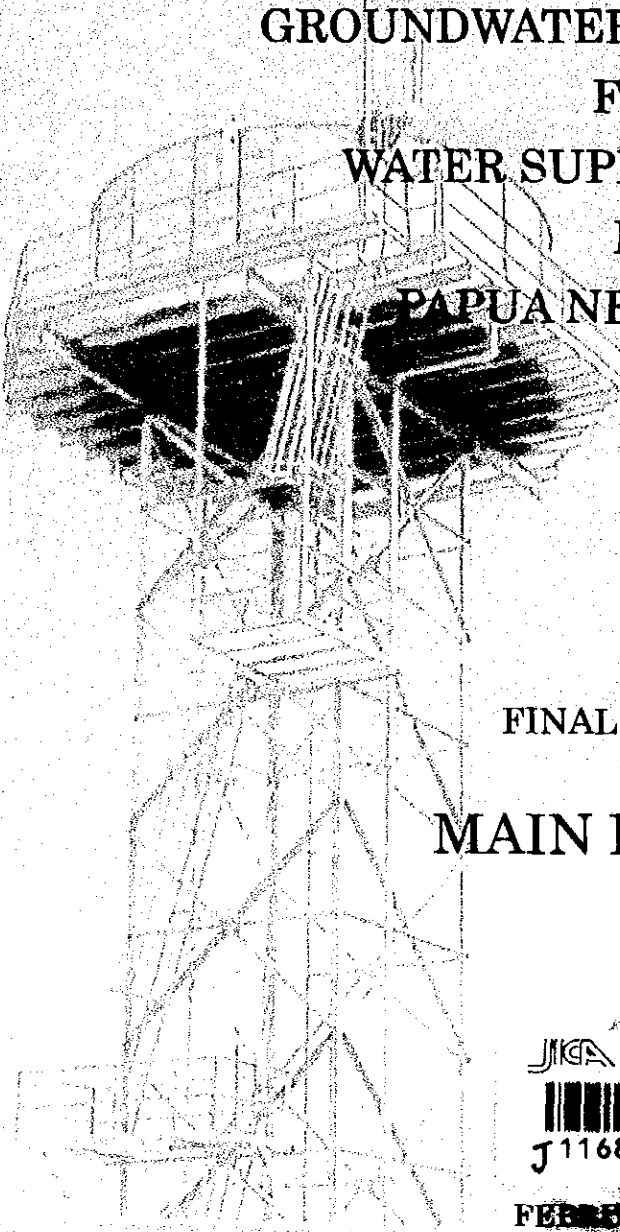


JAPAN INTERNATIONAL COOPERATION AGENCY
THE PAPUA NEW GUINEA WATERBOARD

THE STUDY
ON
GROUNDWATER DEVELOPMENT
FOR
WATER SUPPLY SYSTEMS
IN
PAPUA NEW GUINEA



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THE STUDY ON GROUNDWATER DEVELOPMENT
FOR WATER SUPPLY SYSTEMS IN PAPUA NEW GUINEA

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THE STUDY
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GROUNDWATER DEVELOPMENT
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IN
PAPUA NEW GUINEA

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PREFACE

In response to a request from the Government of Papua New Guinea, the Government of Japan decided to conduct the Development Study on Groundwater Development for Water Supply Systems in Papua New Guinea and entrusted the study to the Japan International Cooperation Agency (JICA).

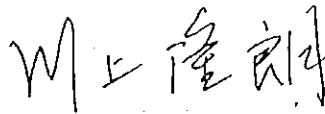
JICA selected and dispatched a study team headed by Mr. Shigeyoshi KAGAWA of JAPAN TECHNO Co., LTD. to Papua New Guinea, three times between March 2000 and February 2002.

The team held discussions with the officials concerned of the Government of Papua New Guinea, 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 the project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Papua New Guinea for their close cooperation extended to the Team.

February 2002



Takao Kawakami

President

Japan International Cooperation Agency

February 2002

Mr. Takao Kawakami
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

Dear Mr. Kawakami:

We are pleased to submit to you the study report on Groundwater Development for Water Supply Systems in Papua New Guinea.

The report presents the study results on the present conditions of water supply as well as the groundwater development potential in the 2 Provincial Towns and 6 District Towns in Papua New Guinea. The report includes master plans for improvement in water supply as well as pilot projects for their implementation.

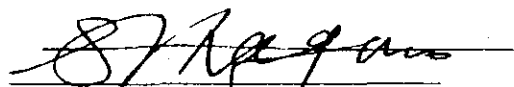
This report consists of the following volumes:

- Summary Report A concise report on the whole study results
- Main Report Description of the study results including the groundwater development, water supply master plan, and prioritized pilot project implementation and evaluation
- Supporting Report Results of geophysical investigation, test drilling, environmental and social study, training, and pilot project
- Data Book Survey data of landsat image, test borehole, resistivity sounding, economy, finance, institution and legal framework, PCM workshop, pre-registration for water supply services, well drilling data, MOU, MOA, concerned persons list, participants and minutes of meetings

We are confident that the implementation of the pilot project would greatly contribute to the improvement of district centers of water supply and sanitation conditions together with open up new market opportunities for PNGWB in the rural communities where more than 80% of the population is concentrated.

We wish to take this opportunity to express our sincere gratitude to your agency and the Embassy of Japan in Port Moresby. We also wish to express our deep appreciation to the Papua New Guinea Waterboard and Aid Coordination and Management Division, Department of National Planning and Monitoring as well as other authorities concerned of the Government of Papua New Guinea for the close cooperation and assistance extended to us during our study activities in your country.

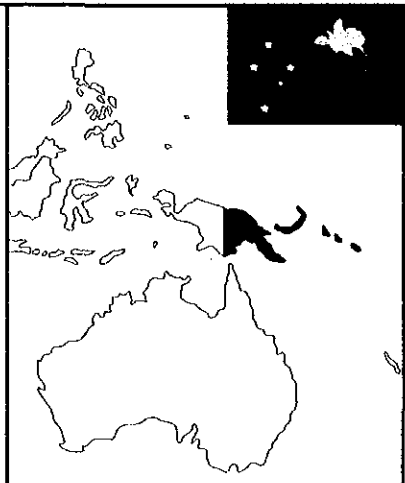
Very truly yours



Shigeyoshi Kagawa
Team Leader

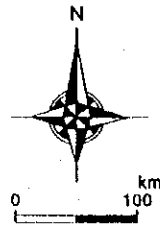
The Study on Groundwater
Development for Water Supply
Systems in Papua New Guinea

