

No.

**BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
RURAL DRINKING WATER SUPPLY IN
PERI-URBAN OF PHNOM PENH CITY
IN
THE KINGDOM OF CAMBODIA**

FINAL REPORT

MARCH 2002

**JAPAN INTERNATIONAL COOPERATION AGENCY
PACIFIC CONSULTANTS INTERNATIONAL**

GR1

CR (2)

02-076

PREFACE

In response to a request from the Royal Government of Cambodia, the Government of Japan decided to conduct a basic design study on the Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh City and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Cambodia a study team from September 26 to November 2, 2001.

The team held discussions with the officials concerned of the Government of Cambodia, and conducted a field survey at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Cambodia in order to discuss a draft basic design, and as this result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Royal Government of Cambodia for their close cooperation extended to the teams.

March, 2002

Takao Kawakami

President

Japan International Cooperation Agency

March, 2002

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh City in the Kingdom of Cambodia.

This study was conducted by Pacific Consultants International, under a contract to JICA, during the period from September, 2001 to March, 2002. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Cambodia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

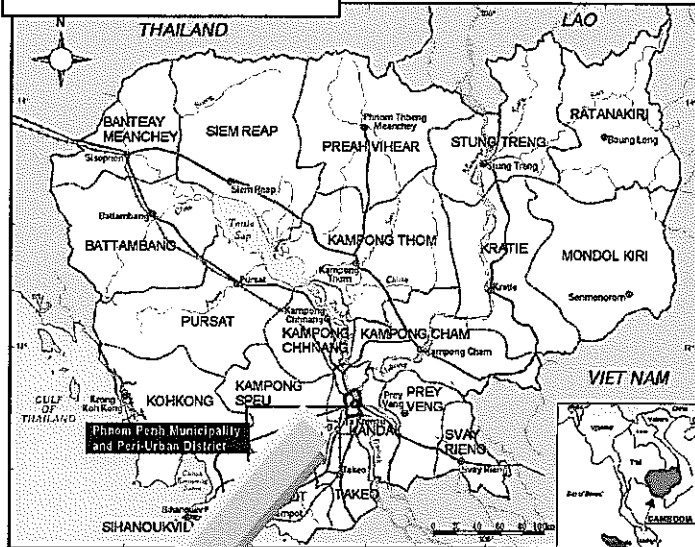
Very truly yours,

Shinichiro Matsumoto

Project Manager,
Basic design study team on the Project for Rural Drinking
Water Supply in Peri-Urban of Phnom Penh City

