territory of Macedonia is vulnerable to erosion. Such research and studies have been carried out to clarify countermeasures for attenuation of erosion in watersheds as a survey on 1:50,000 scale erosion maps of the country prepared by the Faculty of Forest in Sv. Kiril and Methodij University, Skopje (the Skopje University) and Water Development Institute, Skopje (WDI).

According to the survey, the area affected by erosion processes is 24,813.3km^2 or 96.5% in the country. The area classified by the five classes is as follows:

Area Classification by Erosion Process

Class	Erosion Process	Area (km^2) (%)
I	Excessive erosion (gully erosion)	688.0 (2.8)
II	Significant erosion	1,832.4 (7.4)
III	Medium scale erosion	6,893.3 (27.7)
IV	Minor erosion	7,936.1 (32.0)
V	Insignificant erosion	7,463.5 (30.1)
	Total	24,813.3 (100)

Areas classified as I to III are considered to be affected with severe erosion, which is equivalent to 9,413.7km^2 or 37.9% of the total affected area.

Sediment records of major reservoirs are summarized below:

Annual Sediment Yield in Catchment Area of Major Dams

River	Dam	Catchment Area (km^2)	Annual Sediment Yield (m^3/year)	Annual Sheet Erosion Rate (mm/year)
1. Vardar	1) Glaznja	101	50,911	0.51
	2) Lipkovo	112	5,853	0.05
	3) Kalimanci	1,100	1,101,923	1.00
	4) Mantovo	180	71,159	0.40
	5) Tikvesh	5,361	2,675,969	0.50
2. Strumica	1) Vodoca	76	37,327	0.49
	2) Turija	210	91,578	0.43
3. Crn Drim	1) Globochica	3,118	117,934	0.04
	2) Sbpilje	4,198	807,672	0.19
	3) Mavrovo	322	16,580	0.05

(Source: Erosion map, WDI-Skopje)

2.10 Water Quality

The most significant problems regarding water pollution are due to untreated wastewater discharged from mines and industrial plants as well as discharges from large settlements and livestock farms. Surface water has been polluted in the middle and lower reaches of the Vardar main stream, the Pchinja, Bregalnica, and Crna Rivers. Deterioration of the quality in groundwater used through wells has been found near cities like Skopje and Veles in particular, while spring water remains with desirable quality.

For such situation, only 6% of the wastewater in Macedonia is treated before it is discharged into the sewer systems and/or to the rivers. There are only three wastewater treatment plants built in Macedonia, which are only for the treatment of discharges into Lakes Ohrid (120,000p.e.), Prespa (12,000p.e.) and Dojran (6,000 p.e.). Wastewater systems are in the implementation phase in Bitola and Prilep at present, financed through a World Bank loan. A national and Skopje's wastewater treatment master plan is under preparation.

Less than 20 large factories have pre-treatment plants built on the premises. Small factories also have treatment plants of mechanical systems. Reportedly more than 50% of the installed systems are mostly out of order.

2.11 Source of Municipal Water

Source of water in each municipality (the former division) is summarized below:

Source of Municipal Water

Source	No. of Municipality
1. Groundwater	
1) through Well	10
2) Spring	13
2. Surface Water	
1) Reservoir	5
2) River Intake	7

(Plural sources are adopted in some municipalities)

2.12 Rural Water Supply

The coverage rates of the rural water supply were estimated as follows, and the rates for this Study were determined:

Coverage Rate of Rural Water Supply in 1991

Description	Number
Record in Rural Area in 1991:	
(1) Supply from Communal Enterprise (CE)	121,409 persons (108 villages)
(2) Supply from Village Supply (VS)	479,654 persons (660 villages)
- with meter	241,504 persons
- without (w/o) meter	238,150 persons
(3) Subtotal ((1)+(2))	601,063 persons (768 villages)
(4) Not supplied/not connected with network service (or own source)	264,742 persons (957 villages)
(5) Total ((3)+(4))	865,805 persons (1,725 villages)
Rate of above:	
(1) Supply from CE ((1)/(5))	
- person	14 %
- village	7 %
(2) Supply from VS ((2)/(5))	
- person	55 %
- village	38 %
(3) Own source ((4)/(5))	
- person	31 %
- village	55 %

Based on the above, coverage rates in rural areas were adjusted to be 20% supplied by CE(s) and 55% by VS(s), respectively for the current condition in the Study.

2.13 Institutions and Organizations

New Water Law was issued in January 1998, replacing the Law on Water of 1981. It functions as a framework law on water resources issues in Macedonia. The Water Law provides comprehensive provisions on water resources development and management. The important new provisions are (i) water right, (ii) water fund, (iii) establishment of Public Water Management Enterprise (PWME), (iv) establishment of Water Users' Associations, (v) wastewater standards, (vi) water management Inspectors, and so on.

Most provisions stipulated in the Law are not yet to be implemented; institutional setting for water resources development and management is still in a transitional stage.

MAFWE, MUPCE (divided into MUPC and MOEn in December 1998), MOE, MOD, and MOH are the main players in the sector of the water resources

development and management. There are 34 CEs in Macedonia, which belong to each municipal government and supply municipal and industrial water to his responsible municipality. The companies form the Association for Water Supply and Sewerage (MAKKOM) to represent their interests.

HMI, a public institute financed by the Government, is responsible for monitoring water resources, collection and record of river discharge, sediment, water quality and pollution. Geohydroproject is a private enterprise similar to HMI but its responsibility is for groundwater.

2.14 Development Strategy and Plans

There are three nationwide development plans and studies such as "National Development Strategy 1997" prepared in 1997, "Study for Long-term Water Supply in the Republic of Macedonia up to 2025" prepared in 1993 and "Integrated Development of theVardar/Axios River Basin" prepared in 1979.

The Program for Public Sector Investment in the Republic of Macedonia (PIP) has been prepared by MOD with a technical assistance of World Bank; the latest PIP covers the period 1998 to 2000. PIP is a short-list of development projects by sector prioritized based on criteria such as importance of the sector, level of project formulation, possibility of covering project budget by the national budget, capability of loan reimbursement of the government, etc.

The National Environmental Action Plan (NEAP) was prepared in 1996 to 97 with the support of World Bank, and it was developed with the participation of in-country technical experts. NEAP reports that industries have continued to be the major polluters in spite of lower production levels. And the crucial environmental issues in Macedonia are: 1) poor air quality in Veles and Skopje; 2) polluted surface water due to discharge of untreated wastewater; and 3) inadequate solid hazardous waste management system.

In the water resources development and management sector, GTZ and World Bank have been the main players. A German expert dispatched by GTZ has been working as a technical advisor for development project planning. World Bank has commenced three irrigation rehabilitation projects.

EU's PHARE Project plans to start a master plan formulation project about wastewater treatment. EBRD, which is mainly involved in promotion of private sector, has been seeking for the possibility of some environmental protection projects. Many donor-funded projects are being implemented or planned for environmental protection of Lake Ohrid and its surrounding areas, which is designated by UNESCO as a World Natural and Cultural Heritage site.