THE STUDY ON GROUNDWATER DEVELOPMENT FOR WATER SUPPLY SYSTEMS IN PAPUA NEW GUINEA



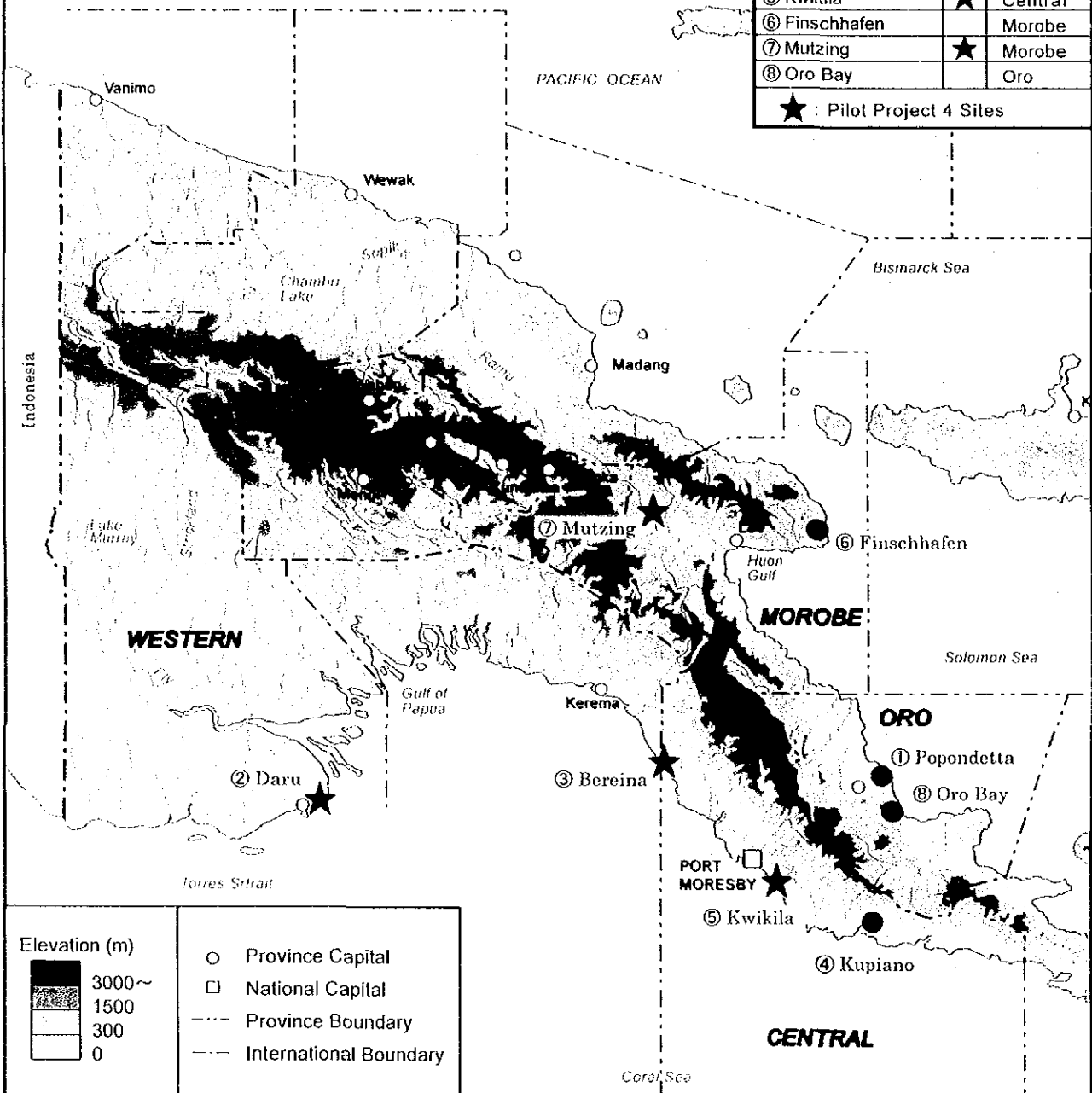
Location of Study Area

- ★ Pilot Project Site (4 towns)
- Other Study Town (4 towns)



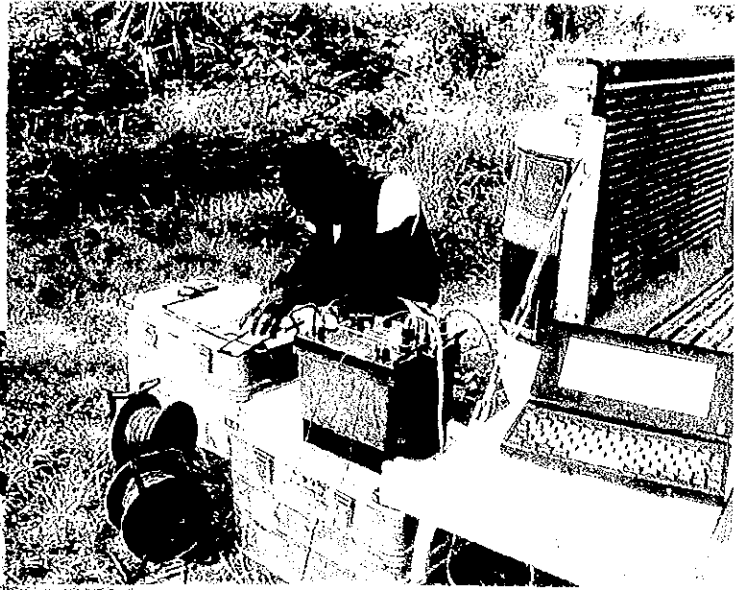
Study Area		Province
①	Popondetta	Oro
②	Daru	★ Western
③	Bereina	★ Central
④	Kupiano	Central
⑤	Kwikila	★ Central
⑥	Finschhafen	Morobe
⑦	Mutzing	★ Morobe
⑧	Oro Bay	Oro