Pacific Consultants International

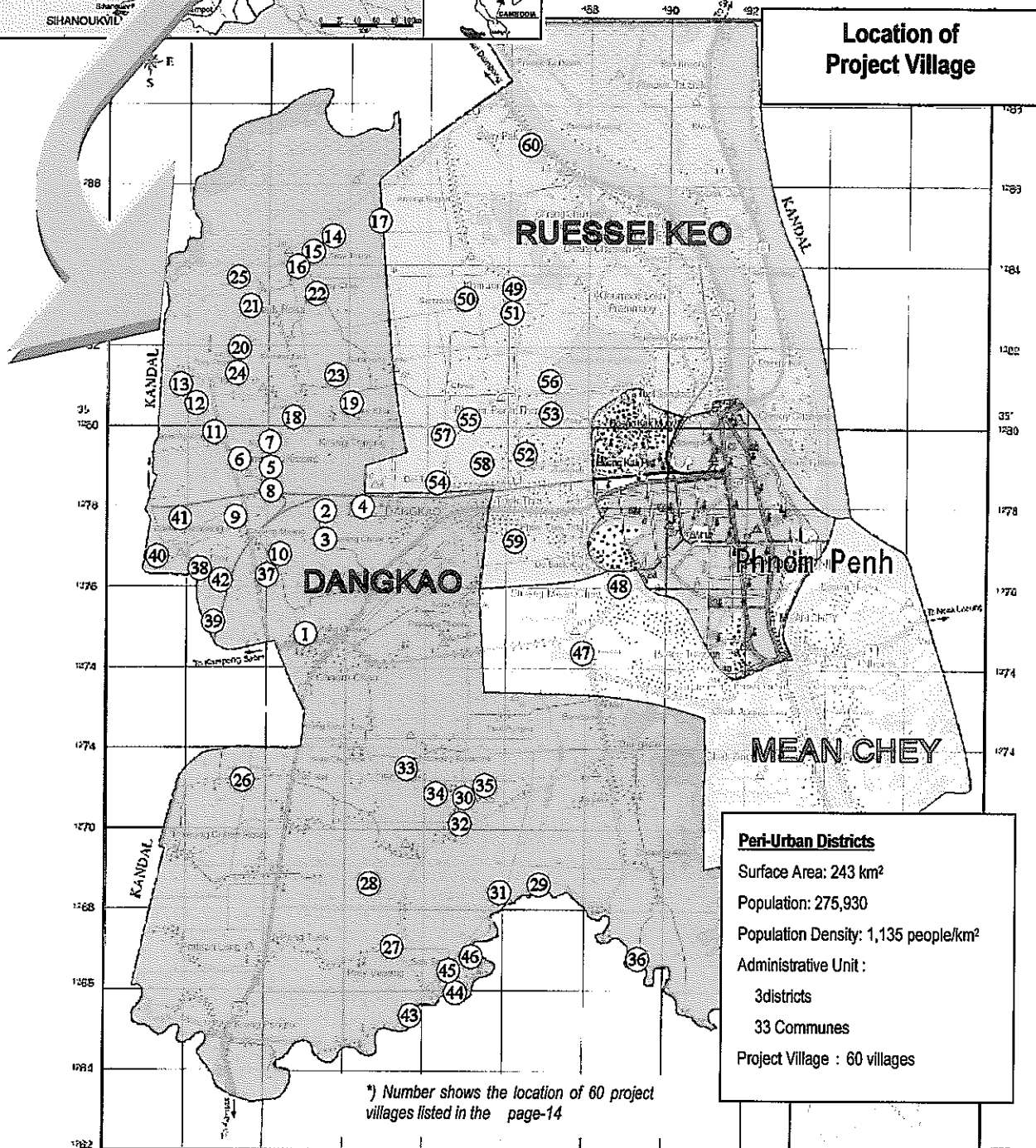
Map of Kingdom of Cambodia



Kingdom of Cambodia

Surface Area: 181,000km²
 Population: 12,210,000 (2000)
 Population Density: 67.5 people/km² (2000)
 Population Growth Rate: 2.27% (2000)
 Capital: Phnom Penh
 Population with acces to safe water (%):
 Urban 53% (2000)
 Rural 25%
 Total 30%
 GNP: US\$ 8.2 billion (1999)
 GNP per Capita: US\$ 710 (1999)
 Current: Riel
 Exchange rate: US\$1=3,815 Riel (August, 2001)

Location of Project Village



Peri-Urban Districts

Surface Area: 243 km²
 Population: 275,930
 Population Density: 1,135 people/km²
 Administrative Unit :
 3districts
 33 Communes
 Project Village : 60 villages

*) Number shows the location of 60 project villages listed in the page-14

LOCATION MAP

- Basic Design Study Report on the Project for Rural Drinking Water Supply in the Peri-Urban Area in Phnom Penh City -

LIST OF TABLES & FIGURES

Tables

Table 1.1.1	Confirmation of Contents of the Request*	1
Table 2.1.1	Number of Wells Installed through RWSP-II, PGDSC and Peri-Urban Project	2
Table 2.1.2	Project Design Matrix	3
Table 2.2.1	Community Participation in the Project*	4
Table 2.2.2	Climate Conditions in Phnom Penh	4
Table 2.2.3	Countries for Procurement of Equipment and Materials	9
Table 2.2.4	Sequence of Alteration made in the Contents of MRD's Request ..	10
Table 2.2.5	Construction Quantities of the Project*	11
Table 2.2.6	Composition of Facilities	13
Table 2.2.7	Proposed Well Construction Sites	14
Table 2.2.8	Test Drilling	17
Table 2.2.9	Standard Well Type	18
Table 2.2.10	Platform	20
Table 2.2.11	Well Success Rate and Drilling Plan	21
Table 2.2.12	Priority and Results of Selection of Equipment*	24
Table 2.2.13	Major Equipment	25
Table 2.2.14	Comparison between Top Drive and Rotary Table Type Drilling Rig	27
Table 2.2.15	Velocity at Ring Sections	28
Table 2.2.16	Responsibilities of DRWS for the Project	34
Table 2.2.17	Scope of Works between Japanese and Cambodian Government ..	37
Table 2.2.18	Supervisors from Japan for the Project	38
Table 2.2.19	Construction Quantities in Each Phase	39
Table 2.3.1	Project Cost of Cambodian Side	41
Table 2.4.1	Annual O/M Cost of Handpump	43
Table 2.4.2	Responsibilities for O/M Works*	44
Table 2.4.3	Disposition of the Equipment Procured by the Project	44
Table 2.4.4	Annual O/M Cost for DRWS Drilling Crew	45
Table 2.4.5	Annual O/M Cost for DRWS Resistivity Survey Team	45
Table 2.5.1	Activities and Outcomes	46
Table 2.5.2	Functions of Related Entities	47
Table 3.1.1	Relations among Problems, Inputs and Effect in the Project*	49