CHAPTER 3 PROBLEM IDENTIFICATION ON WATER RESOURCES DEVELOPMENT AND MANAGEMENT

3.1 Overview of Existing Water-related Problems in Regions

Water-related problems have been identified through (i) information, interview and study results, (ii) current water balance calculation, (iii) PCM workshops, and (iv) interview survey for Communal Enterprises and (v) viewpoint of institutions and legal system. Among the problems identified, those relating to drinking water are the most severe which are summarized below:

1) Seasonal/through a year water shortage in quantity;

2) Leakage losses in water supply networks;

3) Insufficient service facility;

4) Pollution of water in quality;

5) Poor access to safe drinking water

The national area of Macedonia can be divided into five regions from a geomorphological point of view, and hence water-related problems are summarized for each region as follows:

Water-related Problems in Five Geomorphological Regions across Macedonia

River Basin / Description	(1) Vardar upper reach/ Treska/Pchinja	(2) Vardar middle reach/ Bregalnica	(3) Vardar lower reach/ Crna	(4) Crn Drim	(5) Strumica
1. Part in Macedonia	Central/eastern/ northwestern/ central-western	Central-south/ eastern	Southern/ southwestern	Western/ southwestern	Southerneast
2. Major Municipality (the former one)	Skopje Gostivar Tetovo Kichevo M. Brod Kumanovo Kratovo Kriva Palanka	Veles S. Nikole Shtip Probishtip Kochani Vinica Delchevo Berovo	Demir H. Krushevo Bitola Prilep Kavadarci Negotino Valandovo Gevgelija	Resen Ohrid Struga Debar	Radovish Strumica
3. Topography (Altitude)	Mountain/valley/ hill (El.240-2,500 m)	Mountain/ valley/hill (El.270-2,000 m)	Mountain/ highland/hill (El.50-1,400 m)	Mountain/ valley/ highland (El.670-2,700 m)	Mountain/ hill (El.220-1,700 m)
4. Annual rainfall	640 mm	500 mm	560 mm	740 mm	500 mm
Problems:					
1)Water shortage (Seasonal)	Skopje Gostivar Tetovo Kichevo M. Brod Kumanovo Kratovo Kriva Palanka	Veles (all year) S. Nikole Shtip Probishtip Vinica Pehchevo Delchevo	Demir H. Krushevo Prilep Kavadarci Negotino Valandovo Gevgelija	Resen Struga	Radovish Strumica
2) Leakage loss	27 – 40%	20 – 35%	32 – 40%	35% (Struga)	30 – 40%
3) Insufficient service facility	–	–	Demir Hisar Valandovo	Ohrid	–

4) Water Pollution in River	Skopje Gostivar Tetovo Kumanovo Kratovo Kriva Palanka	Veles Shtip Kochani Vinica	Bitola Prilep Kavadarci Negotino Valandovo Gevgelija	Ohrid	Radovish Strumica
5) Poor access to safe drinking water in rural area	Mountainous area and border with FRY and Albania	Mountainous area and border with Bulgaria	Mountainous area and border with Greece, and area between the Vardar and Dojran	Mountainous area and border with Albania	Mountainous area and border with Bulgaria and Greece

3.2 Problems Identified by River Basin

In addition to the above, the following problems were identified:

1) Deterioration of environment at lake shore due to decrease of water level in Lake Dojran;

2) Bank erosion along the Vardar River approximately 20 km upstream from Gevgelija;

3) Deterioration of water quality due to untreated wastewater, decrease of fish catch, and change of macrophytic vegetation in Lake Ohrid;

4) Frequent inundation near the confluence of the Crn Drim and Sateska Rivers.

3.3 Problems with Institutions and Legal Systems

Problems with institutions and legal system at the national level were identified as follows:

1) Policy making and project formulation (though the national development plan has been formulated, coordination among project findings and formation activities is limited, and so on);

2) Limited and partly unauthorized socioeconomic data and no effective system for technical data;

3) Limited attentions to monitoring and evaluation;

4) Insufficient operation and maintenance observed in irrigation projects;

5) Little publicity on the concept of establishment and role of Aid Coordination Unit (ACU) as the coordinator of donors to Macedonia.

3.4 Problems Identified through PCM Workshop

The PCM Workshops were held in Skopje, Radovish, Krushevo, Kochani, and Gevgelija. The main purposes of the Workshops are to understand actual local problems, to identify local needs, and to improve awareness of project ownership and importance of active participation through a participatory planning method.

The major problems and needs clarified in the Workshops, which were represented below almost with same as above, were utilized as one of the criteria of the project evaluation for the master plan formulation.

Major Problems Identified in PCM Workshop

Place	Major Problems
1.Skopje	1) Growing possibility of polluted water sources (urban areas) 2) Limited access to safe drinking water (rural areas)
2. Radovish	1) Seasonal shortage of drinking water in towns
3. Krushevo	1) No access to safe drinking water in mountainous village 2) Seasonal water shortage in Jurban areas 3) Insufficient quantity of irrigation water
4. Kochani	1) Seasonal shortage of drinking water and irrigation water 2) Lack of supply facilities 3) Low water quality
5. Gevgelija	1) Limited irrigation water 2) Seasonal shortage of drinking water

CHAPTER 4 DEVELOPMENT POTENTIAL

4.1 General

Development potential of water resources is estimated by multiplying an annual balance between precipitation and evapotransipration, into the national land area. No data were, however, obtained for evapotranspiration and snowfall, and the development potential was studied based on the potential of surface water and groundwater.

4.2 Surface Water

Potential of surface water is regarded as the total of discharge in the Vardar River and its tributaries of the Treska, Pchinja, Bregalnica, and Crna rivers, the Crn Drim River, and the Strumica River. Flow duration in major rivers is tabulated as follows:

Flow Duration in Major Rivers

(unit : $10^6 m^3$/year)

River Basin	Catchment Area (km^2)	Average Discharge	97% (355 days)	75% (265 days)	50% (175 days)	25% (90 days)
1. Vardar	22,301	4,289 (136.0)	691 (21.9)	1,958 (62.1)	3,157 (100.1)	5,557 (176.2)
2. Treska	1,880	735 (23.3)	164 (5.2)	303 (9.6)	558 (17.7)	1,006 (31.9)
3. Pchinja	2,794	375 (11.9)	25 (0.8)	110 (3.5)	259 (8.2)	517 (16.4)
4. Bregalnica	2,897	353 (11.2)	35 (1.1)	123 (3.9)	218 (6.9)	407 (12.9)
5. Crna	4,526	706 (22.4)	57 (1.8)	164 (5.2)	419 (13.3)	984 (31.2)
6. Crn Drim	1,899	738 (23.4)	303 (9.6)	628 (19.9)	697 (22.1)	842 (26.7)
7. Strumica	1,401	120 (3.8)	3 (0.1)	28 (0.9)	60 (1.9)	136 (4.3)

(Figures in ( ) show discharges (m^3/sec))

At the gauging station of Gevgelija sited on the most lower reach of the Vardar River in the territory of Macedonia (with a catchment area of 22,301 km^2 -covers 87 % of 25,713 km^2 of total national land area), the annual amount of an average discharge is estimated at 4,289 x $10^6 m^3$/year. Summing up the discharge in the Vardar River (4,289 x $10^6 m^3$/year), that in the Crn Drim River (738 x $10^6 m^3$/year), and that in the Strumica River (120 x $10^6 m^3$/year), the total potential of surface water on an average is estimated at 5,147 x $10^6 m^3$/year, approximately 5,000 x $10^6 m^3$/year.

