NO

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR RURAL DRINKING WATER SUPPLY IN KAMPONG CHAM PROVINCE
IN
THE KINGDOM OF CAMBODIA

FEBRUARY, 2005

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

GRANT AID MANAGEMENT DEPARTMENT

GM
JR
05-037

PREFACE

In response to a request from the Government of the Kingdom of Cambodia, the Government of Japan decided to conduct a basic design study on the Project for Rural Drinking Water Supply in Kampong Cham Province and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Kingdom of Cambodia a study team from October 3, 2005 to October1, 2005.

The team held discussions with the officials concerned in the Government of the Kingdom of Cambodia, and conducted a field study in the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to the Kingdom of Cambodia in order to discuss the draft basic design, and as a 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 Kingdom of Cambodia for their close cooperation extended to the teams.

February, 2005

Seiji KOJIMA
Vice-President
Japan International Cooperation Agency

February 2005

LETTER OF TRANSMITTAL

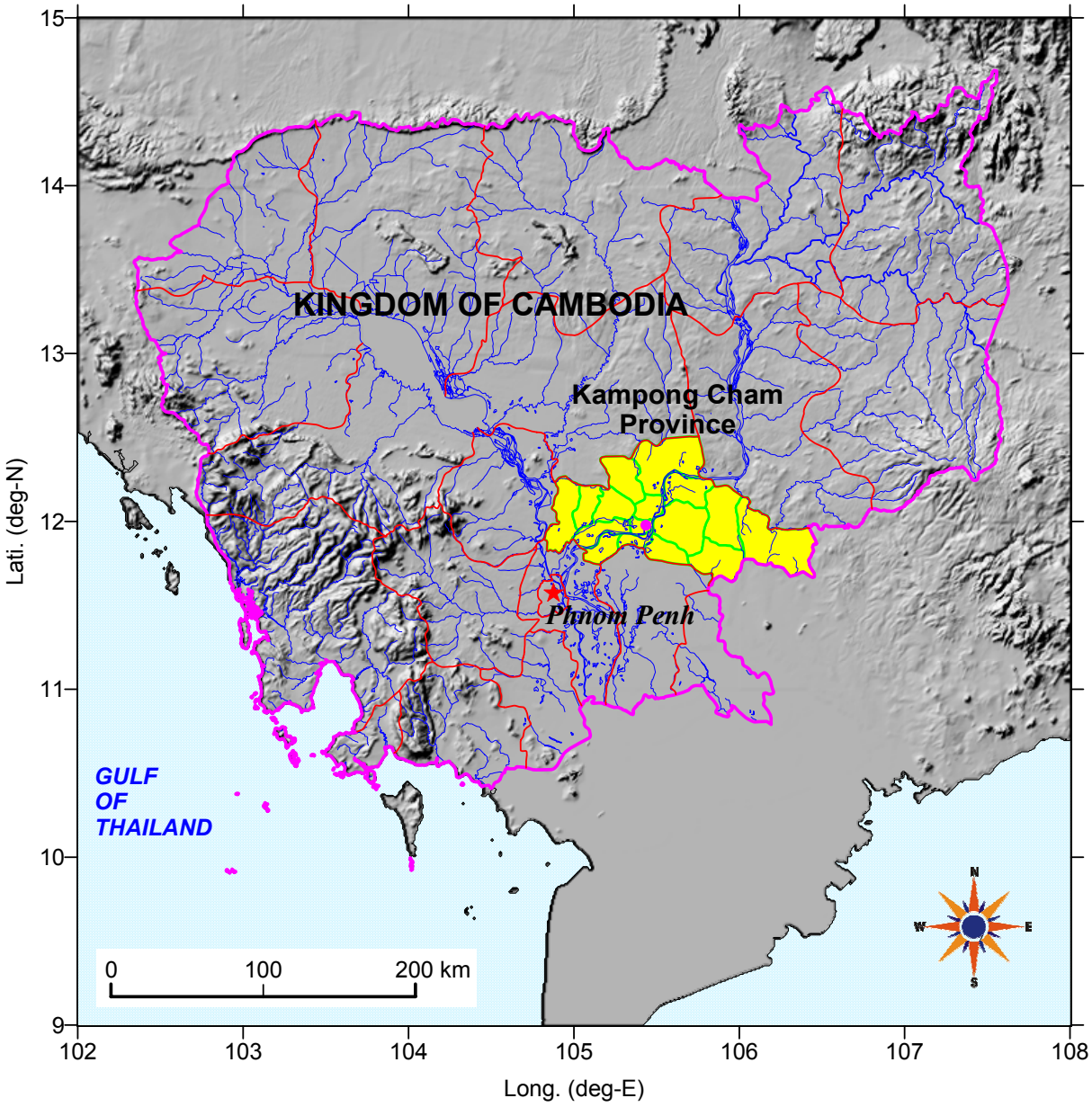
We are pleased to submit to you the basic design study report on the Project for Rural Drinking Water Supply in Kampong Cham Province in the Kingdom of Cambodia.

This study was conducted by Kokusai Kogyo Co., Ltd., under a contract to JICA, during the period from September 2004 to February 2005. 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.