★ : Pilot Project 4 Sites



1. Groundwater Development

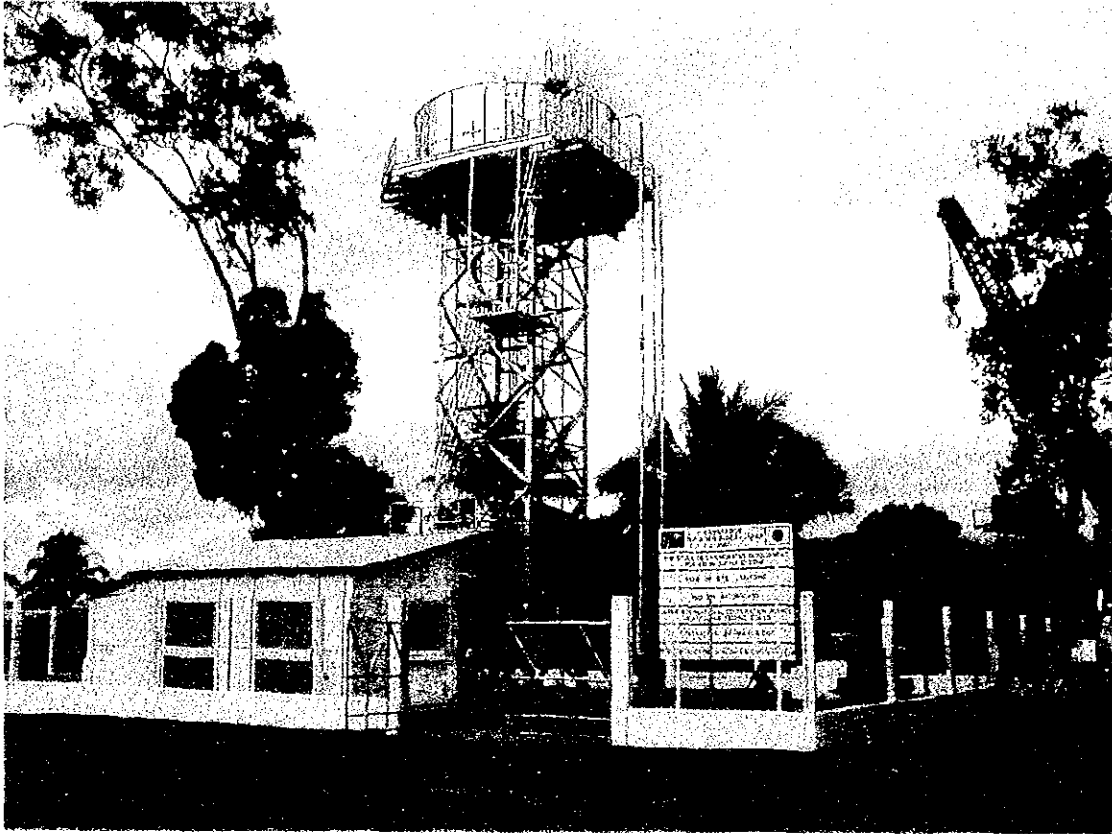
Geophysical Survey



Drilling Borehole



2. Pilot Project for Water Supply Systems



Pumping Station

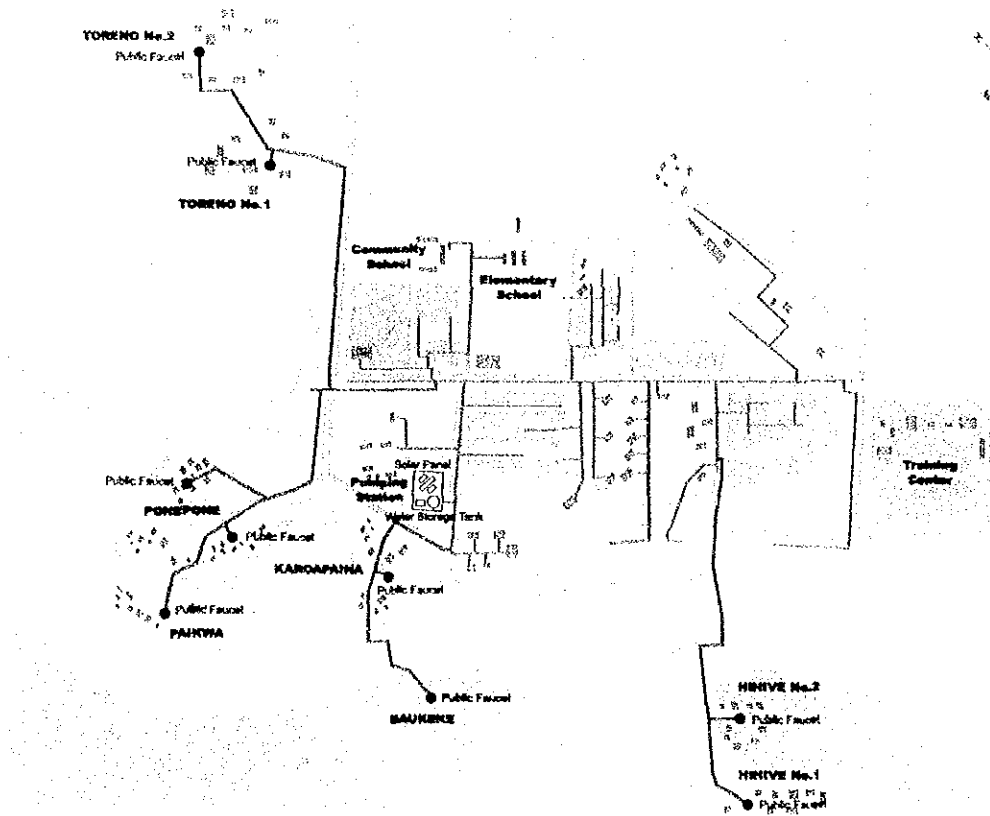


Public Faucet

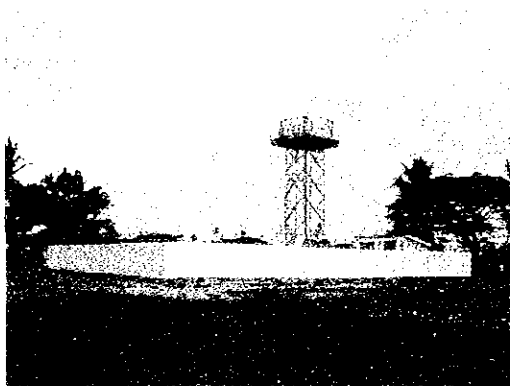


Pilot Project for Improvement of Water Supply System

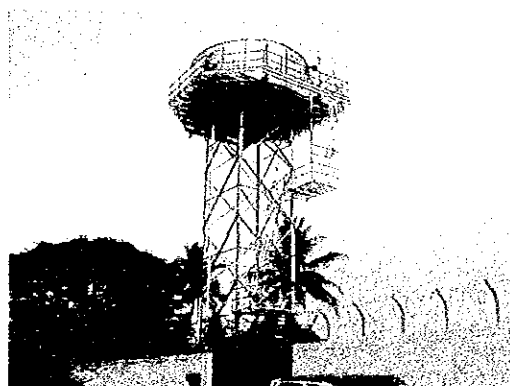
1. Bereina



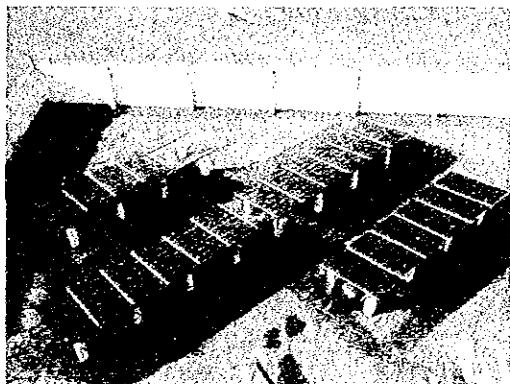
Reticulation map



Pumping station



Water storage tank (80m³-15m)



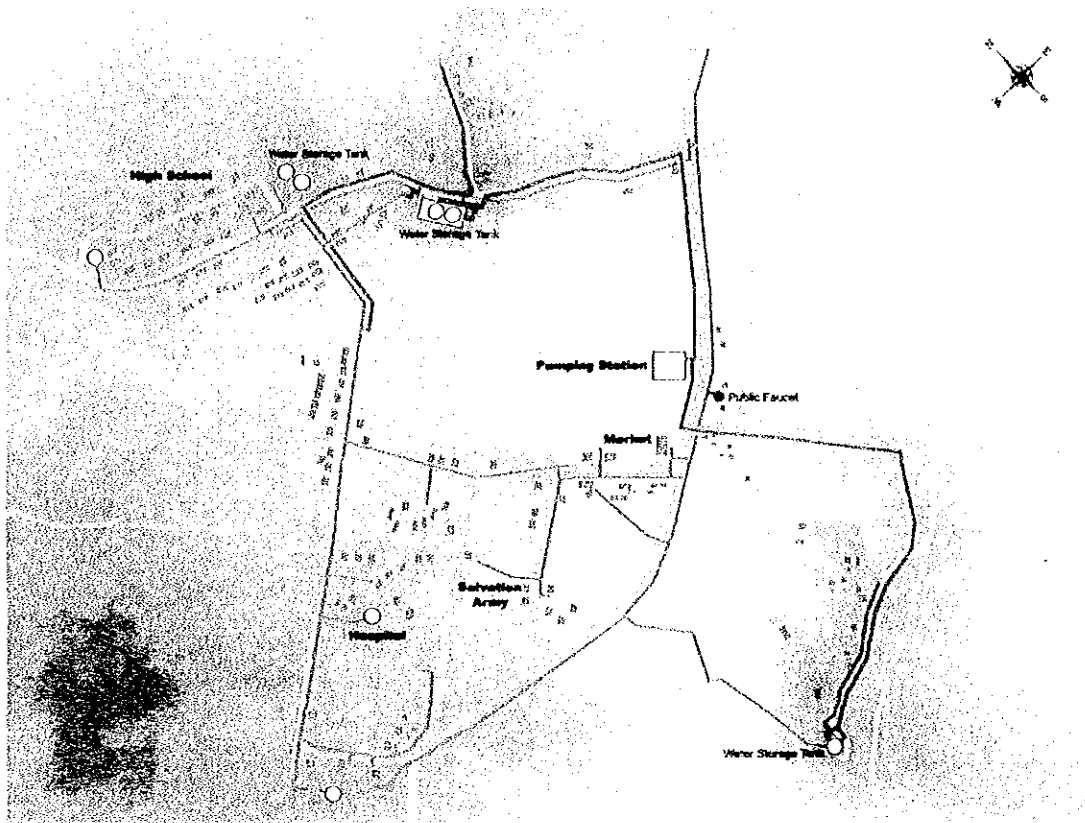
Solar panel



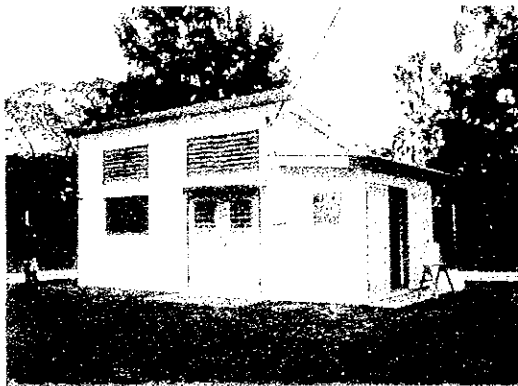
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Pilot Project for Improvement of Water Supply System