4.3 Groundwater

Total amount of groundwater and spring water is summarized as follows:

Total Amount of Groundwater and Spring Water

(Unit: $10^6 m^3$/year)

Situation	Groundwater (wells)	Springs	Total
1.Exploited (under use)	64.4	195.2-243.8	259.6-308.2
2. Potential (available for development from now on)	140.0	434.8-512.7	574.8-652.7
Total	204.4	630.0-756.6	834.4-960.9
NDS 1997	520	420	940

For spring water, the former figure shows that by a spring inventory, while the latter does that by a groundwater analysis.

4.4 Potential of Water Resources

The total potential of surface water on an average is estimated at approximately 5,000 x $10^6 m^3$/year.

On the other hand, the potential of groundwater is estimated at approximately 834 x $10^6 m^3$/year, consisting of that of wells (204 x $10^6 m^3$/year) and springs (630 x $10^6 m^3$/year).

Combining the potential of surface water and groundwater, the total potential of water resources in Macedonia on an average is estimated at approximately 6,000 x $10^6 m^3$/year.

Annual amount of rainfall in Macedonia is roughly estimated at 15,000 x $10^6 m^3$/year (=25,713 km^2 x nearly 600 mm/year). Comparing the amount with the total potential of surface water on an average (5,000 x $10^6 m^3$/year), the loss rate is estimated at around 30%.

Further it is estimated at around 40%, when the amount is compared with the total potential of water resources on an average (6,000 x $10^6 m^3$/year).

CHAPTER 5 WATER DEMAND PROJECTION

5.1 General

Water demand projection was conducted based on a development scenario set in line with the socioeconomic frame, which shows the vision of Macedonia. The scenario targets the year 2025, which is divided into three phases: PHASE I (up to 2005), PHASE II (2006 to 2015) and PHASE III (2016 to 2025). The projection was conducted for each phase, and as the sum of municipal, agricultural and industrial water as well as ecological minimum.

5.2 Socioeconomic Frame

The Socioeconomic Frame to the year 2025 prepared in the Study, which was formulated through downward revision of the development targets given by NDS 1997 and agreed after careful discussions with the Macedonia side, is summarized below:

Socioeconomic Frame in the Study

	Actual data	Estimation based on the previous census data				
	1994	1995	1996	2005	2015	2025
Total population	1,945,932 persons	1,960,000 persons	1,974,000 persons	2,090,000 persons	2,203,000 persons	2,304,000 persons
GDP growth rate	--	--	1.5%	3.0%	4.5%	5.5%
GDP per capita	--	--	US$1,580	US$1,790	US$2,500	US$4,000

	During the period 1998 - 2025
Average annual growth rate of per capita GDP (value term)	3 – 4 %
Average annual growth rate of agricultural sector (value term)	5 – 6 %
Average annual growth rate of industrial sector (value term)	4 – 5 %

5.3 Water Demand Projection

5.3.1 Municipal Water

The demand of municipal water was projected based on population (60 % urban and 40% rural) projection and the preconditions and targets as listed below:

1) Population served by CEs : 95% (1996) to 100% (2025) in urban area and 20% (1996 to 2025) in rural area

2) Target per capita consumption : Domestic use – 150 lpcd
Communal use – 24 lpcd (1996) to 27 lpcd (2025)
Commercial use – 19 lpcd (1996) to 25 lpcd

(2025)

3) Other : Estimated by linear regression on past records
4) System loss : 35.5% (1996) to 30% (2025)
5) Per capita in rural water supply : 250 lpcd

Population projection and number of population who will be covered with the water supply network services are as follows:

(i) Water Quantity Demanded to CEs in Urban and Rural Areas

(10^3m^3/year)

Description	1996 - Current	2005	2015	2025
1) Population (persons)	1,278,801	1,368,985	1,472,194	1,569,384
Demand :				
2) Domestic household (150 lpcd)	70,014	74,952	80,603	85,924
3) Communal use (lpcd)	11,202 (24)	12,492 (25)	13,971 (26)	15,466 (27)
4) Commercial Use (lpcd)	8,868 (19)	10,493 (21)	12,359 (23)	14,321 (25)
5) Others	10,564	12,521	12,521	12,521
Subtotal (2 to5)	100,648	110,458	119,454	128,232
6) System loss (%)	55,395 (35.5%)	56,903 (34%)	56,214 (32%)	54,957 (30%)
7) Total (2 to 6)	156,043	167,361	175,668	183,189

(ii) Water Quantity Demanded to VSs in rural Area

(10^3m^3/year)

Description	1996 - Current	2005	2015	2025
1) Population (persons)	437,311	503,002	616,460	734,613
2) Water quantity (250lpcd)	39,905	45,899	56,252	67,033

(iii) Demand Projection of Municipal Water

(10^3m^3/year)

Description	1996 - Current	2005	2015	2025
1) Demand to CEs	156,043	167,361	175,668	183,189
2) Demand To VSs	39,905	45,899	56,252	67,033
3) Total	195,948	213,260	231,920	250,222

Figure 2 shows development directions of municipal water supply.

5.3.2 Agricultural Water

Agricultural water demand projection was conducted based on projection of irrigation area and with basic conditions that installation density of discharge

measuring devices will be increased and skill of gate operation will be improved, and the irrigation efficiency will be increased from 58% at the present to 63% by 2005, 65% by 2015 and 2025.

Agricultural water demand was projected, combining that for irrigation water with that for livestock. The irrigation area for each cropping pattern is projected below:

Irrigation Area Projected for Each Cropping Pattern

(Unit : 1,000ha)

Cropping Area No.	1996	2005	2015	2025
1	23	25	25	35
2	42	46	46	72
3a	63	80	118	120
3b	29	32	32	32
4	2	4	4	4
5	9	16	16	16
Total	168	203	241	280

(a) Irrigation water demand

Annual irrigation water demand is summarized as follows, which was projected on the basis of the average gross unit water demands of the 36 years.