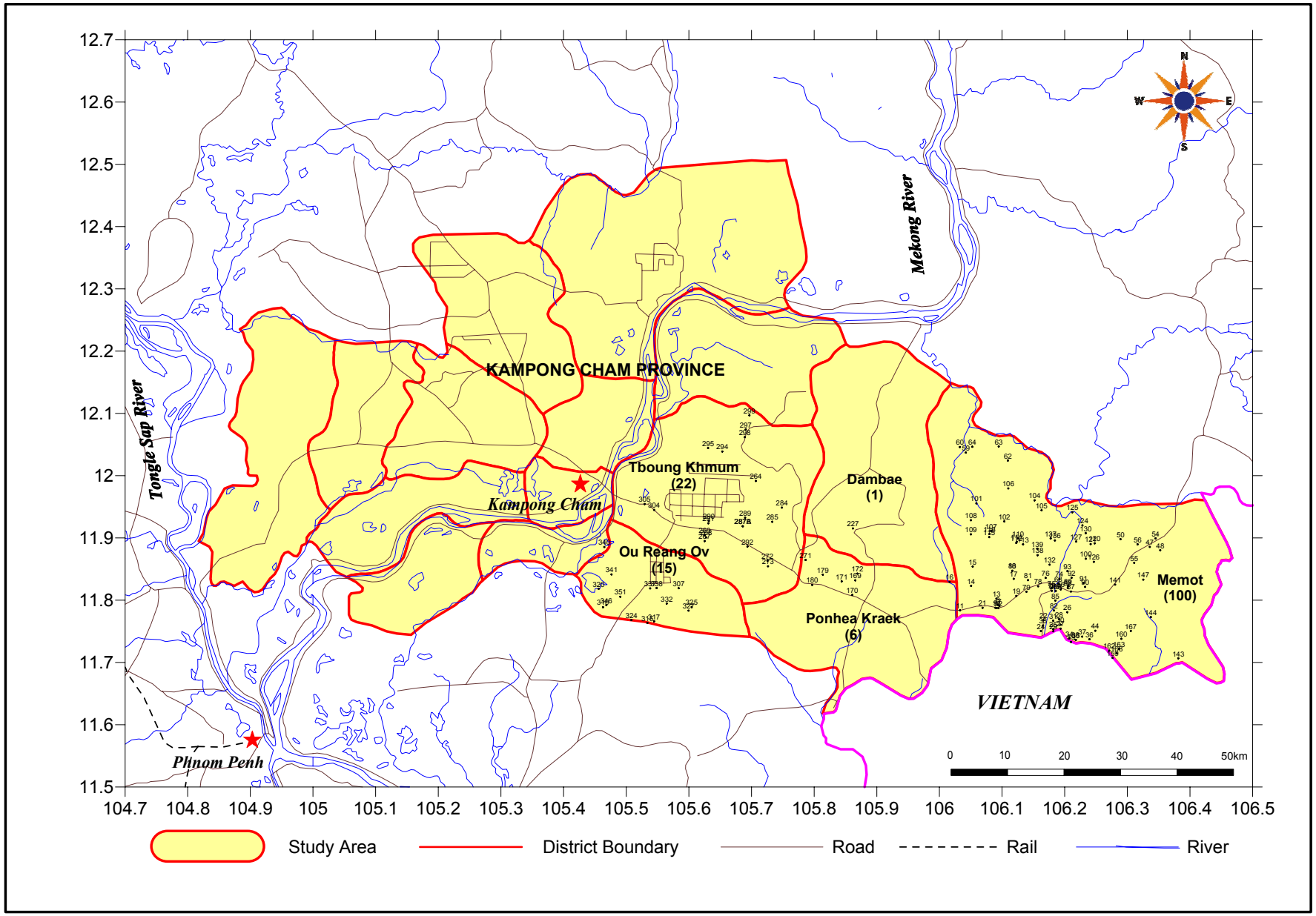
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Chief Consultant,
Basic Design Study Team on the Project for
Rural Drinking Water Supply in Kampong
Cham Province in the Kingdom of Cambodia
Kokusai Kogyo Co., Ltd.



Location Map


KAMPONG CHAM PROVINCE
Mekong River
Tongle Sap River
Kampong Cham
Phnom Penh
Tboung Khmum
(22)
Dambae
(1)
Ou Reang Ov
(15)
Ponhea Kraek
(6)
Memot
(100)
VIETNAM
N
S
W
E
0 10 20 30 40 50km
12.7
12.6
12.5
12.4
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Abbreviation

ADB	: Asian Development Bank
Afridev	: "Name of Hand pump"
AISC	: Arsenic Inter-Ministerial Subcommittee
A/P	: Authorization to pay
B/A	: Banking Arrangement
BHN	: Basic Human Needs
CDC	: Cambodia Development Committee
CMAC	: Cambodian Mine Action Center
CMDGs	: Cambodian Millennium Development Goals
C/P	: Counter Part
D/D	: Detailed Design
DOD	: District of Rural Development
DRHC	: Department of Rural Health Care
DRWS	: Department of Rural Water Supply
DTH	: Down-the-hole
E/N	: Exchange of Notes
EU	: European Union
IRD	: Iron Removal Device
JICA	: Japan International Cooperation Agency
M/D	: Minutes of Discussions
MDG	: Millennium Development Goals
MIME	: Ministry of Industry, Mining and Energy
MOH	: Ministry of Health
MRD	: Ministry of Rural Development
NPRS	: National Poverty Reduction Strategy 2003-2005
OJT	: On the Job Training
O/M	: Operation and Maintenance
PDM	: Project Design Matrix
PDRD	: Provincial Department of Rural Development
PRASAC	: "Name of EU supported Project"
PRDC	: Provincial Rural Development Committee
SEDP-II	: Second Five Year Socio-Economic Development Plan 2001-2005
SEILA	: "Name of Cambodian Government's Program funded by WB"
SIP	: Rural Water Supply and Sanitation Sector Investment Plan 2003-2012 (SIP)