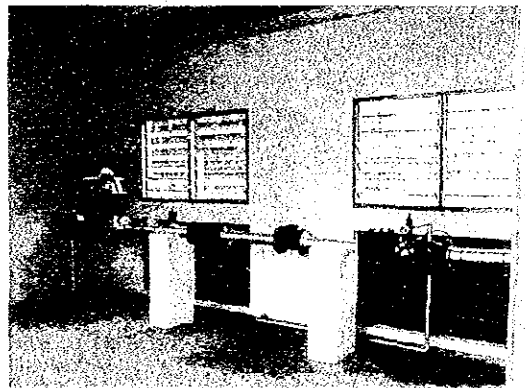
2. Kwikila



Reticulation map



Pumping house



Interior of pumping house



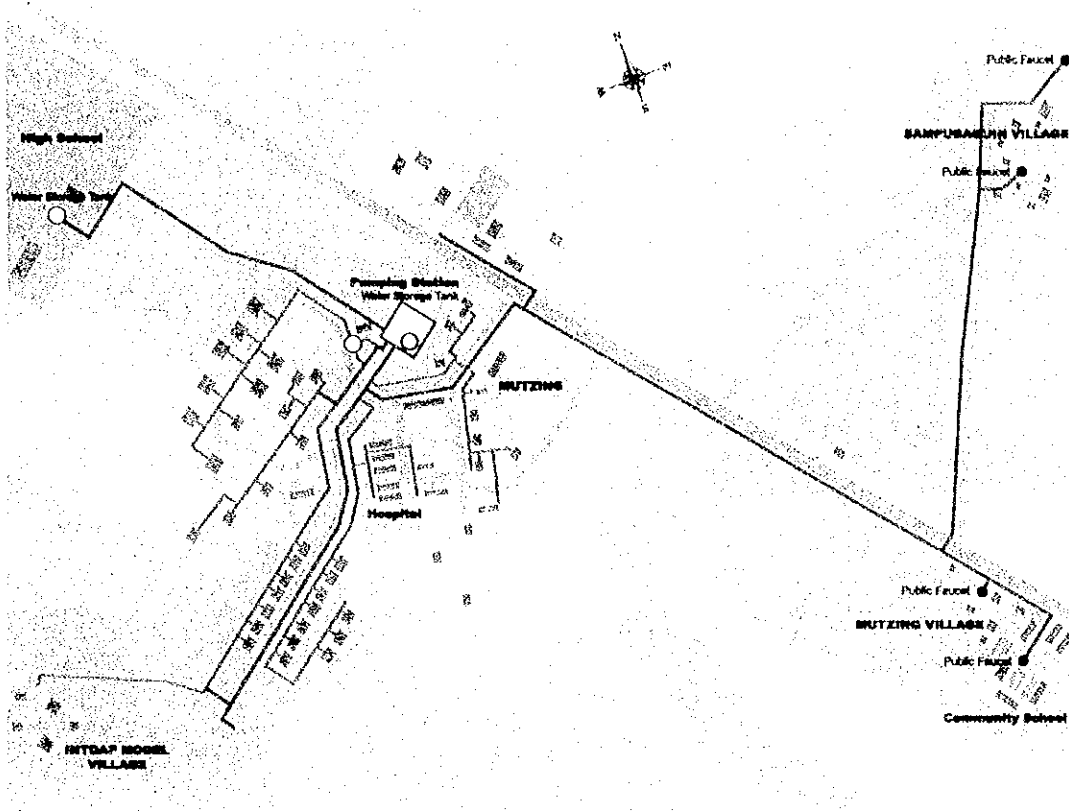
Public faucet



Water storage tanks (60m³ x2)

Pilot Project for Improvement of Water Supply System

3. Mutzing



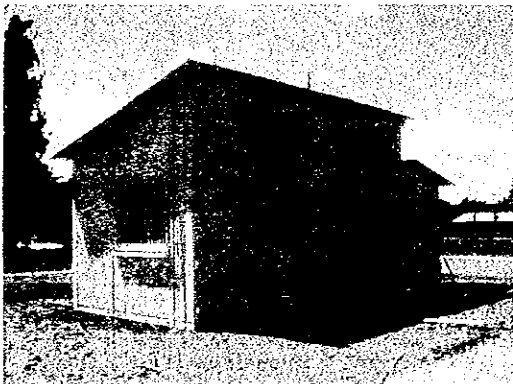
Reticulation map



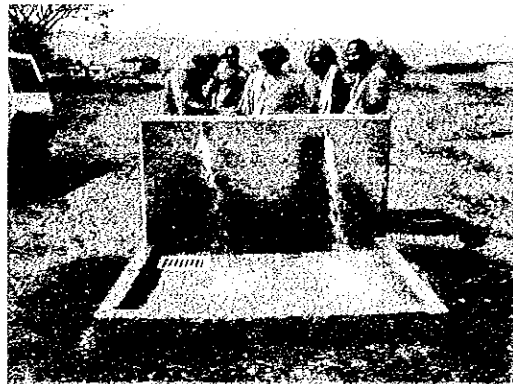
Pumping station



Borehole pit

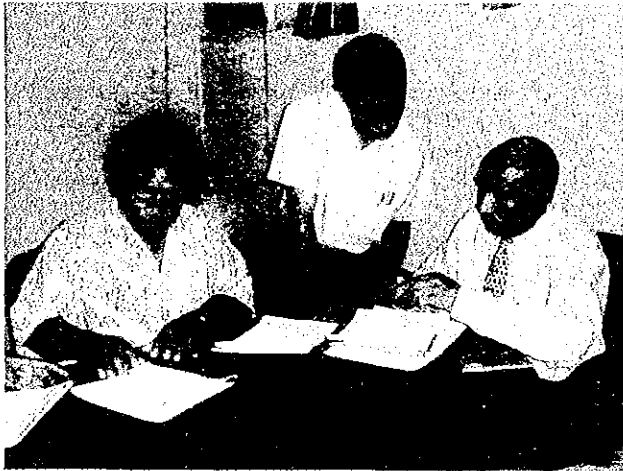


Pumping house

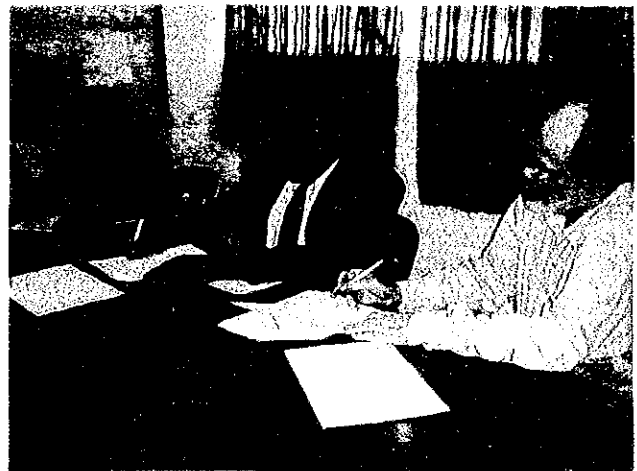


Public faucet

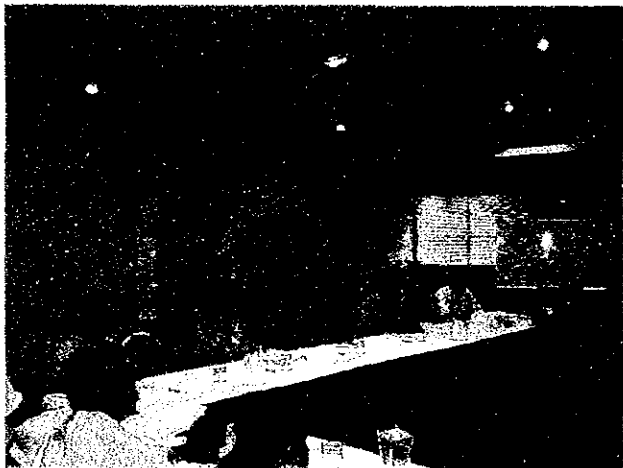
Photo-1



Signing of MOU & MOA (Central Province), June 1, 2001



Signing of MOU & MOA (Morobe Province), May 31, 2001



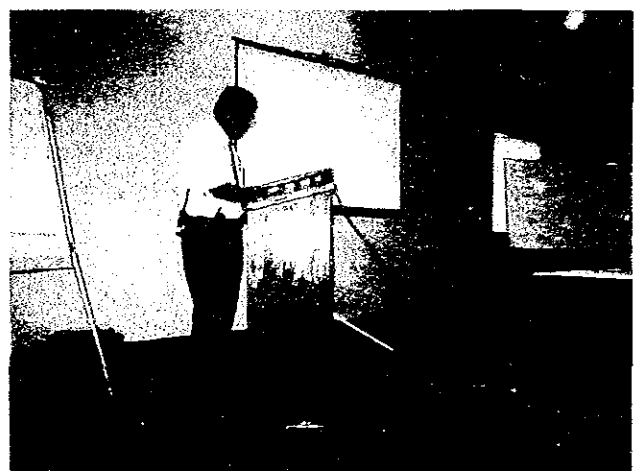
JICA Study Team at Workshop on PDM, June 8, 2001