Annual Irrigation Water Demand Projection

(Unit : $10^6 m^3$/year)

Cropping Area No.	1996	2005	2015	2025
1	128	120	111	151
2	323	301	279	414
3a	542	608	833	827
3b	311	315	312	321
4	10	19	19	19
5	71	112	107	103
Total	1,385	1,475	1,661	1,835

(b) Livestock water demand

Annual livestock water demand is summarized as follows, which was projected on the basis of number of livestock by each municipality that was projected on an assumption that same rate as the present national level could be applied, and unit water requirement of each livestock;

Livestock Water Demand Projection

(Unit : m^3/sec)

Livestock	1996	2005	2015	2025
1) Cattle	0.31	0.32	0.32	0.32
2) Horse	0.04	0.05	0.05	0.05
3) Pig	0.05	0.07	0.09	0.10
1) Sheep	0.32	0.32	0.33	0.34
5) Poultry	0.06	0.05	0.05	0.05
Total	0.78 ($24.6 \times 10^6 m^3$)	0.81 ($25.5 \times 10^6 m^3$)	0.84 ($26.5 \times 10^6 m^3$)	0.87 ($27.4 \times 10^6 m^3$)

(Figures in ( ) show the demand projection on annual basis)

Agricultural water demand was projected, summing up that of irrigation water and livestock water as follows:

Agricultural Water Demand Projection

(Unit : $10^6 m^3$/year)

Breakdown	1996	2005	2015	2025
1) Irrigation water	1,385	1,475	1,661	1,835
2) Livestock water	25	26	27	27
Total	1,410	1,501	1,688	1,862

Figure 3 shows a development curve of agricultural water.

5.3.3 Industrial Water

Water supplied to industry and water used for production from 1990 up 1996 shows a pronounced downward trend that reflects the reduction in industrial activity witnessed over the past decade following the break-up of the former Yugoslav. This downward trends, particularly for heavy industries, is unexpected and is also consistent with what was experienced in Eastern Europe following the break-up of the Soviet Union. Considering these trends, industrial water demand was projected, focusing on higher value-added light industry and commercial enterprises with a growth rate of 3 to 4.5% of which source is mainly by groundwater, while water demand for heavy industry will be kept with same rate as that of the present and potable water in factories will be increased with same rate as the municipal water

Industrial water was projected based on the above conditions as follows:

Industrial Water Demand Projection

(Unit : $10^3 m^3$/year)

Breakdown	1996	2005	2015	2025
1) Potable water	34,920	38,377	41,834	45,221
2) Raw process water from groundwater	28,030	36,579	51,613	80,155
3) Raw process water from surface water	50,933	50,933	50,933	50,933
Total	113,883	125,889	144,380	176,309

Figure 4 shows a development curve of industrial water.

5.3.4 Biological Minimum

The biological minimum and/or ecological need was determined, from the ecological standpoint, as being 10% of the average flow, according to the Water Economy Basis of Macedonia as mentioned in NDS 1997.

According to the hydrological study, average flows in major rivers for the 36 years from 1961 to 1996 are as follows, together with 10 % of them as the ecological need.

Biological Minimum from Ecological Standpoint

Basin/Gauging Station (Catchment Area)	(1) Average Flow (m^3/s)	(2)= (1) x 10% (m^3/s)	Annual Amount of (2) (10^6m^3)
1. Vardar/Gevgelija ($22,301km^2$)	136.0	13.6	429
2. Treska/Sveta Bogorodica ($1,880km^2$)	23.3	2.3	73
3. Pchinja/Katlanovska Banja ($2,794km^2$)	11.9	1.2	38
4. Bregalnica/Shtip ($2,897 km^2$)	11.3	1.1	35
5. Crna/Rasimbegov Most ($4,526 km^2$)	22.4	2.2	70
6. Strumica/Novo Selo ($1,401 km^2$)	3.8	0.4	12
7. Crn Drim/Lozani (-)	23.4	2.3	73
Total			730

Following NDS 1997, river flow of around 730 x 10^6m^3/year will be required for the biological minimum from the ecological standpoint.

5.3.5 Total Water Demand Projection

From the above, total water demand projection was conducted as follows, including the ecological need:

Total Water Demand Projection

(10^6m^3/year)

Sector	1996	2005	2015	2025
1) Municipal Water	196	213	232	250
2) Agricultural Water	1,410	1,501	1,688	1,862
3) Industrial Water	114	126	144	176
4) Ecological Need	730	730	730	730
Total	2,450	2,570	2,794	3,018

CHAPTER 6 STUDY ON BALANCE BETWEEN WATER SUPPLY AND DEMAND

6.1 General

Balance between water supply and demand was studied, dividing the supply water into surface water and groundwater.

In case water is supplied from surface water, the major demand is by agricultural sector to be followed by municipal and industrial water. For this case, a basin model was prepared, in which the national land was divided into seven river basins consisting of 26 sub-basins (See details of the basin model in Volume II Main Report).

In case water is supplied from groundwater, the major demand is by municipal and industrial water. For this case, the balance was studied for each municipality (the former division). The balance for the present conditions was referred to answers to the supplemental interview survey for communal enterprises carried out in October to December 1998 (There is difference between balance taken from answers to the survey and results of balance calculation for each municipality).

6.2 Balance Calculation for Surface Water

As the results of calculation based on river discharge records for 36 years from 1961 to 1996, high water shortages among sub-basins obtained through the calculation are represented by the following:

High Water Shortage in Each River Basin

(Unit : $10^6 m^3$/year)

River Basin	Current Condition (1996)	2005	2015	2025
1. Vardar River				
B1-5: Valandovo and Gevgelija	-38.5	-72.6	-70.7	-71.3
2. Pchinja River				
B3-2: Kriva Palanka	-0.5	-1.5	-126.4	-140.7
B3-3: Kumanovo	-88.9	-78.1	-72.6	-72.1
3. Bregalnica River				
B4-2: Kochani, Vinica, etc.	-238.5	-249.1	-249.5	-260.4
4. Crna River				
B5-1: Prilep	-33.3	-27.3	-26.2	-162.7
B5-3: Tikvesh	-111.5	-107.4	-102.0	-101.2
5. Strumica River				
B6-2: Turija	-75.8	-66.5	-62.5	-61.1
B6-3 :Strumica	-42.3	-38.4	-36.0	-35.8

6.3 Balance Calculation for Groundwater

6.3.1 Water Balance in Current Condition

Groundwater is used as sources of municipal and a part of industrial water supplied by CEs. Referring to answers to the supplemental interview survey for communal enterprises, one municipality (Veles) experiences water shortage throughout a year, and 17 municipalities (Skopje, etc.) have seasonal water shortage, while no water shortage is in 12 minicipalities (Kichevo, etc) as tabulated below:

Water Balance of Municipal and Industrial Water in Municipality (Current Condition)