T/N	: Technical Notes
UNICEF	: United Nations Children's Fund
VDC	: Village Development Committee
VLOM	: Village Level Operation and Maintenance
WSUG	: Water and Sanitation User's Group
WB	: World Bank
WHO	: World Health Organization

Summary

The Kingdom of Cambodia (hereinafter referred to as "Cambodia") is located in the southwestern part of the Indochina peninsula. It covers an area of 181,100 km2 and has a population of 13.5 million. Cambodia's Gross Domestic Product (GDP) is 291US$ per capita (in 2002), making it one of the most destitute countries in South-east Asia.

Due to the weakening of regional organization, the deterioration of rural infrastructure, etc. resulting from 20 years of civil war that started in 1970, there is a serious lack of safe drinking water supply in the rural area, where 85% of the population lives. The supply rate of safe drinking water in the rural area remains at a low level. In the dry season in particular, local residents rely on dirty pond water, resulting in a high rate of water-borne diseases. Under such circumstances, the Government's priority project, the "Rural Water Supply and Sanitation Sector Investment Plan (2003-2012)", aims to increase the rural water supply coverage, which was 24% in 2002, to 45% in 2012, and the Ministry of Rural Development (MRD) is promoting the plan to supply safe drinking water to the rural area based on the cooperation of international organizations such as UNICEF, donor countries, and NGOs, focusing on the Department of Rural Water Supply (DRWS), the implementing organization in this project.

Since the Study on Groundwater Development in Central Cambodia, which was implemented by the Japanese Government in 2000-2002, new hand pump wells have been constructed in the surroundings of Kampong Cham City and along major roads such as National Road 7 under assistance programs by other donors. Furthermore, some of the villages where water supply conditions were improved are in the target area of Kampong Cham Province. However, in areas far from Kampong City and the main roads, such as Memot District, water supply conditions have not improved since the time of the development study and there is still a great need for safe drinking water. In the target area, the main water sources include shallow hand-dug wells, rivers, ponds, etc., which are used for drinking water despite the fact that they are contaminated with fecal coliform, etc. As a result, water-borne diseases such as diarrhoea and typhus are widespread. The improvement of water supply conditions in the target area is, therefore, an urgent matter.

In response to a request by the Cambodian Government, the Government of Japan has so far conducted "The Study on Groundwater Development in Southern Cambodia (2001)" and "The Study on Groundwater Development in Central Cambodia (2002)". Furthermore, based on the results of those development studies, the Government of Japan also carried out "The Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh (1.2 billion yen)" for the procurement of drilling equipment and the construction of deep wells with hand pumps under grant aid. However, because there is still a serious need for the construction of water supply facilities in the rural area, following the above project, the

Government of Cambodia made a request to Japan for grant aid to implement a water supply project targeting four provinces (Kampong Cham, Kandal, Kampong Speu, and Ta Keo province) in Southern and Central Cambodia.

The contents of the request submitted by the Government of Cambodia in April 2004 are as follows:

- Construction of 1,036 deep wells with hand pumps in 256 villages in the above four provinces.
- Procurement of drilling equipment, including a rig, testing and survey equipment, and operation and maintenance equipment.
- Soft component for operation and maintenance for water supply facilities.
- Technology transfer for well drilling through on-the-job training.

Based on the request, the Government of Japan sent a preliminary study team to Cambodia in October 2004 to confirm the contents of the request. In this study, the study team confirmed that out of the four target provinces, the Cambodian side put priority on Kampong Cham province.

Based on the results of the preliminary study, the Government of Japan decided to conduct a basic design study, and JICA sent a basic design study team to Cambodia from October 3 to October 31, 2004 to verify and evaluate the effect of the project and to make a suitable plan. The study team held discussions with the implementing agency, and confirmed the contents of the request as follows:

- Construction of 562 deep wells with hand pumps in 142 villages in Kampong Cham province.
- Procurement of drilling equipment including a rig, testing and survey equipment, and operation and maintenance equipment.
- Soft component for operation and maintenance of water supply facilities
- Technology transfer for well drilling through on-the-job training.

In addition, in order to effectively use the limited Grant Aid budget, the Japanese side explained the basic policies, such as to not procure a new boring rig and utilize the equipment owned by the implementing agency whenever possible, to select the target area based on natural and socio-economic conditions, etc., to the Cambodian side and their understanding was obtained.

After that, the survey results were analyzed and examined in Japan and a Draft Basic Design Study Report was prepared, and a team was sent by JICA to Cambodia from January 31 to February 10, 2005 to explain and discuss the report.