Figures

Fig. 2.1.1	Upper and Related Plan for the Project	2
Fig. 2.2.1	Bedrock Depth in Peri-Urban Area	6
Fig. 2.2.2	Outline of the Project	12
Fig. 2.2.3	Relation between Water Quality and Successful Well	16
Fig. 2.2.4	Well Type in the Projected Villages	19
Fig. 2.2.5	Well Drilling Plan in Phase	22
Fig. 2.2.6	Distribution Plan for the Equipment	26
Fig. 2.2.7	Outline Drawing of Main Equipment	31
Fig. 2.2.8	Project Implementation Organization	33
Fig. 2.2.9	Organization of DRWS	35
Fig. 2.2.10	Organization of PDRD	36
Fig. 2.2.11	Implementation Schedule	40
Fig. 2.4.1	O&M System of Rural Water Supply Facilities in Cambodia	42
Fig. 2.4.2	Organization of WPC	43
Fig. 2.5.1	Implementation Schedule for Soft Component	48

Abbreviations

CHEB	: Central Health Education Bureau/ Ministry of Health
DAP	: Department of Agricultural Planning/ Ministry of Agriculture and Irrigation
DDA	: Department of Development Affairs/ Ministry of Progress of Border Areas and National Races and Development Affairs
DO	: Dissolved Oxygen
DTH	: Down-the-Hole Hammer Drilling
DTW	: Deep Tube Well
EC	: Electric Conductivity
E/N	: Exchange of Notes
ESD	: Environmental Sanitation Division/ Ministry of Health
FERD	: Foreign Economic Relations Department
JICA	: Japan International Cooperation Agency
M/D	: Minutes of Discussions
NPA	: National Programme of Action
O&M	: Operation and Maintenance
pH	: Potential of Hydrogen
PDM	: Project Design Matrix
STW	: Shallow Tube Well
UNDCP	: United Nations International Drug Control Programme
UNDP	: United Nations Development Programme
UNICEF	: United Nations International Children's Emergency Fund
WHO	: World Health Organization
WRUD	: Water Resources Utilization Department
cfm	: cubic feet per minute
psi	: pound per square inch

SUMMARY

SUMMARY

The Kingdom of Cambodia located in the Southwestern part of the Indochina Peninsula, has a national land area of 181,000 km² and a total population of 11.43 million (in 1999), of which over 80% lives in rural areas. Cambodia is one of the poorest countries in Southeast Asia, with a gross national per capita income (GNI) of 260 US dollars.

During 20 years period since 1970, Cambodia broke into a long period of civil strife that weakened rural governmental organizations and devastated the agricultural infrastructure, resulting in serious delays and poor conditions of the rural water supply. The percentage of residents that have access to safe drinking water was only 29% in 1998, a very low figure when compared with the other neighboring countries.

To secure drinking water, rural residents have traditionally depended upon natural water sources such as rainwater, rivers, ponds and lakes, as well as shallow wells and irrigation ponds. These water sources are seriously contaminated with coliform bacilli and other bacteria, and dry up in dry season. Severe water shortage conditions and high incidence of waterborne diseases significantly hamper improvements in health and hygiene conditions in rural areas. These conditions, therefore, makes the implementation of the groundwater development and deep well construction project for the supply of safe drinking water as an extremely urgent need.