Workshop conclusion of PDM, June 8, 2001



Workshop on O, M & M, June 29, 2001



Opening Remarks by JICA Representative, Mr. Iwasaki

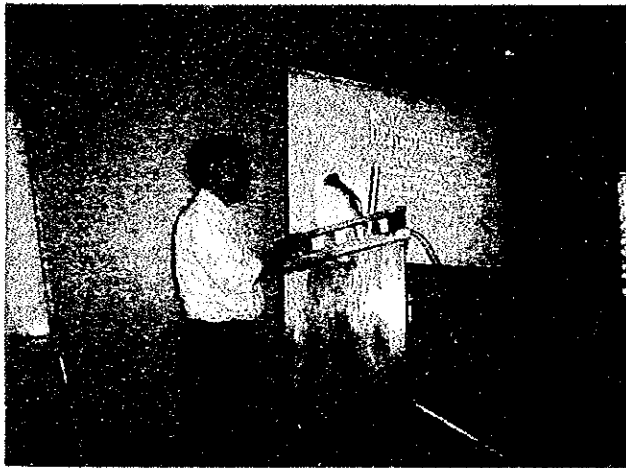
Photo-2



Speech by PNG Waterboard Managing Director, Mr. Amini



The attendance of Workshop on O, M & M, June 29, 2001



Explanation by JICA Study Team, June 29, 2001



Explanation by JICA Study Team, June 29, 2001



Explanation & Discussion at Village (MUT'ZING), May 2001



Seminar & Training at Village (BINATURI), June 2001

Opening Ceremony of Water Supply System at MUTZING (Oct 8, 2001)



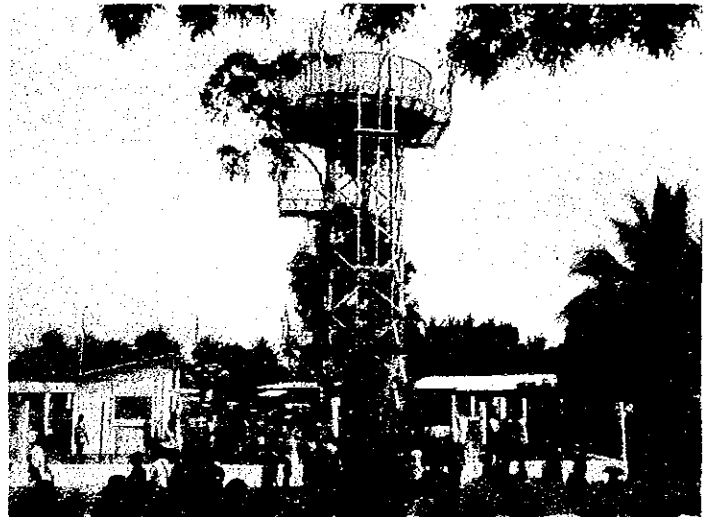
The invited guests proceeding to the ceremony stage



The ceremony stage and audience



Address by JICA Resident Representative Mr. Iwasaki



Decorated water tank & audience



Demonstration of water supply at Tank



PNG Waterboard and JICA Cooperation hand in hand

Opening Ceremony of Water Supply System at BEREINA (Oct 19, 2001)



The invited guests proceeding to the ceremony stage



The invited guests at the ceremony stage



Address by H.E. Ambassador of Japan Mr. Tanaka



Audience gathering for the ceremony



Welcome by dancing groups



Demonstration of water supply at the Tank

DARU • BINATURI



Water Vending Unit at Samari Corner (Oct 4, 2001)



Water Vending Unit at Frog Town (Oct 4, 2001)



Hand pump at Boze (Oct 3, 2001)



Hand pump at U'ume No,1 (Oct 3, 2001)



Rain water tank at Boze (Oct 3, 2001)



Rain water tank at Masingala (Oct 3, 2001)

THE STUDY ON GROUNDWATER DEVELOPMENT FOR WATER SUPPLY SYSTEMS
IN PAPUA NEW GUINEA

FINAL REPORT
- MAIN REPORT -

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ABBREVIATIONS

ADB	Asian Development Bank
ADF	Average Daily Flow
AHF	Average Hourly Flow
APEC	Asia-Pacific Economic Cooperation
Aus AID	Australian Agency for International Development
BOT	Build, Operate and Transfer
CSA	Commercial Statutory Authority
DDP	District Development Programme
DEC	Department of Environment and Conservation
DF	Daily Flow
DNPM	Department of National Planning and Monitoring
DOH	Department of Health
DOW	Department of Works
DSG	District Support Grant
DWC	Daily Water Consumption
ELCOM	Papua New Guinea Electricity Commission
GDP	Gross Domestic Product
GNP	Gross National Product
HDPE	High Density Polyethylene Pipe
HPLC	High-Performance Liquid Chromatography
ICP	Inductively Coupled Plasma
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
JDP&BPC	Joint Development Planning & Budget Prioritization Committee
K	Kina
LLG	Local Level Government
MOA	Minutes of Agreement
MOU	Minutes of Understanding
NARI	National Agricultural Research Institute
NAL	National Analysis Laboratory
NCD	National Capital District
NGO	Non-Governmental Organization
NPV	Net Present Value
NSC	National Standard Council
NWSS Act	National Water Supply and Sewerage Act 1986
ORD	Office of Rural Development

PCM	Project Cycle Management
PDF	Peak Daily Flow
PG	Provincial Governments
PHF	Peak Hourly Flow
PNGS	Papua New Guinea Standards
PNGWB	Papua New Guinea Waterboard
PSG	Provincial Support Grant
PVC	Polyvinyl Chloride Pipe
RRA	Rapid Rural Appraisal
SAA	Standards Association of Australia
S&RDG	Social and Rural Development Grant
TC	Tank Capacity
TP	Target Population
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
VAT	Value Added Tax
WD	Water District
WET	Water Executive Team
WHO	World Health Organization
WRMD	Water Resources Management Division
WVU	Water Vending Unit

CHAPTER 1 INTRODUCTION

1.1 General

This is the Final Report for the Study on Groundwater Development for Water Supply Systems in Papua New Guinea (hereinafter referred to as "the Study"). This Report was prepared for the Study of Phase I and Phase II, Work in Papua New Guinea and Work in Japan from March 2000 to December 2001. This is in accordance with the Scope of Work agreed upon by the Papua New Guinea Waterboard (hereinafter referred to as "PNGWB") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") in Port Moresby on December 20, 1999 and Amendments of the Scope of Work on November 9, 2000.

The Study commenced in the middle of March 2000 in Japan and was completed by the end of February 2002 with submission of the Final Report. The study is divided into two phases as follows.

- Phase I: Investigation of Groundwater and Formulation of Water Supply Plan
- 1) Work in PNG (1) Investigation of Groundwater Potential and Water Supply System
- Phase II: Pilot Project for Improvement of Water Supply System
- 2) Work in PNG (2) Pilot Project
 - 3) Work in Japan (1) Preparation for Draft Final Report
 - 4) Work in PNG (3) Explanation and Discussion on Draft Final Report, Implementation of the Seminar for Technology Transfer, and Evaluation for Pilot Project.
 - 5) Work in Japan (2) Completion of Final Report

The JICA Study Team carries out the work in close co-operation with the counterpart personnel from the PNGWB, with emphasis on technology transfer.

1.2 Background of the Study

The Government of PNG requested a technical assistance from the Japanese Government in 1998 to conduct the study for groundwater development for water supply systems due to the serious drought in 1997-1998 affected by El Niño. In response to this request, JICA dispatched a Preparatory Study Team in December 1999 and formulated the Scope of Work for this Study. The Field Study for Phase I started in April 2000 in Port Moresby with the submission and discussion of the Inception Report, and conducted the groundwater potential study including geophysical prospecting and test drilling. The groundwater potential study including formulation of a master plan for water supply systems was completed to confirm the groundwater potential for water supply systems on September 2000 by the submission of the Progress Report (1), Phase I. Based on the study results of Phase I, the

Amendments of the Scope of Work for Phase II study was concluded between the PNGWB and JICA on November 9, 2000 to implement a Pilot Project at 5 sites, namely Bereina, Kwikila, Mutzing, Daru and Binaturi.