The primary objective of the project is to improve the living environment of residents in the target villages, and the project goal is to improve the coverage of safe water supply. This grant aid is to contribute to achieving the project goal and primary objective through the construction of deep wells which can provide a safe and stable water supply. A comparison of the original request and basic design

is shown in the table below.

Table 1: Comparison of original request and basic design

	Original request April 2004 - (1)	Revised request October 2004 - (2)	Basic design
Facilities	● Construction of 1,036 deep wells with hand pump in 256 village (Kampong Cham, Kandal, Kampong Speu and Ta Keo)	● Construction of 562 deep wells with hand pump in 142 village (Kampong Cham, Kandal, Kampong Speu and Ta Keo)	● Construction of 380 deep wells with hand pumps in 115 villages in Kampong Cham province.
Equipment	● Procurement of well drilling equipment, including rig, support vehicles, and testing and survey equipment ● Procurement of equipment for O&M	● Procurement of well drilling equipment, including rig, support vehicles, and testing and survey equipment ● Procurement of equipment for O&M	● Procurement of testing and survey equipment ● Procurement of equipment for O&M
Technical support	● Soft component for sustainable operation and maintenance of water supply facilities. ● Technical assistance for well drilling	● Soft component for sustainable operation and maintenance of water supply facilities. ● Technical assistance for well drilling	● Soft component for sustainable operation and maintenance of water supply facilities. ● Technical assistance for well drilling

A summary of facility construction and a description of the main equipment to be procured in the basic design study are shown below.

Table 2: Summary of facility construction

Description	Specifications	Quantity
Deep well	4”PVCscreen casing、depth : 25～80m	380 points
Earth filling		380 places
Platform and drainage	Reinforced concrete	380 places
Hand pump	Afridev type	380 units
Iron removal unit	Stainless movable type	27 units
Sign board for hygiene campaign		380 units

Table 3: Description of equipment to be procured

Category	Equipment	Quantity
Testing and survey equipment	Borehole logging equipment	1 set
	Well development equipment	1 set
	Pumping test equipment	1 set
	Water analysis kit	1 set
	Cargo truck with crane	2 units
	Pick-up truck (for testing and survey)	2 units
Equipment for O&M	Pick-up truck (for O&M)	1 unit
	Motor bike	4 units
	Video set	1 set
	Projector set	1 set
	Computer set	1 set

The project will be conducted in two phases, and the estimated project cost will be 882 million Yen (Japan's Grant Aid: 868 million Yen; Cost Borne by the Cambodia Side: 14 million Yen). The duration of the project is expected to be 11.5 months for detailed design, 25.5 months for construction of the facilities, 3.0 months for procurement of equipment, and 25.0 months for the soft component.

Through this grant aid project, deep wells with hand pump will be constructed in 115 target villages, supplying safe drinking water to an estimated target population of approximately 108,400 people, and this will lead to a decline in the incidence of water-borne diseases. Furthermore, the supply rate of safe drinking water in the 115 target villages will be improved from 9.5% to 82.3%, which will contribute to achieving the objectives of priority programs, such as the Cambodian Millennium Development Goals (CMDGs), the Second Five Year Socio-Economic Development Plan 2001-2005 (SEDP-II), and the Rural Water Supply and Sanitation Sector Investment Plan 2003-2012 (SIP). In addition, through the soft component of this project, the implementing agency's support system for operation and maintenance will be strengthened, and the Rural Development Committees in the 115 target villages will form Water and Sanitation User's Groups for the 380 water supply facilities, which will enable operation and maintenance of the facilities by the residents at the village level and sustainable O&M of the facilities based on the sharing of responsibility between the implementing agency and residents. The implementing agency's technical capacity for well drilling will also be improved through to the technical assistance to be extended based on the procurement of survey and testing equipment for well drilling in the project.

In order to ensure the sustainability of the project effects, it is vital that the implementing agency take the initiative in solving the following two problems:

- Continuation of overall support activities concerned with O&M of water supply facilities

In order to ensure the continued operation and maintenance of water supply facilities in the future, government agencies need to continuously support the independent O&M activities at the village level. The implementing agency must have a comprehensive understanding of village level O&M activities and the support activities by the District Office of Development (DOD) and the Kampong Cham Provincial Department of Rural Development (PDRD) and if necessary, give advice and guidance.

- Dissemination of well drilling techniques to the private sector

Based on the national water supply and sanitation policy, which specifies the encouragement of public sector participation in the water supply sector, private companies will play a greater role in well drilling works in the future. Therefore, it is important that the DRWS improve the technical capacity for well drilling in Cambodia, by transferring the well drilling techniques it will acquire to the private sector using the survey and testing equipment provided in this project.

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Chapter 1 Background of the Project

Chapter 1 Background of the Project

(1) Background

Based on the request, the Government of Japan carried out the development studies, "The Study on Groundwater Development in Southern Cambodia (2001)" and "The Study on Groundwater Development in Central Cambodia (2002)". Based on the results of those studies, the Government of Japan carried out "The Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh (1.2 billion yen)" for the procurement of drilling equipment and the construction of water supply facilities under grant aid.