To improve water supply, health and hygiene conditions, the Ministry of Rural Development (MRD) promoted the “First Five Year Rural Water Supply Project (1996 - 2000)” to supply safe drinking water to 65% of the rural population of 6.8 million in 2000. However, implementation of this plan lagged far behind the goal. At the end of 1998, the rural water supply rate had only reached 29% due to the fragile financial basis, with the government depending upon international organizations and NGOs for the greater part of the project funds, and the fact that the well drilling machinery that MRD has are obsolete and outdated.

MRD reflected its realization that the goal set in the “First Rural Water Supply Plan” was too difficult to achieve when it formulated the “Second Five Year Rural Water Supply Project (2001 - 2005)”, establishing a new goal to improve the rural water supply rate from 29% (in 1999) to 40% in 2005. This second plan has set a target of constructing 44,700 new water sources, including 6,100 deep tube wells, by 2005, and supplying 3.6 million people with safe drinking water. This Project is positioned within this “Second Five Year Rural Water Supply Project”.

With the above background, the Government of Cambodia requested assistance from the Japanese Government to conduct the “Study on Groundwater Development in Southern Cambodia” in September 1995. The objectives of this study are to formulate groundwater development projects and water supply projects for 472 villages in five provinces and three districts in Peri-Urban areas of Phnom Penh city in order to supply the rural residents with safe drinking water and improve the health and hygiene conditions. In response to this request, the Japan International Cooperation Agency (JICA) carried out the development study from December 1996 to January 2002.

In July 1999, the Government of Cambodia made a request for Grant Aid to the Government of Japan for the construction of tubewells with hand pump at 769 sites spread across three districts in Peri-Urban areas and three provinces in the Southern Cambodia that were given priority after screening in the “Study on Groundwater Development in Southern Cambodia”, and the procurement of equipment necessary for construction.

In response to the request, the Government of Japan decided to implement the Basic Design Study for 60 priority villages in the Peri-Urban areas. Subsequently, JICA dispatched the study team for the Basic Design Study to Cambodia from September 26 to November 2, 2001. The team carried out the site survey on the groundwater development and well construction works in the Peri-Urban areas, and collected necessary data and information. After that, the team held discussions with the officials of the Government of Cambodia on the request and confirmed the items.

After returning to Japan, the team examined the appropriateness of the request and discussed the needed items, the relevant quantities and the specifications of the equipment and materials, and prepared the Draft Final Report. A mission was sent to Cambodia in order to explain a Draft Final Report from February 26 to March 8, 2002 and held discussions on the draft basic design. The final basic design also reflects the opinions of the Cambodian side.

The results of examination on the construction of facilities are as follows:

- To maintain coordination with the “Study on Groundwater Development in Southern Cambodia”, this project was examined on the plan in which i) target year was 2005, ii) standard water demand was set to 40 liters per capita, iii) pumping capacity of handpump was designed to 17.5 liters/min and iv) operating hours was set 8 hours/day. The required numbers of deep tube wells with handpump were designed to be 165 to ensure water supply to all the residents in the target villages except the beneficiary population in the existing safe water supply facilities and urban water supply project, that have been constructed under the assistance of the World Bank.
- The conditions of a successful well were determined as follows: i) the well spring capacity is 600 liters/hour or more; ii) the pumping water level is less than 40m below ground surface (AFRIDEV pump performance); and iii) the water quality conditions are arsenic content of less than 0.05mg/L (Cambodian standard) and fluorine content of less than 2.0mg/L or less (under USEPA guidelines). The WHO water quality standards are applied to other items.
- Even if the water quality values other than arsenic exceed the standard levels, some wells shall be equipped with handpumps when strongly required by communities in order to improve the water shortage conditions (for washing and bathing) that is not used for drinking.
- Three standard types of wells will be designed in consideration of the hydro-geological conditions: i) type A (60m deep) at 44 sites; ii) type B (100m deep) at 69 sites; and iii) type C (120m deep) at 52 sites. The successful well rates are classified into three levels of 80%, 85% and 90% in consideration of the results of the geophysical survey and water quality analysis.
- The AFRIDEV handpump that is used as the standard type for deep tubewells in Cambodia has been adopted. Two types of platforms will be designed: i) standard type at 152 sites and ii) flooded area type at 13 sites. In addition, 12 iron removal devices will be introduced in the villages where the groundwater has high iron content.
- To promote the community participation in this project, a construction method by community participation will be introduced. Only the supply of construction materials and technical consultation by Japanese engineer will be provided for construction of platforms and iron removal devices.