The Pilot Project involves a new concept, with three particular aspects. The first aspect, which is the first of its kind, involves experimental and trial studies of District Water Supply at Bereina, Kwikila and Mutzing in PNG consisting of construction and rehabilitation of existing water supply facilities and operation, management and maintenance by the PNGWB. The second aspect involves the trial studies of a Water Vending Unit system supplying clean drinking water for lower income groups on Daru Island as part of the Provincial Town Water Supply. The third and final aspect of this concept looks at the involvement and participation of villagers in a water supply project as part of the Rural Water Supply Project. In Phase II, a Pilot Project for the construction and rehabilitation of water supply systems was executed successfully from December 2000 to July 2001 and handed over to PNGWB to operate, manage and maintain.

The 26 years old Independent State of PNG in the South Pacific lies just below the equator in the Eastern South Pacific. The country comprises of more than 600 islands and covers a total area of over 462 thousand km². The main island of New Guinea is shared with West Irian, Indonesia. The population of the country is estimated to be about 5 million in 2001 distributing about 26% in the coastal plains of the main island and 36% in the high mountains, 20% in the southern part of the main island, and 16% in the island archipelagos. PNG has a moderate tropical climate with high levels of seasonal rainfall totalling more than 2,000mm to 6,000 mm in a year. However, the low rainfall in 1997-98 led to drought over large areas of PNG. Some parts of the mountains were also affected by serious frosts due to El Niño. There was widespread destruction of the food gardens on which much of the PNG population depends. At the same time, water sources for water supply systems were dry and serious shortage of drinking water affected by the drought was encountered.

Water resources in PNG are not well developed though in some areas the potential is high. The study of water resources for both surface and groundwater will enable proper planning of this natural resource for social welfare. In the Five Years Development Plan, 2002-2006 for each District, the plans for supplying safe and potable water and construction of water supply facilities are given high priority. The PNGWB, which was established under the National Water Supply and Sewerage Act, 1986, was required to be both a commercially oriented agency, delivering eleven (11) Provincial Towns water supply and sewerage and the main sector of advisory and planning division for local town water supply in PNG. Japan has assisted the Government of PNG in the sectors of

transportation, public health facilities and drinking water supply and sewerage as well as other kinds of official development assistance programs.

With this background, the Government of PNG requested the Government of Japan in 1999 for the study on investigation and development of groundwater for water supply systems. In response to the request, JICA dispatched a preparatory study team in December 1999 and formulated the Scope of the Work for the study. The study areas consisting of 2 Provincial Towns and 6 District Towns are located in the main islands of New Guinea. The basic concept of the Study is designed to pay close attention to the decentralization currently being introduced by the Government through the Organic Law 16 (1995). Provincial and Local Level Governments intend to broaden the base of improvement of living conditions and economic development in PNG in order to benefit the majority of the rural people who have suffered relatively through neglect in the past. Many communities throughout the country are seriously affected by the lack of safe drinking water and adequate sanitation facilities. Only 30 % of the population has access to safe drinking water and about 22 % of the population has adequate sanitation facilities. Therefore, it is planned to improve the coverage of water supply to 50 % in 2010 by the Government of PNG.

1.3 The Objectives of the Study

The objectives of the Study are:

- 1) To formulate a water supply plan through the investigation of groundwater potential,
- 2) To conduct the pilot project for improvement of water supply system in the selected areas, and
- 3) To transfer technology to counterpart personnel in the course of the Study.

1.4 Study Area and Pilot Project Sites

The Study covers two (2) Provincial Towns and six (6) District Towns, and the Pilot Project will cover one (1) Provincial Town and three (3) District Towns. The Study area is shown in the map at the beginning of this Report and the list of four (4) sites for Pilot Project are presented hereafter. The proposed population of the Study area was totally 23,800 in 1999, however after the Study of PNG (1) in 2000, the surveyed population was 46,160, which was almost two times. The Pilot Project was selected based on the results of Study of PNG (1), Phase I in 2000 as shown in Table-1.1.

Table-1.1 Study Area and Pilot Project Sites

No.	Province	Study Area	Pilot Project Area	Provincial/District	Population (1999)	Surveyed Population 2000
					Proposed by PNGWB	
1	Oro	Popondetta		Provincial Town	8,500	14,656
2	Western	Daru *	⊙	Provincial Town	9,000	10,286
3	Central	Bereina	⊙	District Town	1,000	1,343
4	Central	Kupiano		District Town	1,000	7,131
5	Central	Kwikila	⊙	District Town	1,000	2,926
6	Morobe	Finschhafen		District Town	800	3,802
7	Morobe	Mutzing	⊙	District Town	500	2,100
8	Oro	Oro Bay		District Town	2,000	3,916
		8 Areas	4 Areas		23,800	46,160

(1) * : The shift of Provincial Town of Western province from Daru to Kiunga was announced in February 2000, however there are no actual movements in July 2001.

1.5 Scope of the Study

This Study was conducted based upon the scope of work for the Study, which was basically agreed upon between the PNGWB and the JICA on December 20, 1999. And the amendment of scope of work for Pilot Project was concluded on November 9, 2000 based on the results of Study in PNG (1). The details of the Study are shown in the next section of this Report.

1.6 Basic Study Policy

As agreed in the Minutes of Discussions on Inception Report dated May 4, 2000 in Port Moresby, the JICA Study Team executed the Study in accordance with the following basic policies:

- 1) Existing data and information were organized systematically and used effectively to fully comprehend local conditions related to the living environment, water supply, sanitation, hydrogeology and other relevant subjects, and accurate field survey results were acquired to formulate an optimum development plan for groundwater development for water supply systems. In addition, similar studies were carried out through other donor organizations as well as previous projects implemented through JICA studies, and plans related to the Study were reviewed and reflected in the present Study.

- 2) The Study was effectively carried out for mutual understanding of current water supply conditions, local requirements, and technology transfer in order to:
 - (a) Establish optimum solutions to the prevailing problems;
 - (b) Formulate a water supply improvement plan which is most suitable in terms of groundwater development; and
 - (c) Prepare an optimum operation and maintenance plan for a sustainable water supply system.

- 3) The Study was executed in cooperation with counterpart personnel from the PNGWB, local government in order to complete the Study according to the schedule with emphasis on technology transfer in pursuit of capacity building for water resources survey, design and construction and/or rehabilitation of water supply system, and its proper management, operation and maintenance.

- 4) Through this development study, the Pilot Project was implemented at the selected district towns based on the results of test drillings, reviews and plans for improvement of existing water supply facilities, operation and maintenance, and willingness of people to pay for the water. Through workshops and seminars, the results of the Study were opened and views were exchanged with the participants such as government personnel, water supply/sanitation sector related personnel, concerned donor and international agencies representatives, NGOs and other relevant persons.

1.7 Study Schedule

The Study is carried out from March 2000 to February 2002, for a period of twenty four (24) months in Papua New Guinea and Japan. This is divided into two (2) Phases as described below and shown in the attached Study Schedule.

Table-1.2 Study Schedule

Phase I:		(March, 2000 to November, 2000)
Investigation of Groundwater Development and Formulation of Water Supply Plan		
1. Preparatory Work in Japan:		
1) Preparation of Inception Report (IC/R):		March 2000
2. Work in PNG (1):		
1) Explanation and discussion of the IC/R		April 2000 to September 2000
2) Preparation of progress report I (P/R-I)		
3) Explanation and discussion of the P/R-I		
Phase II:		(December 2000 to February 2002)
Pilot Project for Improvement of Water Supply Systems		
3. Work in PNG (2):		
1) Explanation and discussion of Pilot Project		December 2000 to July 2001
2) Implementation of Pilot Project		
3) Workshop for the O&M of water supply systems		
4) Preparation of progress report II (P/R-II)		
5) Explanation and discussion of the P/R-II		
4. Work in Japan (1):		
1) Preparation of Draft Final Report (DF/R)		End of July to September 2001
2) Preparation of the Seminar for Technology Transfer		
5. Work in PNG (3):		
1) Explanation and Discussion on Draft Final Report (DF/R)		October 2001
2) Implementation of the Seminar for Technology Transfer		
3) Evaluation of the Pilot Project		
4) Preparation of progress report III (P/R-III)		
5) Explanation and discussion of the P/R-III		
6. Work in Japan (2):		
1) Completion of Final Report (F/R):		February 2002

1.8 Social Survey Method

Concerning the socio-economic survey, the main source of information was collected based on the methods of household survey with questionnaire, semi-structured interview and direct observation in the study area. Other specific survey methods have been used in this Study giving special attention to participatory approaches as follows:

- 1) The RRA (Rapid Rural Appraisal) enables to rapidly and intensively assess the features of the

living conditions of the district town and rural population for diagnosis of issues and problems. The basic concept underlying RRA is that the people know their own life best and have wisdom empirically.