However, following the above project, there was still a need for the construction of water supply facilities in rural villages in Cambodia. Therefore, the Government of Cambodia made a request for Japanese grant aid in Southern and Central Provinces (Kampong Cham, Kandal, Kampong Speu and Ta Keo provinces) and the Government of Japan conducted the preliminary study "Rural Water Supply in Southern and Central Provinces".

This study was conducted based on the request above and the result of the preliminary study.

(2) Changes in Requested Items

1) Original request

The lists of request submitted by Cambodia side on April 2004 are as below.

A) Facilities construction

Target village	Kampong Cham	Kandal	Kampong Speu	Ta Keo	Total
Number of village	131	31	32	62	256
Expected Population (2005)	118,320	26,371	18,696	48,854	212,241
Required number of tube well	526	140	104	266	1,036

B) Procurement of equipments

- Well drilling equipments:

1. Drilling rig 2 sets
2. High pressure air compressor 2 sets
3. Drilling tools 2 sets
4. Hand pump 1,036 sets
5. PVC casing 1,036 sets
6. Low pressure air compressor 2 sets

7.	Pumping test equipments	2 sets
8.	Cargo track with crane	2 sets
9.	Water tank track	2 sets
10.	Fuel tank track	2 sets
11.	Pick-up track for well drilling	2 sets
12.	Pick-up truck for resistivity survey	2 sets
13.	Station-wagon for resistivity survey	2 sets
14.	Borehole logging equipment	2 sets
15.	Resistivity survey equipment	2 sets
16.	Water analysis kit	2 sets
17.	Notebook computer with projector for health and hygiene education	2 sets

■ Equipments for operation and maintenance:

1.	Spare parts for hand pump	1,036 sets
2.	Maintenance tools for hand pump	120 sets
3.	Hand pump	120 sets
4.	Pick-up for WTC	4 sets
5.	Video set with screen for hygiene education	1 set

C) Soft component

- ♦ Socio-Economic Analysis
- ♦ Setting up and guidance of O & M organization
- ♦ Hygiene campaign
- ♦ Monitoring of water point committee's O & M

D) Technology transfer by the on-the-job training

- ♦ Resistivity survey technique skill
- ♦ Drilling machine (Especially DTH) operation & Maintenance
- ♦ Borehole logging technique
- ♦ Skill for water quantity measurement
- ♦ Water quality
- ♦ Well database management skill

2) Confirmed Request

The final lists of request submitted by Cambodia side on October 8, 2004 during the Basic design study are as below.

A) Facility Construction

Region	Province	Number of Villages	Target Year 2005	
			Population	Required Number of Tube Wells
Central Cambodia	Kampong Cham	142	124,905	562
	Total	142	124,905	562

B) Procurement of Equipment

■ Drilling Equipment

1. Drilling rig: 2 sets
2. High pressure air compressor: 2 sets
3. Drilling tools: 2 sets
4. Cargo truck with crane: 2 sets
5. Water tank truck: 2 sets
6. Fuel tank truck: 2 sets
7. Pick-up truck for well drilling: 2 sets

■ Testing and Survey Equipment

1. Pumping test equipment: 2 sets
2. Cargo truck with crane for pumping test: 2 sets
3. Borehole logging equipment: 2 sets
4. Pick-up truck for well logging: 2 sets
5. Resistivity survey equipment: 2 sets
6. Station-wagon for resisitivity survey: 2 sets
7. Water analysis kit: 2 sets

■ Equipment for Operation & Maintenance

1. Pick-up truck for WSUG training: 2 sets
2. Video set with screen for training: 1 sets
3. Notebook computer with projector for health and hygiene education: 2 sets
4. Computer set for data base 1 sets
5. Low pressure air compressor for well rehabilitation: 2 sets

C) Soft Component

- ♦ Socio-Economic Analysis
- ♦ Setting up and guidance of O & M organization
- ♦ Hygiene campaign

- ♦ Monitoring of water point committee's O & M

D) On the job training on construction work

- ♦ Resistivity survey technique skill
- ♦ Drilling machine (Especially DTH) operation & Maintenance
- ♦ Borehole logging technique
- ♦ Skill for water quantity measurement
- ♦ Water quality
- ♦ Well database management skill

Chapter 2 Contents of the Project

Chapter 2 Contents of the Project

2.1 Basic Concept of the Project

This project shall cover the implementation of the following assistance operations:

Construction of water supply facilities including well drilling works

Procurement of the necessary equipment and materials for surveys and tests relating to well drilling

Procurement of the necessary equipment and materials for operation and maintenance

Transfer of technology to the implementing agency in order to improve its technical capacity for well drilling and schedule control

Transfer of technology to the implementing agency relating to operation and maintenance activities and hygiene education activities

Soft component for operation and maintenance education of residents

The contents of the project are summarized by PDM (project design matrix) shown in Table 2-1. The method of measurement for effectiveness, base line and targets are summarized in Table 2-2 and Table 2-3.