No.	Municipality/CEs	(1) Period (month/year)	(2) Municipal Water (10^6m^3)	(3) Industrial Water (10^6m^3)	Remarks
1.	Skopje	2	- 1.6	- 9.3	
2	Gostivar/Mavrovi Anovi	4	- 0.3	- 0.6	
3	Tetovo	8	- 2.2	- 3.5	
4	Kichevo	0	0	+	No shortage
5	Makedonski Brod	1	0	0	Negligible
6	Kumanovo	4	- 2.1	- 2.8	
7	Kratovo	3	- 0.8	- 1.5	
8	Kriva Palanka	4	- 0.3	- 0.5	
9	Veles	12	- 2.0	- 4.5	
10	Sveti Nikole	5	- 0.5	- 1.1	
11	Shtip	3	- 0.2	- 0.9	
12	Probishtip	3	- 0.3	- 0.5	
13	Kochani	0	0	0	No shortage
14	Vinica	4	- 0.3	- 0.5	
15	Delchevo	2	- 0.2	- 0.2	
16	Berovo	0	0	0	No shortage
17	Demir Hisar	0	0	0	No shortage
18	Krushevo	0	0	0	No shortage
19	Bitola	0	0	0	No shortage
20	Prilep	0	0	0	No shortage
21	Kavadarci	4	- 0.5	- 1.0	
22	Negotino/Demir Kapija	6	- 0.8	- 1.5	
23	Valandovo	0	0	0	No shortage
24	Gevgelija/Bogdanci/ Star Dojran	5	- 0.7	- 1.0	
25	Ohrid	0	0	0	No shortage
26	Struga	3	- 0.8	- 1.2	
27	Debar	0	0	0	No shortage
28	Resen	2	- 0.2	- 0.3	
29	Radovish	3	- 0.4	- 0.7	
30	Strumica	0	0	0	No shortage

(Makedonski Brod has water shortage one month per a year, which quantity is negligible small)

6.3.2 Results of Balance Calculation for Future Conditions

The results of the calculation for municipal water and sum of municipal water is tabulated below, together with that in the current condition, which is shown only for reference. In the table, municipalities, which have no water shortage at current condition as well as in future as the results of the calculation, are not included. They are Makedonski Brod (5), Krushevo (18), Prilep (20), Gevgelija (24) and Ohrid (25).

Results of Water Balance Calculation for Municipal (M) and Industrial (I) Water

(unit : $10^6 m^3$/year)

No.	Municipality	(M)		(M)+(I)	
		Current	2025	Current	2025
1	Skopje	+	+	- 0.3 (S)	- 43.5 (Y)
2	Gostivar	+	+	+	+
3	Tetovo	-9,1 (Y)	-15.6 (Y)	-11.6 (Y)	-19.2 (Y)
4	Kichevo	+	+	+	- 2.5 (Y)
5	Makedonski Brod	+	+	+	+
6	Kumanovo	(reservoir)	(reservoir)	(reservoir)	(reservoir)
7	Kratovo	(reservoir)	(reservoir)	(reservoir)	(reservoir)
8	Kriva Palanka	-1,3 (Y)	-1.3 (Y)	-1.7 (Y)	-1.9 (Y)
9	Veles	(river)	(river)	(river)	(river)
10	Sveti Nikole	(reservoir)	(reservoir)	(reservoir)	(reservoir)
11	Shtip	-3,5 (Y)	-4.6 (Y)	-7.5 (Y)	-14.1 (Y)
12	Probishtip	-0.6 (Y)	-0.8 (Y)	-1.7 (Y)	-3.1 (Y)
13	Kochani	-0.3 (S)	-1.0 (S)	-0.6 (S)	-1.7 (Y)
14	Vinica	(reservoir)	(reservoir)	(reservoir)	(reservoir)
15	Delchevo	-0.2 (S)	-0.8 (Y)	-0.4 (S)	-1.2 (Y)
16	Berovo	(reservoir)	(reservoir)	(reservoir)	(reservoir)
17	Demir Hisar	- 0.2 (S)	- 0.2 (S)	- 0.2 (Y)	- 0.3 (Y)
19	Bitola	(reservoir)	(reservoir)	(reservoir)	(reservoir)
21	Kavadarci	- 0.4 (S)	-1.1 (S)	- 1.1 (Y)	-2.2 (Y)
22	Negotino	- 1.7 (Y)	-2.9 (Y)	- 2.5 (Y)	-3.7 (Y)
23	Valandovo	+	-0.2 (S)	+	- 0.3 (S)
26	Struga	+	+	+	-0.7 (S)
27	Debar	- 0.7 (Y)	-1.6 (Y)	- 1.0 (Y)	- 2.0 (Y)
28	Resen	- 0.2 (S)	- 0.3 (S)	- 0.4 (S)	- 0.7 (Y)
29	Radovish	- 1.7 (Y)	-2.5 (Y)	- 1.7 (Y)	-2.7 (Y)
30	Strumica	(reservoir)	(reservoir)	(reservoir)	(reservoir)

(+ : no water shortage, (Y) : Water shortage through a year, (S) : Seasonal shortage)

Water balance in eight municipalities, of which source of water is surface water/reservoir, was reviewed by comparing the demand of municipal water with a net capacity of each reservoir for municipal water use as follows:

Demand of Municipal Water and Reservoir Net Capacity

No.	Municipality	Reservoir	Net Capacity ($10^6 m^3$)	Water Demand ($10^6 m^3$/year) Current(1996)	2025
6.	Kumanovo	Glaznja	24.00*	11.6	14.8
7.	Kratovo	(Zletovia)	1.58	1.0	1.0
9.	Veles	(Lisiche)	23	6.3	7.3
11.	Sveti Nikole	Mavrovica	2.52*	2.0	2.1
14.	Vinica	Osojnica	-	1.7	2.2
16.	Berovo	Ratevska	9.00*	1.7	2.0
19.	Bitola	Strezevo	99.50*	10.3	11.6
30.	Strumica	Turija Vodoca	45.00* 25.12*	8.1	10.8

* : commonly used with irrigation water supply. According to the outflow records of the Glaznia reservoir, which is the main source of municipal and industrial water for Kumanovo, the periods when sufficient water was supplied to meet the current water demand (11.6 x $10^6 m^3$/year in 1996) were only 6 years in the last decade (from 1989 to 1998). Out of the periods, for 4 years, there were water shortages of the municipal and industrial water. Therefore, it can be noted water shortage was occurred once a two or three years in Kumanovo.

CHAPTER 7 PROCESS OF MASTER PLAN FORMULATION

7.1 Basic Guidelines

The Integrated Water Resources Development and Management Master Plan in the Former Yugoslav Republic of Macedonia (the Master Plan) has been formulated according to the following basic guidelines:

1) The Master Plan aims also at the well-balanced development with the basic concept of respecting environmental conservation as well as promoting effective use of water resources, in consideration of the possible negative impact on the environment, which is expected to increase with the development progress unless appropriate countermeasures are taken. Therefore, the Master Plan consists of two main components: one is a water resources development plan and the other is a water resources management plan.

   i) The water resources development plan proposes the development strategy and the development projects for each region.

   ii) The water resources management plan proposes reinforcement and establishment of the efficient and effective management system.