- 2) On the other hand, the PCM (Project Cycle Management) method was used for logical composed planning of development project with a participatory approach. The main purpose of the PCM workshops were to exchange information between the JICA Study Team and the PNG side consisting of national government, district officers, local level government and PNGWB. Also by analysing existing problems in relation to water supply, realistic solutions for existing problems were sought. Each workshop was scheduled for 2 days. Because of time constraints, Participation Analysis (Stakeholders Analysis), Problems Analysis, Objective Analysis and part of Alternatives Analysis were done during the workshops.

1.9 Study Team and JICA Advisory Team

The JICA Study Team is composed of eleven (11) experts and one (1) coordinator. The work assignment of the team members is as shown in the attached assignment schedule.

Table-1.3 JICA Study Team and JICA Advisory Committee

JICA Study Team		
Name	Function	Affiliation
1. Mr. Shigeyoshi KAGAWA	Team Leader/Water Supply Planning	Japan Techno Co., Ltd.
2. Mr. Ichiro TAKAMATSU	Economic, Finance, Institution and Legal Framework	Japan Techno Co., Ltd.
3. Mr. Christopher JAYAKARAN	Hydrology & Hydraulics	Japan Techno Co., Ltd.
4. Mr. Masaru FUJITA	Geophysics Survey & Geology	Japan Techno Co., Ltd.
5. Mr. Chifumi YAMASHITA	Drilling Supervisor 1	Japan Techno Co., Ltd.
6. Mr. Yoshihiro YAMAUCHI	Drilling Supervisor 2	Japan Techno Co., Ltd.
7. Mr. Toyosaku KATO	Water Quality Analysis	Japan Techno Co., Ltd.
8. Mr. Nobuyuki ISHII	Facilities Design & Water Supply 1	Japan Techno Co., Ltd.
9. Mr. Minoru KIMISHIMA	Facilities Design & Water Supply 2	Japan Techno Co., Ltd.
10. Mr. Masahiko SUGINAGA	Social Survey	Japan Techno Co., Ltd.
11. Mr. Jun YOSHIKAWA	Facilities Design & Water Supply 3	Japan Techno Co., Ltd.
12. Mr. Hideaki MATSUOKA	Coordinator	Japan Techno Co., Ltd.
JICA Advisory Committee		
Dr. Yuji MARUO	JICA Headquarter, Development Specialist,	

Table-1.4 The Study on Groundwater Development for Water Supply Systems in Papua New Guinea

Work Schedule

		Number of Month																											
		Year 1			Year 2-1						Year 2-2						Year 3												
		Month / Year																											
		2000												2001						2002									
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
Investigation of Groundwater and Formulation of Water Supply Plan	1. Preparatory Work In Japan	1) Existing data analysis			■																								
		2) Consideration of basic policy for the Study			■																								
		3) Preparation of the Inception Report (IC/R)			■																								
	2. Work in PNG (1)	1) Explanation and discussion of IC/R				■																							
		2) Collection and analysis of supplementary data and review of past studies and projects				■	■	■	■	■																			
		3) Analysis of existing organizations and laws				■	■	■	■	■																			
		4) Survey of geology, hydrogeology, existing water sources, and water supplies and water use conditions				■	■	■	■	■	■																		
		5) Study of target areas				■	■	■	■	■	■																		
		6) Survey of hygiene and sanitation				■	■	■	■	■	■																		
		7) Survey of living conditions and water uses				■	■	■	■	■	■																		
		8) Geophysical survey				■	■	■	■	■	■																		
		9) Test drilling and evaluation of test wells					■	■	■	■	■	■																	
		10) Water demand forecast									■	■																	
		11) Decision of design criteria									■	■																	
		12) Planning of water supply facilities									■	■																	
		13) Review of O&M organizations									■	■																	
14) Estimation of implementation costs									■	■																			
15) Assessment of financial, economic and social impacts									■	■																			
16) Preparation, explanation and discussion of the 1st Progress Report (P/R)									■	■																			
Pilot Project for Improvement of Water Supply System	3. Work in PNG (2)	1) Implementation of pilot project for the improvement of water supply facilities										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
		2) Workshop for the O&M of water supply facilities											■	■															
		3) Environmental Study on Intake from Binatun River for water source of Daru											■	■															
		4) Preparation, explanation and discussion of the 2nd Progress Report (P/R)																											
	4. Work in Japan (1)	1) Preparation of the Draft Final Report (DF/R)																											
		2) Preparation of the seminar for technology transfer																											
	5. Work in PNG (3)	1) Implementation of the seminar for technology transfer																											
		2) Submission, explanation and discussion of the DF/R																											
		3) Monitoring and evaluation of O&M of water supply facilities constructed under the pilot project																											
		4) Explanation and discussion of the results of the pilot project																											
6. Work in Japan (2)	1) Completion of the Final Report (F/R)																												
Submission of Reports		2000												2001						2002									
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
					▲					▲										▲		▲	▲					▲	
					IC/R					P/R-1										P/R-2		DF/R	P/R-3					F/R	

**Table-1.5 The Study on Geoundwater Development for Water Supply Systems in Papua New Guinea
Assignment Schedule**

		Year 1	Year 2-1							Year 2-2											Year 3																	
		2000																							2001											2002		
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23																
1) Team Leader & Water Supply Planning	Shigeyoshi KAGAWA		4/22	6/30	7/23	9/18			12/2	12/22	1/12	4/12	4/20	7/18	10/1	10/30																						
2) Economi, Finance, Institution and Legal Framework	Ichiro TAKAMATSU		4/22	6/20	8/10	9/18			12/2	12/22	2/5	3/16	5/31	7/18	10/1	10/30																						
3) Hydrology & Hydraulics	Christopher JAYAKARAN		5/19	7/10	9/1	9/15	9/29			1/11	2/26																											
4) Geophysics Survey & Geology	Masaru FUJITA		4/22	9/3						1/12	2/15																											
5) Drilling Supervisor 1	Chifumi YAMASHITA		6/21	9/18																																		
6) Drilling Supervisor 2	Yoshihiro YAMAUCHI		6/5	9/9																																		
7) Wate Quality Analysis	Toyosaku KATO		5/8	6/11	8/27	9/15			12/2	12/22																												
8) Facilities Design & Water Supply 1	Nobuyuki ISHII		5/15	6/13	7/23	9/18			12/2	12/22	1/12	2/15	4/20	8/7	10/1	10/30																						
9) Facilities Design & Water Supply 2	MInoru KIMISHIMA		7/23	9/15						2/1	5/1	6/4	7/27																									
10) Social Survey	Masahiko SUGINAGA		5/3	8/30					12/2	12/22	1/20	3/9	3/16	5/30	7/18	10/1	10/30																					
11) Facilities Design & Water Supply 3	Jun YOSHIKAWA		3/5	4/28	6/9	7/18																																
12) Coordination	Hideaki MATSUOKA		8/9	9/20						1/12	2/10	2/24	5/12	8/3																								
			IC/R																																			