Table 2-1: Project Design Matrices (PDM)

Summary	Indicators	Measurement	External Conditions
Primary Objective Improved living environment	Incidence of water borne diseases among residents.....A	Questionnaire survey	
Project Goal Increased service population and sustainable supply of safe and clean water for the target villages	Water supply coverage.....B	Estimate the number of users of safe water supply facility such as deep wells and Determine its proportion to the total population	No substantial change in the Cambodia's water and sanitation policy
Outcomes 1. Water supply facilities will be constructed in the study area 2. Well drilling equipment will be provided to the counterpart/implementing agency 3. The counterpart/ implementing agency will be improved well drilling work technically. 4. Residents will utilize the water supply facilities. 5. Establishing of operation and maintenance (O&M) system.	1. No. of wells constructed . .....C 2. Conditions of equipment owned by the implementing agency ...D 3. No of wells constructed by the implementing agency .....E 4. No. of facility users.....F 5-1. No. of WSUG's set up.....G 5-2. Frequency of cleaning of facility surroundings .....H 5-3. Collection rate of O&M fee.....I 5-4. No. of contracts signed between target villages and JICA/MRD on their respective responsibilities.....J	1. Materials on construction works 2. Records of equipment utilization 3. Records of activities of the implementing agency 4. Questionnaire survey 5-1. Questionnaire survey 5-2. Records of activities of WPC 5-3. Fee collection records 5-4. No. of contracts signed	No rapid increase or migration of the population
Activities（The numbers corresponds to those of the results above） 1-1. A Water Supply Facility Development Plan will be formulated. 1-2. Well drilling works and facility construction works will be conducted. 2. Equipment and materials for well drilling and O&M of facilities will be procured. 3. The implementing agency will receive training in construction techniques. 4-1. The implementing agency will provide hygiene education for the residents 4-2. Residents will decide on the location of construction sites (informed decision) 5-1. An O&M Plan will be formulated. 5-2. Technology will be transferred to the implementing agency for O&M of facilities. 5-3. The residents will set up WSUG. 5-4. The implementing agency will give instruction to residents on method for O&M of facilities.	Input (Japanese side) ・Water supply facility construction ・Drilling equipment/ materials ・O&M equipment ・Soft component ・Transfer of technology ・Consulting services (Cambodian side) ・Securing of site for construction ・Drilling staff ・O&M of facilities ・Drilling equipment		No unforeseeable drought or decline in groundwater level **Prerequisite** Residents have an incentive for implementation of the project

Supervising Agency : Ministry of Regional Development（MRD）
Implementing Agency : Water Supply Bureau（DRWS）
WSUG : Water and Sanitation User's Group

Table 2-2: The method of measurement for project effect index

Project effect index	The method of measurement
A. Incidence of water borne diseases	As the medical institutions in the study area are limited, statistical data on the number of patients is difficult to obtain or does not reflect the actual situation. According to surveys, about 40% of the residents have problems with typhus and/or diarrhoea due to unsanitary water; therefore, this will be the baseline in the development study. The project effect index will be measured based on a questionnaire survey on typhus and diarrhoea.
B. Water supply coverage	The percentage of the population in the target villages covered by facilities that supply safe drinking water (210 persons/well with hand pump)
C. Number of constructed well	The number of wells constructed in the project will be recorded and managed. The baseline will be zero.
D. Utilization of equipment owned by DRWS	A portion of the wells in the project will be constructed using the DRWS's equipment. Therefore, the equipment used and the duration of use will be recorded.
E. Number of wells constructed by DRWS	A portion of the wells in the project will be constructed by DRWS. Therefore, the number of such wells will be recorded.
F. Utilization of constructed facility	Whether or not the water facilities constructed in the project are utilized will be determined by questionnaire survey.
G. Number of established WSUG	Whether or not the WSUGs of the water facilities constructed in the project have been established will be determined by questionnaire survey.
H. Frequency of cleaning around the water facility	The frequency of cleaning around the water facility will be checked based on the WSUG report.
I. Rate of collection of O&M fees.	WSUG will be instructed to keep records of the O&M fees collected, and the collection rate of O&M fees will be determined based on those records.
J. No. of contracts signed between target villages and JICA/MRD on their respective responsibilities	As proof that an O&M system has been established, the number of contracts signed between WSUG and MRD (DRWS/PDRD) specifying their respective roles will be determined by questionnaire.

Table 2-3: Base line and target for project effect index.

	Project effect index	Base line	Target
A	Incidence of water borne diseases	40%	20%
B	Water supply coverage	9.5%	65%
C	Number of constructed well	0 no	380 no
D	Utilization of DWRS' s equipments (monthly working record)	0 month	15 months
E	Number of constructed well by DWRS	0 no	90 no
F	Utilization of constructed facility (Ratio against WSUG registered personnel)	0 person	80%
G	Number of the established WSUG (Ratio against constructed well)	0 %	80%
H	Frequency of the cleaning around water facility (monthly)	0 time	2 times
I	Ratio of the correction of O&M fees.	0 %	80%
J	No. of contracts signed between target villages and JICA/MRD on their respective responsibilities	0 %	80%

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

(1) Basic Policy

1) Procurement of new drilling equipment

In order to reduce of the project cost, new drilling equipment shall not be procured by this project.

2) Utilization of equipment owned by implementing agencies

In order to reduce the project cost, well drilling equipment owned by the implementing agency shall be used for the construction of the facilities whenever possible, after its capacity and condition has been carefully examined.