2) The target area is the whole national land area of 25,713 km^2.

3) The final target year is set as the year 2025. The 27-year period from 1999 to 2025 is divided into three phases; PHASE I(up to 2005), PHASE II(2006 to 2015) and PHASE III(2016 to 2025). The development direction and strategy are to be given in the Master Plan.

4) The development goal (water volume to be developed) is set-up based on the Socioeconomic Frame, which was prepared in the Study following the National Development Strategy of the Republic of Macedonia 1997 (NDS 1997), and the result of the water balance study conducted in the Study. The development goal, the Socioeconomic Frame, and the result of the water balance study were all agreed by the Macedonian side.

5) The prioritization of water use purposes is fixed basically based on the priority order set in the Water Law (Article 11) issued in January 1998.

7.2 Method and Procedure of Master Plan Formulation

Formulation process of the Master Plan taken in the Study is shown in Figure 5. The method and procedures in each step are summarized below:

1) Formation of Socioeconomic Frame (See Subsection 5.2)

2) Setting-up of Development Goal and Establishment of Direction

Development needs and environmental issues by region were also identified (See Tables 1(1/3) to (3/3)). Figure 6 shows those for the water supply except the rural water supply, while Figure 7 shows those for the rural water supply. Based on the above development goal, development needs and environmental problems, a development direction was established by region with preparation of the development curves showing the water volume to be developed in each target year by region and by water use.

3) Identification, Selection and Tentative Phasing of Development Projects

The projects identified/selected for project evaluation are shown in Table 2.

4) Project Evaluation and Tentative Prioritization

The selected projects were evaluated from the six aspects: the economic, financial, technical, social, and institutional aspects as well as the project priority previously given by the Macedonian side through the Program for Public Sector Investment (PIP) based on the evaluation criteria in Table 3. The selected projects were tentatively prioritized based on the results of the comprehensive evaluation (See Tables 4(1/2) to (2/2)).

The rural water supply projects, to be developed in a mountainous and/or border area far from urban areas, were evaluated separately from the other projects, considering their service in the interest of the public to meet needs in the communities and their relatively low-level performance of financial and economic evaluation. Further, contribution to enhancement of BHN was given the top priority in the social aspect, which is the main criteria in the evaluation.

5) Final Prioritization and Project Phasing

The phasing of the development projects included in the water resources development plan was determined finally, which is shown in Table 5.

6) Formulation of the Master Plan

Based on the results of these analyses, the development plan by region was formulated. Then, considering the environmental impact which is expected to be caused by the development plan, the water quality conservation plan was developed (See Tables 6(1/4) to (4/4)). Additionally, the watershed conservation plan, the surface water and groundwater monitoring improvement plan, the water-related facilities operation and maintenance improvement plan, the institutional strengthening plan, and the human resources development plan were designed. Compiling all of these plans, the Master Plan was completed as described in Chapter 8.

CHAPTER 8 THE MASTER PLAN

8.1 Rationale and Objectives

Stable and safe water supply is essential for improving the living conditions of the people in Macedonia, where droughts have happened and caused various negative impacts almost everywhere and in each of the past 10 years. In addition, this country has been in a transition period to cope with the democratic system and market-oriented economy since its independence in 1991 with the final goal of joining the European Union; "water" is one of the precious resources for reestablishment of the economic potentials in the agricultural and industrial sectors. Substantial investments were made in the development of water resources, however, a more integrated approach is required for the optimum utilization of the limited water resources in Macedonia.

In order to meet the requirement, the Master Plan has been formulated, of which process is explained in Chapter 7, on the purpose of giving the comprehensive scope of effective and sustainable water resources development in Macedonia.

8.2 Components

The Master Plan consists of the two components: (1) the water resources development plan and (2) the water resources management plan.

The water resources development plan proposes the development strategy for the facility construction and rehabilitation as well as development projects by regions and phases..

The water resources management plan proposes reinforcement and establishment of an efficient and effective management system for the development projects as well as the commissioned projects to bring out the best of the projects effects, consisting of six plans such as the water quality conservation plan, and so on.

8.3 Water Resources Development Plan

The following tables show development projects proposed dividing the national land area into the five regions and allocated into the three phases:

(1) Proposed Projects in the Region of Vardar River Upper Reach

PHASE	Project Name (No.)	Purpose/ Supply of
I	1) Water Supply Project for Tetovo – River Pena Intake (1)	1) M&I
	2) Kichevsko Pole Irrigation System Rehabilitation Project (2)	2) RI
	3) Patishka Reka Water Supply Project (3)	3) M
	4) Slupchanka Dam Project (4)	4) M
	5) Treska Upper Reach Rural Water Supply Project (34)	5) RS
	6) Skopje Circle Rural Water Supply Project (35)	6) RS
	7) Kriva Palanka/Kumanovo Circle Rural Water Supply Project (36)	7) RS

II	1) Studena Voda Groundwater Development Project (9) 2) Paligrad Multipurpose Dam Development Project (10) 3) Lipkovo – Glaznja Area Irrigation Rehabilitation Project (11) 4) Kiselichka Dam Project (12) 5) Vakuf Multipurpose Dam Development Project (13) 6) Vardar Upper Reach Rural Water Supply Project (38)	1) M 2) M&I,A, P 3) RI 4) M&I,A 5) M&I,A, P 6) RS
III	1) Construction of By-pass Channel Raven – Rechica (23) 2) Pelince Dam Project (24)	1) A 2) A

(M : Municipal Water, I : Industrial Water, A : Agricultural Water, RI : Improvement/ Rehabilitation of Existing Irrigation System, P: Hydroelectric Power Generation Water, RS : Rural Water Supply)

(2) Proposed Projects in the Region of Vardar River Middle Reach

PHASE	Project Name (No.)	Purpose/ Supply of
I	1) Zletovica Multipurpose Dam Development Project (5)	1) M&I
II	1) Razlovci Dam Project (14) 2) Rechani Multipurpose Dam Development Project (15) 3) Construction of Irrigation of Sub-system "Shtipsko Pole", left side (16) 4) Beregalnica River Basin Rural Water Supply Project (39)	1) M&I,A 2) M&I,A, P 3) M&I,A 4) RS
III	1) Blatec Dam Project (25)	1) M&I,A

(3) Proposed Projects in the Region of Vardar River Lower Reach

PHASE	Project Name (No.)	Purpose/ Supply of
I	1) Valandovo Area Irrigation System Rehabilitation Project (6) 2) Pelagonija Rural Water Supply Project (37)	1) RI 2) RS
II	1) Studencica Supplemental Water Supply Project (17) 2) Kovansko Dam Project (18) 3) Konsko Dam Project (19) 4) Vardar River Lower Reach/Strumica River Basin Rural Water Supply Project (40)	1) M&I 2) A 3) M&I,A 4) RS
III	1) Krapa Dam Project (26) 2) Zhban Dam Project (27) 3) Obedenic Dam Project (28) 4) Kochishte Dam Project (29) 5) Zhurche Dam Project (30) 6) Konjarka Dam Project (31) 7) Petrushka Dam Project (32)	1) M&I,A 2) A 3) A 4) A 5) A 6) A 7) A