The results of examination on equipment procurement are as follows:

- The station wagons and electromagnetic survey equipment that are considered neither necessary nor appropriate have been excluded from the project.
- The quantities of drilling rigs and support equipment have been reduced from two sets to

one set because the Department of Rural Water Supply (DRWS) has a fragile financial base, and has to depend on the assistance of some international organizations to provide the maintenance and management costs for the procured equipment.

- The equipment to be procured is divided into three lots for fair bidding and economical procurement: i) well drilling machines (lot A), ii) support vehicles (lot B) and iii) equipment for survey (lot C).

In addition, in order to facilitate sustainable maintenance and management of the water supply facilities to be constructed under this project, soft component, consisting of facilitating the participation of rural residents and strengthening of water point committee (WPC), and technical transfer for geophysical survey and database of groundwater development to DRWS's staff, will be introduced.

Based on the results of the examinations as described above, the final basic design was proposed as shown in the table below.

Item	Items	Q'ty	Purpose
Facility Construction	1.1 Drilling of well type A (60m depth)	44	Including 2 test wells
	1.2 Drilling of well type B (100m depth)	69	Including 1 test well
	1.3 Drilling of well type C (120m depth)	52	Including 3 test wells
	Sub-total	165	
	2. Installation of handpumps	165	Installation by DRWS
Equipment Procurement	3. Construction of platforms for well	165	Construction by community participation
	4. Construction of iron removal devices	12	Construction by community participation
	A.1 Drilling rig	1	For well drilling
	A.2 High pressure air compressor	1	For DTH drilling
	A.3 Drilling tools	1	For well drilling
	A.4 Low pressure air compressor	1	For well development
	A.5 Pumping test equipment	1	For pumping test
	B.1 Cargo truck with crane	1	For transportation of heavy equipment
	B.2 Water tank truck	1	For transportation of water for drilling
	B.3 Fuel tank trunk	1	For transportation of fuel for drilling
	B.4 Pick-up truck for well drilling	1	For transportation of staff and equipment
	B.5 Pick-up truck for resistivity survey	1	For transportation of staff and equipment
	B.6 Pick-up truck for O/M	1	For transportation of staff and equipment
B.7 Motorbike for O/M	3	For O/M services by PDRD staff	
C.1 Borehole logging equipment	1	For casing program	
C.2 Resistivity survey equipment	1	For geophysical survey	
C.3 Water analysis kit	1	For water quality test	

The O/M of the facilities will be undertaken by WPC to be organized by the beneficiary residents after completion of this Project. Soft components will be introduced to facilitate sustainable O/M of the facilities, consisting of education of residents on health and hygiene, organizing a workshop to reinforce the WPC organization, training of WPC caretakers for repair and O/M of handpumps and other necessary activities.

The procured equipment will be handed over to DRWS as the implementing agency and will be maintained and managed by DRWS staff after completion of this Project. The technical transfer in handling, operation and analysis of the procured equipment will be made to DRWS staff through on-the-job-training (OJT). The OJT will be carried out during the well drilling works to be conducted by the Japanese contractor and the geophysical survey to be conducted by the consultant in the detailed design phase.

In case of the implementation of this Project under the Japan's Grant Aid, the entire

project period will take 32 months, including the detailed design. The period of equipment procurement will require 12 months, including the detailed design. The project cost borne by the Government of Cambodia is estimated to be US\$32,610 (US\$18,540 in the Phase I and US\$14,070 in Phase II).

If this Project is implemented, safe drinking water will be supplied to about 30,000 people and the water supply rate in the study area will be improved from 51.7% to 100%. The improved health and hygiene conditions will greatly decrease the waterborne diseases, and a reduction in the workload on women and children to obtain water, as well as an improvement in safety and relief from poverty is expected.

After completion of this Project, the equipment procured under this Project will be effectively used for groundwater development projects under the assistance of UNICEF and ADB, contributing to the enhancement of the rural water supply in Cambodia. In particular, the technologies of geophysical survey and hard rock drilling that DRWS staff will acquire through OJT will ensure a higher success rate in drilling wells, thereby reducing the cost of groundwater development projects in Cambodia.