3) Utilization of local resources

In order to reduce the project cost, existing local drilling equipment (owned by local firms) shall be positively utilized.

4) Selection of project sites

Based on the results of field surveys conducted in 144 villages concerning the natural and social conditions, water supply facilities shall be constructed in villages seriously in need of water and with potential (in water quality and quantity) for groundwater development, where private companies are not likely to conduct water supply business and the residents clearly have the intention to participate in this project of their own will and conduct sustained operation and maintenance of the water supply facilities.

(2) Policy on Natural Conditions

Although the water quality in the project area is generally satisfactory, the water in some areas is assumed to have high iron content. Therefore, attention shall be paid to the setting of water standards in relation to iron in this project and the installation of iron removers shall be examined.

In the province of Memot, there are some villages with poor accessibility. These villages, which are presumed to be difficult to access in the rainy season, shall be given due consideration when establishing the project implementation schedule.

Interviews were carried out with the Cambodia Mine Centre (CMAC) to get information about un-removed mines in the project area. According to CMAC, careful attention must be paid when entering the forest. However, if the project activities are within the daily living area of villagers, there should be no problem. As the project shall be conducted within the living area of the people, it is

considered to be safe. However, project staff shall pay careful attention to the said conditions.

(3) Policy on Social Conditions

As observed in the pilot water supply facilities constructed in the development study, no fee is collected from well users for operation and maintenance of existing well facilities with hand pumps by residents. Since a periodical fee collection system, such as a flat monthly rate, is not considered to suit the present state of the locality, appropriate methods of collection of maintenance fees shall be examined.

(4) Policy on Setting the Grade of Facilities and Equipment

1) Facilities

The water supply facilities shall be a Level-1 water supply system consisting of a tube well, hand pump and ancillary facilities, requiring low operation and maintenance costs and easily operated and maintained by the residents.

The hand pump shall be the DRWS-standard Afridev model widely used in the locality, which can be easily operated and maintained by the residents and can be repaired with spare parts supplied by the existing local distributor.

The well shall be provided with concrete surrounds and equipped with a drain of an appropriate length so that dirty water on the ground will not penetrate the well. The area around the well shall be raised by banking in order to ensure the necessary gradient for draining. The concrete surrounds and drain shall be reinforced with steel bars to prevent cracks due to uneven settling in the future.

The water quality of the well shall meet the quality requirements for drinking water. In terms of iron, which is assumed not to meet the Cambodian quality standard in some areas, an iron remover shall be installed if necessary at the request of residents.

Signboards for educational purposes shall be placed around the well to improve residents' awareness of the importance of daily operation and maintenance and hygienic use of the facilities.

2) Equipment

As for the equipment required for this project, in principle the equipment supplied in the Peri-Urban Project shall be utilized and only the minimum necessary equipment shall be procured. In consideration of sustainable operation and maintenance, models that allow repair and spare parts procurement in the locality shall be selected.

Since the roads near the target villages are unpaved and accessibility is poor in the rainy season,

the vehicles shall be four-wheel drive models.

(5) Policy on Cost Reduction

Under this project, the policy on cost reduction is as follows:

1) Utilization of locally procured materials and equipment

For construction of deep wells, many construction materials such as cement, reinforcing bars and gravel shall be locally procured. As for materials and equipment for which local procurement is difficult, the costs of procurement in Japan and in a third country shall be compared and the less expensive shall be adopted.

2) Utilization of equipment supplied under Grant Aid and local construction companies

The most shall be made of equipment supplied under Japan's Grand Aid program in the past and currently owned by the implementing agency (such as well drilling equipment, support vehicles and survey equipment). Furthermore, local engineer and laborers shall be employed so that the number of personnel from Japanese construction companies can be kept to a minimum.

(6) Policy on Construction Conditions

1) Related Laws

In Cambodia, the Labour Code was enacted in 1997 to establish many working standards such as statutory working hours, minimum wage, allowance for overtime work, and paid leave of absence.

Therefore, allowances for local workers shall be established based on the estimated labor cost (standard unit price) in the locality while adding up the various allowances stipulated in the Cambodian Labour Code.

2) Landing Port and Road Conditions

Equipment procured in this project shall be landed at the Port of Sihanoukville, an international port. The equipment shall be discharged and cleared through customs at the Port of Sihanoukville and transported by land via Phnom Penh to the project site in the province of Kampong Cham. The roads from the Port of Sihanoukville to Phnom Penh and then to the project site in the province of Kampong Cham are paved so there is no problem in using them for land transport.

3) Construction Materials

Materials and equipment required for construction work shall be locally procured whenever possible. However, materials and equipment that cannot be locally procured or can be procured with

difficulty within a given period of time due to problems in quality or physical distribution shall be procured in Japan or a third country. As for materials and equipment that cannot be locally procured, the costs of procurement in Japan and in a third country shall be compared and the less expensive shall be adopted.

Many of the construction materials to be used in this project can be locally procured. While no cement or PVC pipes are produced in Cambodia, Thai-made products are commonly sold in the market and the said product shall be procured as Cambodian-made.

4) Hand Pumps

Afridev hand pumps are the standard model used in Cambodia. There are two types of Afridev hand pumps: original products made in India and copies made in Cambodia. The Department of Rural Water Supply (DRWS) recommends the original product because the copy is inferior in quality and often breaks down. Since there are distributors of Indian-made Afridev pumps in the locality, Indian-made original products shall be procured through the distributors.