(4) Proposed Projects in the Region of Crn Drim River Basin

PHASE	Project Name (No.)	Purpose/ Supply of
I	1) Irrigation System Betterment Project in Resen (7)	1) RI
II	1) Ohrid Area Irrigation Rehabilitation Project (20) 2) Southwest Mountainous Area Rural Water Supply Project (41)	1) RI 2) RS

(5) Proposed Projects in the Region of Strumica River Basin

PHASE	Project Name (No.)	Purpose/ Supply of
I	1) Oraovica Dam Project (8)	1) M,E
II	1) Mantovo Area Irrigation Rehabilitation Project (21) 2) Strumica Area Irrigation Rehabilitation Project (22)	1) RI 2) RI
III	1) Podares Dam Project (33)	1) M&I,A

The location of projects proposed in the water resources development are shown in Figure 8.

Prevention from water pollution in the five regions is included in the water quality conservation plan in the water resources management plan (See Subsection 8.4.1).

One rural water supply project is proposed by combination with that listed up in PHASE II and the Vardar River lower reach.

A nationwide rural water supply extension/improvement project is proposed to complete the rural water supply project in the whole country by 2015. For 10 years since 2015 until 2025 in PHASE III, one package project (Project No. 42) is proposed for all the country to extend the facilities to deal with increase of population in the rural area and to rehabilitate facilities which will be deteriorated.

8.4 Water Resources Management Plan

8.4.1 Water Quality Conservation Plan

For smooth promotion of the development projects and improvement of living conditions and social welfare of Macedonian people, it is indispensable to prevent water from pollution which is an environmental issue identified in each river basin through the Study (See Figure 9). Thus, reduction of the pollutant load due to increasing water utilization after completion of the projects should be proceeded. Tables 6(1/4) to (4/4) tabulate the water quality conservation plan as the counter-plans required based on results of identification of the water utilization and water quality conditions at the present and environmental states in the future forecasted with the results of the pollutant load analysis and water quality monitoring. Following the tables, it is proposed to provide wastewater treatment facilities by region to deal with the present water pollution and in line with the progress of the development of the projects as the water quality conservation plan.

8.4.2 Watershed Conservation Plan

In the aspect of conservation of potential water resources and maintenance of the water-related structures, the watershed conservation plan is proposed by river basin as shown in Figure 10. The watershed conservation plan in the five regions are tabulated as follows:

(1) **Watershed Conservation Plan in Vardar River Upper Reach**

Project Name (Project No.)	River Basin	Purpose
Pena River Erosion Control Project (1)	Pena and Mazradracha Rivers	Debris Flow Control
Dzhepishte River Erosion Control Project (2)	Dzhepishte River	Debris Flow Control
Markova and Kadina River Basins Erosion Control Projects (3)	Markova and Kadina Rivers	Protection against Surface Erosion
Shara Mountains Erosion Control Projects (4)	Shara Mountains	Protection against Surface Erosion
Skopsko Crna Gora Mountains Erosion Control Project (5)	Skopje and its Suburban Area	Protection against Surface Erosion

(2) **Watershed Conservation Plan in Vardar River Middle Reach**

Project Name (Project No.)	River Basin	Purpose
Kalimanci Reservoir Erosion Control Project (6)	Bregalnica River	Restriction of Sediment Yield
Ratevska Reservoir Erosion Control Project (7)	Ratevska River	Restriction of Sediment Yield
Kamenicika River Erosion Control Project (8)	Kamenicika River	Protection against Surface Erosion
Bregalnica Middle Reach River Improvement Project (9)	Bragalnica River	Protection of river Bank Erosion
Vinicika River Erosion Control Project (10)	Vinicika River	Protection against Surface Erosion
Mantovo Reservoir Debris Flow Control Project (11)	Kriva Lakavica River	Debris Flow Control

(3) **Watershed Conservation Plan in Vardar River Lower Reach**

Project Name (Project No.)	River Basin	Purpose
Pelagonija Field Drainage Improvement Project (12)	Crna River	Improvement of Drainage Canal
Vardar River Lower Reach Improvement Project (13)	Vardar River	Protection against River Bed and Bank Erosion
Konsko River Improvement Project (14)	Konsko River	Protection against Bank Erosion
Selechka Mountain Erosion Control Project (15)	Tributary from Left Bank of Crna River	Protection against Surface Erosion
Kavadarci Area Erosion Control Project (16)	Tributary from Right Bank of Vardar River	Protection against Surface Erosion

(4) **Watershed Conservation Plan in Crn Drim River Basin**

Project Name (Project No.)	River Basin	Purpose
Sateska River Basin Conservation Project (17)	Sateska River	Protection against Surface Erosion and Flood Control
Debar Reservoir Erosion Control Project (18)	Crn Drim River	Restriction of Sediment Yield
Galichica and Pelister Mountains Erosion Control Project (19)	Creeks in Galichica and Pelister Mountains	Protection against Surface Erosion

In the Strumica river basin, a development project to control debris flow in the Irovica River basin (tributary joining from left side of the Strumica River) is underway. Since few area and/or river stretches needing urgent countermeasure is identified through the Study, no project is formulated in this river basin.

8.4.3 Surface Water and Groundwater Monitoring System Improvement Plan

Operation and maintenance of the existing monitoring network for climate, surface water and groundwater over the country, is carried out by HMI. Regarding the climatology monitoring network, principal stations (35 nos.) and rain gauge stations (295 nos.) sufficiently cover the national territory. The operation and maintenance conditions are moderately good. On the other hand, regarding water level gauging stations (110 nos.), the stations properly maintained are around only 50 % and the existing facilities/organizations are also insufficient level. Further, monitoring stations of groundwater working properly are under 50 % in total, which causes a bottleneck of safe water supply.

Considering the current conditions, an improvement plan of the existing surface water and groundwater monitoring is proposed as follows to achieve efficient and effective water utilization and management. The component of the plan is tabulated in Table 7 and location is shown in Figure 11.

8.4.4 Water-related Facilities Operation and Maintenance Improvement Plan

Preparation of operation and maintenance manual for the water-related facilities such as dam, tapping/ transporting/ purifying/ distributing facilities and irrigation facilities etc. is inevitable to strengthen water resources management.

In the nationwide level, the existing facilities can not play the designed function due to poor maintenance and repair of instruments and structures caused by lack of operation and maintenance manual. To meet this situation, the following three improvement plans of water-related facilities operation and maintenance improvement are proposed to be prepared as soon as possible.