The implementing agency, DRWS, has constructed about 12,000 boreholes under UNICEF's assistance to date. Therefore, the technical capability of DRWS staff is not a concern in O/M of drilling rig. However, the weak financial base of DRWS is a concern to raise its own project funds. But it has been receiving continuous assistance from UNICEF and ADB, and these organizations are expected to appropriate funds for the maintenance and management of the procured equipment in an efficient and sustainable way.

As described above, the implementation of this Project as one of Japan's grant aid projects is significant and appropriate.

Finally, it is recommended that the following measures be taken by the Cambodian side for implementing this Project in an effective and efficient way:

- MRD and its related agencies should promote participation of residents in this Project and educate the residents for it.
- Budgetary measures to define the responsibilities of DRWS and Phnom Penh Rural Development Department (PDRD), and ensure they are carried out.
- Cooperation with the related ongoing projects of other donors and NGOs in the planned area.

Basic Design Study Report
on
The Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh City

TABLE OF CONTENTS

Preface		
Letter of Transmittal		
Location Map		
List of Tables & Figures		
Abbreviations		
Summary		
		<u>Page</u>
Chapter 1	Background of the Project	1
Chapter 2	Contents of the Project	2
2.1	Basic Concept of the Project	2
2.1.1	Related Plans for the Project	2
2.1.2	Project Design Matrix	3
2.2	Basic Design of the Requested Japanese Assistance	4
2.2.1	Design Policy	4
2.2.1.1	Basic Concept	4
2.2.1.2	Policies for Natural Conditions	4
2.2.1.3	Policies for Social Conditions	5
2.2.1.4	Policies for Construction Conditions	5
2.2.1.5	Policies for Local Subcontractor Conditions	7
2.2.1.6	Policies for O/M Capabilities	7
2.2.1.7	Policies for Scope and Grade of Facilities and Materials	8
2.2.1.8	Policies for Construction/Procurement Method and Construction Period	8
2.2.2	Basic Plan	10
2.2.2.1	Outline of the Project	10
2.2.2.2	Construction Plan	13
2.2.2.3	Equipment Procurement Plan	23
2.2.3	Basic Design Drawing	32
2.2.4	Implementation Plan	33
2.2.4.1	Implementation Policy	33
2.2.4.2	Implementation Conditions	37
2.2.4.3	Scope of Works	37
2.2.4.4	Consultant Supervision	38
2.2.4.5	Procurement Plan	38
2.2.4.6	Implementation Schedule	39
2.3	Obligations of Recipient Country	41
2.3.1	Undertakings of the Government of Cambodia	41
2.3.2	Project Costs Borne by the Government of Cambodia	41

2.4	Project Operation Plan	42
2.4.1	Basic Policies	42
2.4.2	O/M System for Rural Water Supply Facilities	42
2.4.3	Water Point Committee (WPC)	43
2.4.4	O/M Cost for Handpump	43
2.4.5	Share of O/M Works	44
2.4.6	O/M Plan for the Equipment	44
2.4.7	O/M Cost for the Equipment	45
2.5	Soft Component	46
2.5.1	Tasks for Sustainable O/M	46
2.5.2	Objectives of Soft Component	46
2.5.3	Activities and Outcomes	46
2.5.4	Items of Responsibility on Cambodian Side	47
2.5.5	Functions of Related Entities	47
2.5.6	Implementation Schedule of Soft Component	47
Chapter 3	Project Evaluation and Recommendations	49
3.1	Project Effect	49
3.2	Recommendations	50

APPENDICES

Annex 1	Member List of the Study Team	A-1
Annex 2	Study Schedule	B-1
Annex 3	List of Parties Concerned in the Recipient Country	C-1
Annex 4	Minutes of Discussions	D-1
Annex 5	Technical Notes	E-1
Annex 6	Cost Estimation Borne by the Recipient Country	F-1
Annex 7	Five Years Plan for Rural Water Supply Program	G-1
Annex 8	Results of Resistivity Survey and Water Quality Analysis	H-1
Annex 9	Evaluation of Proposed Well Construction Sites	I-1
Annex 10	Basic Design Drawings	J-1
Annex 11	References	K-1