■ : Work in PNG

□ : Work in JAPAN

▨ : Additional Assignment by Japan Techno

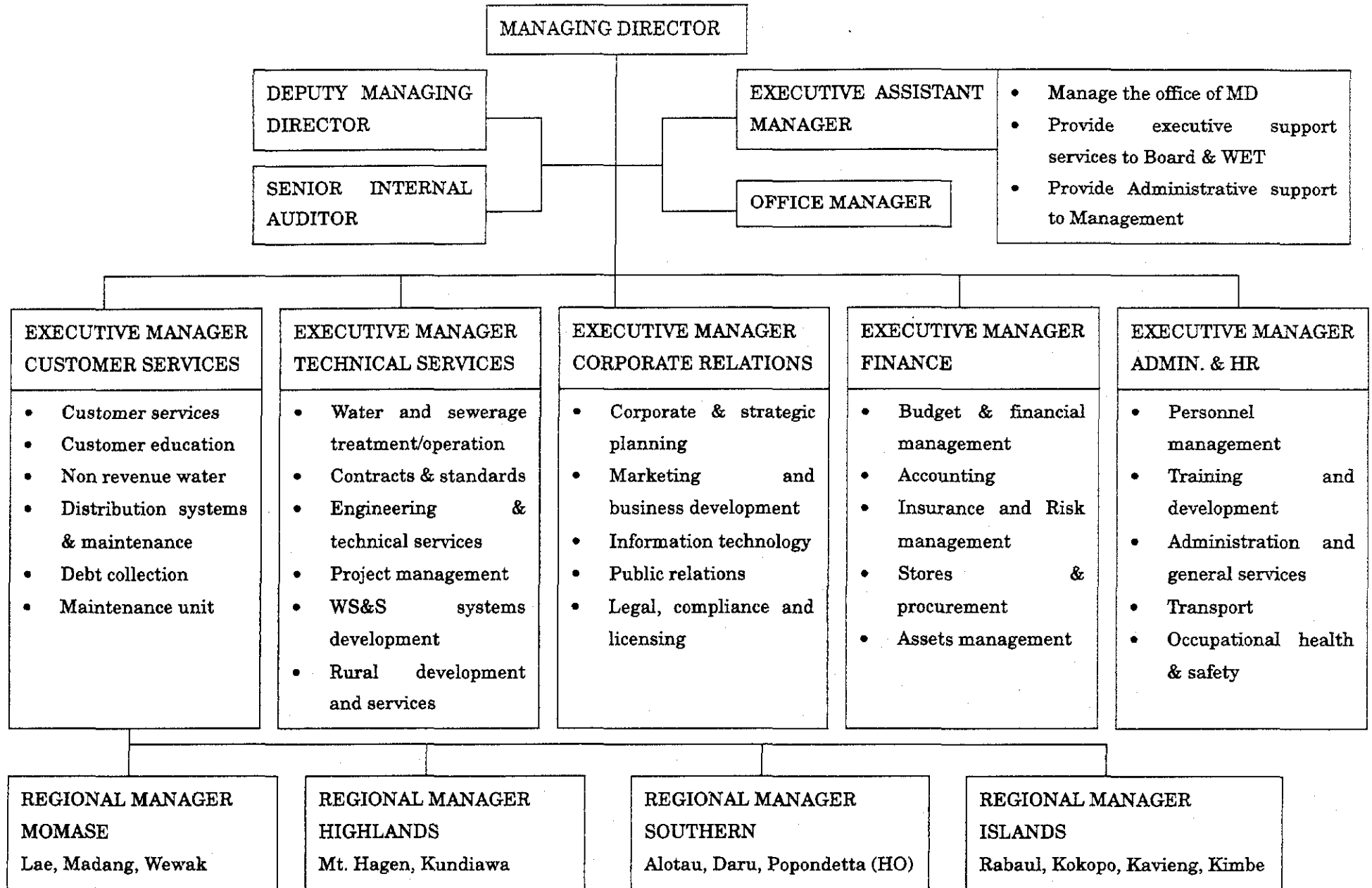


Fig.-1.1 PNG WATERBOARD ORGANIZATION STRUCTURE

CHAPTER 2 BASIC CONSIDERATIONS ON GROUNDWATER DEVELOPMENT FOR WATER SUPPLY SYSTEMS

1. Considering groundwater development, the geophysical investigations were carried out to determine the drilling points and target depths. The selection for drilling points were decided based upon the considerations for the priority of groundwater potentials and water supply area.
2. Logistics and drilling programme were severely affected by the unexpected wet weather in 2000, which made the unmentioned all-weather roads and drilling sites impassable.
3. Drilling programme and borehole specifications were prepared for the discussions with local drilling contractors including their experiences and knowledge, and the actual drilling contractors were selected based upon their local experiences and proposals.
4. The targeting areas were decided based on the cooperative works of geophysicists and hydrogeologists thorough discussions on their survey results and interpretation. The good groundwater potential areas are not always the best drilling points due to consideration of the distance to the water supply area and the ownership of land.
5. The groundwater development study was carried out to evaluate the groundwater potential based on the results of test boreholes drilled in Phase I in 2000. Considering the results of groundwater discharge and existing water supply conditions, Pilot Project, Phase II was implemented in 2001 to save time and costs for the Project. However, the maximum discharge of successful test boreholes was 350 m³/day due to the limited diameter of borehole of 6 inch and the available capacity of submersible motor pump. Therefore, this type of study was useful for District Town water supply rather than Provincial Town water supply due to the suitable supply population of several to five thousand persons to be covered by one borehole. Production boreholes for Provincial Town water supply shall be recommended with diameter of 10 inch.
6. Considering groundwater development, we need experts consisting of geophysicists, hydrogeologists and drilling supervisors together with experienced drilling contractors. Through our groundwater study we found difficulties to complete production boreholes of 10 inch diameter with 100m well depths due to low technology and their old drilling rigs.
7. All future groundwater projects in PNG should involve groundwater specialists and capable

drilling rigs such as combination types of mud circulation and Down-the-Hole air hammer (DTH). Also, it is necessary for close cooperation between PNGWB and Geological Survey of PNG, and exchanging of viewpoints on water supply to increase their low level of national water supply coverage of about 30% in PNG.

8. This drilling programme was regarded as an investigation/test drilling programme and those six (6) Study Areas out of eight (8) Study Areas were successful. Then, three (3) Study Areas of the successful boreholes in Bereina, Kwikila and Mutzing were utilized as production boreholes for the Pilot Project.
9. The transfer of technology for groundwater development to the counterparts from PNGWB was carried out considering the operation and management for geophysical prospecting and water well drilling at the sites with emphasis on sustainable groundwater supply as the water source for water supply system.
10. In this study, rehabilitation, construction and extension of the water supply systems at six (6) District Towns were considered. The revenue from this kind of small-scale water supply system serving populations from two (2) to ten (10) thousands is not enough to cover the operation cost, and the financial evaluation tends to be severe. All six (6) District Towns gave negative financial balances in 15 years to the target year of 2015. However, if the Provincial Government's subsidy is provided to PNGWB in the amount which is equivalent to the amount of their budget being spent for current water supply systems, the deficit from the operation will be compensated to PNGWB, and PNGWB will be able to sustain operation of water supply services in these District Towns. The most serious problem is the fact that water supply service in more District Towns means heavier financial burden for PNGWB. Therefore, the extension of water supply services in District Towns has to be at a slow pace. If a system to flexibly allocate the development fund for capital investment from the budget of the Central Government is established, the situation would change. However, currently the Central Government faces a severe financial condition and it seems difficult to expect such change immediately.
11. On the other hand, economic evaluation confirms that the economic benefit will exceed the cost if the water supply system is run properly. Moreover, it is assumed that improvement of water supply services will bring larger positive effects socially than the economic one. It is expected to contribute to development activities in the area and favourable economic effect caused by this development would spread further.

12. The construction works for Pilot Project was planned from February 2001 to July 2001. Although the works were done in accordance with the planned schedule the following problems seriously affected the construction works for water supply systems. Therefore, when we prepare the construction schedule we should carefully consider the factors and implementing periods.

- 1) The delay of customs clearance and legal processes for tax exemption
- 2) Deteriorated conditions of the access roads due to heavy rains
- 3) The delay of transportation of the materials and the equipment by sea due to bad weathers
- 4) The air flights not on schedule
- 5) The delay of electricity works by ELCOM
- 6) The land issues, especially changed opinions and attitudes by the villagers, and so forth.

13. Another factor affecting the schedule was the land issues, which are common in PNG. Although the routes for pipelines and the locations of public faucets and other water facilities were explained to the local residents and the agreements were made in advance, different opinions and attitudes came out from the residents after commencement of the construction works in many areas. As a result of which, the construction works were inevitably interrupted in order to have agreements again. Many of the land issues in this country have complicated historical backgrounds with conflicts between the Government and the landowners. Therefore, there are cases that the problems emerge after the commencement of the construction works. The following should be done to avoid the problems above.

- 1) To avoid nation wide scattering of project sites, and to consider the access to the sites for execution and management of the project and the transportation of material and equipments to the selected sites,
- 2) To avoid rainy seasons for the construction works and allow enough time in the implementation schedule,
- 3) To pay high attentions to the access roads, and ask appropriate agencies immediately in case there are some negative factors,
- 4) To keep several options to prepare for unpredictable incidents and be flexible for the change of the schedule.