Water-related Facilities Operation and Maintenance Improvement Plan

(a) Operation and Maintenance Manual of Water Supply Facilities Contents: Preparation of O & M Manual of facilities Implementing agency: MUPC Purpose: Technical enhancement on operation and maintenance, strengthening of distributed water control, promotion of water restriction for end-user Target facilities: Purification plant, service reservoir, distribution pipeline and pumping station, etc.
(b) Operation and Maintenance Manual of Dam and Appurtenant Structures Contents: Preparation of basic data for operation Preparation of operation and maintenance guideline - Embankment (leakage, deformation, condition on surface of slopes, pore pressure, etc.) - Abutment (leakage, crack, falling, sliding, etc.) - Intake and river outlet facilities (operation rules of valves and gates for discharge measurement/control - reservoir (sedimentation, surface sliding, etc.) Implementing agency: MAFWE Purpose: Preparation of technical guideline for operation and maintenance rules of dam and reservoir Target facilities: Existing major dams (20 locations in total), reservoirs and appurtenant facilities

(c) **Operation and Maintenance Manual for Irrigation Facilities**
Contents: Preparation of manual for measurement of intake volume
Preparation of technical guideline of gate operation
Implementing agency: MAFWE
Purpose: Strengthening of water supply control and operation/maintenance of facilities
Target facilities: Intake facilities, canals and distribution facilities etc.

8.4.5 Institutions and Legal System Strengthening Plan

In order to ensure smooth, efficient, and effective realization of the water resources development plan and the management plan, it is essential to promote the capacity building in the related institutions and in the legal system especially focusing on the following points:

(1) Institutional Strengthening in Decision-making Level: Establishment of Coordination Committee of Water Resources Development and Management

(2) Institutional Strengthening at Executing Agencies Level: Early establishment of PWME management system

(3) Institutional Strengthening for Promoting Rural Water Supply Projects: Establishment of Rural Water Supply Unit

(4) Institutional Strengthening at Users Level: Promotion of Community Participation

(5) Institutional Strengthening in the Legal System

8.4.6 Human Resources Development Plan

The development of human resources is very important for successful implementation of the Master Plan. Currently, education and training programs for engineers and managers in the water resources development and management have not been well established. Only on-the-job training has been provided at the working places.

Therefore, it is proposed to formulate a human resources development plan, consisting of education and training for the concerned people engaging in various stages of development projects and/or in the entire part of the water resources development and management.

CHAPTER 9 RECOMMENDATIONS FOR FUTURE PROMOTION OF THE MASTER PLAN

9.1 Recommendations on Action Plan

Figure 12 shows the proposed implementation schedule of the development projects included in the water resources development plan in the Master Plan by region, by water use purpose, and by PHASE, with the project costs. The total project costs required in the period from 1999 to 2025 is estimated at 1.965 billion US$ including those for the water resources management plan (price level: January 1999). The implementation program and investment plan in PHASE I are shown in Figure 13 and the table below:

Investment Plan in PHASE I

Year	Expected Start of Projects (Name and No.)	Investment (106 x US$)	Expected Completion of Projects (Name and No.)
1999	—	0	—
2000	—	0	—
2001	· Slupchanka (No.4) · Zletovica (No.5) · Resen (No.7)	20.8	—
2002	· Tetovo (No.1) · Patishka Reka (No.3) · Skopje (No.35) · Kriva Palanka/ Kumanovo (No.36)	50.2	· Slupchanka (No.4) · Resen (No.7)
2003	· Kichevsko (No.2) · Valandovo (No.6) · Oraovica (No.8) · Pelagonia (No.37)	68.0	· Tetovo (No.1) · Patishka Reka (No.3) · Skopje (No.35)
2004	· Treska (No.34)	57.6	· Kichevsko (No.2) · Zletovica (No.5) · Kriva Palanka/ Kumanovo (No.36)
2005	—	29.5	· Valandovo (No.6) · Oraovica (No.8) · Treska (No.34) · Pelagonia (No.37)
	Total	226.1	

The investment cost required for PHASE I is estimated at 226.1 million US$ (averaged at 45 (=226.1/5) million US$ per a year), summing up the annual investment costs of 5 years from 2001 (20.8 million US$) to 2005 (29.5 millionUS$). In the meanwhile, the public investment cost relating to the water supply and irrigation sector was about 20 million US$ among the national budget of 750 million US$ in 1996, and about 16.5 million US$ was provided annually on an average according to a report of ACU, resulting in 36.5 (=20+16.5) million US$ per a year combining those for the public investment for

the water supply and irrigation sector.

That means further 8.5 (=45-36.5) million US$ per a year will be required, being compared with the current annual investment, in case implementation of the projects as proposed in PHASE I.

To deal with this, it is strongly recommended in the early time to carry out further investigation and study on the feasibility level and to estimate the investment cost and internal rates of return of each project with a certain accuracy so as to formulate a fund raising plan incorporating the fund sources of the projects like foreign currency (foreign aids), local currency (government budget), and others (BOT/PFI, etc.).

9.2 Recommendations on General Issues in Water Resources Development

(1) Consideration to the issue of the international river

Coordination about the international rivers with the neighboring countries for the implementation of some of the development and management projects, which needs to be managed by the Government of Macedonia.

(2) Coordination among donors

Currently, the irrigation system rehabilitation projects are being implemented with the World Bank cooperation and the nationwide master plan formulation study on the treatment of wastewater and solid waste under the PHARE program. The cooperation between the Master Plan and these on-going projects contributes to the efficient implementation of the Master Plan.

(3) Early establishment of the Water Economy Base Plan

It is desirable to formulate the Water Economy Base Plan, which is expected to be completed by PWME, as the concrete and practical action plan in the water resources management as soon as possible based on the output of the Master Plan. For the preparation, institutional strengthening for operation and maintenance and enhancement of the legal system should be carefully considered in addition to the facility construction.

9.3 Recommendations on General Issues about Development Plan

(1) Review and upgrading of the National Development Strategy

The National Development Plan should be developed through reviewing and upgrading of the National Development Strategy. The National Development Plan needs to provide the comprehensive image of the improvement in the population's living conditions, the development of the agricultural, industrial, and commercial sectors, the regional development, and environmental conservation. The plan is also expected to show the concrete directions of the "development goals and targets", "development strategy", "action plan" etc..

(2) Formulation of regional and sectoral development plans

According to the National Development Plan, which is proposed in the previous paragraph, the development plans by regions and by economic sectors including agricultural, industrial, trading etc. are required. The regional development plans will show the concrete action plans based on the direction of development for each region, which is given in the National Development Plan. The sectoral development plan needs to provide the new direction of the development toward the market-oriented economy through the preparation of the nation-wide inventory of the existing production activities, facilities, etc. In addition to the agricultural and industrial sectors, the improvement of the marketing and distribution system is also important.

(3) Strengthening of project planning and implementation system through participatory development method

The participatory development method, such as the PCM method, etc. is desirable to be introduced in each of the steps of the project cycle including project formulation, project selection and appraisal, planning, implementation, and monitoring and evaluation. This will improve the ownership and sustainability of the development projects.