5) Equipment to Be Procured

As for equipment such as vehicles, motorbikes and electric appliances (including computers and video cameras), basically products of those makers with distributors, service factories, etc. in the city of Phnom Penh shall be procured in consideration of future operation and management.

(7) Policy on Utilization of Equipment Owned by Implementing Agency

The implementing agency, the DRWS of the Ministry of Rural Development (MRD), has adequate equipment to carry out the project. In order to reduce the project cost, the equipment shall be utilized as much as possible after examination of its capacity, condition and future schedule.

(8) Policy on Utilization of Local Equipment

Local well drilling companies are considered to have an adequate amount of drilling equipment to carry out the project. In the event that drilling equipment is procured locally, the cost shall be much lower than the procurement in Japan. Therefore, in this project local equipment shall be utilized as much as possible.

(9) Policy on Technology Transfer

1) Technologies for well drilling

The implementing agency and private constructors are inexperienced in well drilling technology and they do not possess the equipment or materials necessary for survey and testing technologies such as

geophysical prospecting, borehole logging and pumping tests related to well drilling. These technologies are required for a high well-drilling success rate and effective water intake through the selection of a good aquifer. To improve the well drilling technology in the entire country of Cambodia, it is necessary for the implementing agency to acquire these technologies and spread them among the private constructors.

The transfer of technologies for the surveys and tests in the well drilling works to be implemented in this Project will be made concerning the following items and contents.

2) Maintenance and operation

The soft component for maintenance and operation and hygiene education that is being implemented in the Peri-Urban Project in Cambodia has been highly evaluated. "It is very effective and will be a good model for future projects." This Project will also introduce a soft component for maintenance and operation and hygiene education in order to enhance the technical level of DRWS as the facilitator and transfer technology to the Kampong Cham Provincial Department of Rural Development (PDRD).

(10) Policy on Construction and Procurement Methods and Work schedule

1) Construction Method

Two methods of well drilling will be adopted in this Project: the DTH drilling method using air hammers and the mud circulating rotary drilling method. In other construction work, no construction method requiring special technology will be adopted.

2) Procurement Method

The equipment to be procured is not made in Cambodia. In the Peri-Urban Project, most of the equipment was made in Japan and the equipment was adequate. Furthermore, there was no trouble with the necessary maintenance such as the procurement of spare parts and after sales service. Therefore, in principle the equipment shall be procured from Japan. However, in the event that there is only one supplier in Japan, procurement from a third country shall be considered. Equipment such as computer and video camera shall be procured locally in view of better after sales service.

3) Construction schedule

The construction schedule shall be determined based on natural conditions such as rainfall and accessibility, number of facilities and number of construction parties, and divided into periods if necessary.

2.2.2 Basic Plan (Facilities Plan/Equipment Plan)

(1) Overview of grant aid project

Based on the results of the surveys of natural and social conditions in the 144 villages where field surveys were made, water supply facilities will be constructed in villages where the water supply is in a serious condition, there is potential for groundwater development (in water quality and quantity), there is no possibility of the participation of private constructors, and residents have a clear intention to form resident organizations by themselves to participate voluntarily in the Project and carry out sustainable maintenance of the water facilities. The water supply facilities will consist of a tube well, hand pump and incidental facilities that can be maintained and operated easily by residents at a low maintenance cost.

As for equipment procurement, the survey and testing equipment necessary for enhancement of the well drilling technology of DRWS and the maintenance equipment necessary for DRWS, PDRD and District Office of Development (DOD) to support residents in the maintenance and operation of the facilities will be procured.

Consulting services will be provided for design and supervision of the Project.

The engineers necessary to enhance the well drilling technology of the implementing agency will be dispatched.

Soft component support will be provided for the activities of the implementing agency including maintenance and operation activities and hygiene education.

(2) Results of Selection of Target Villages

The number of target villages before the field survey started was 142, but it became clear during the field survey that two of the villages had been divided into two after the "Study on Groundwater Development in Central Cambodia" (hereinafter called the Development Study) was made. Therefore, the total number of study villages was 144.

The results of the field survey showed that, around the Ou Rieng Ov district in the southwestern part of the study area, the number of existing wells had increased considerably compared with the time of the Development Study (2001), probably because private constructors had built a number of low-cost wells. As more low-cost wells are expected to be built by private constructors in this area, it will be excluded from the Project under the selection criteria.

In addition, among the study villages, there are a number of candidate villages for the Piped Water Supply Project under a private-sector initiative led by the Ministry of Industry, Mines and Energy

(MIME) and the World Bank (WB). If the Piped Water Supply Project is implemented by private operators in the future, the water supply facilities to be constructed in this Project will affect the piped water supply project, but there is no prospect of that project being implemented at the present time. If the piped water supply project is started, it is thought that the poor will not be able to pay the water charges and will not receive any safe water. For this reason, in this Project, the minimum number of water supply facilities will be constructed under criteria established for relief of the poor, taking into account their need and the current urgency.

Based on the above discussions and under the selection criteria resulting from the surveys of natural and social conditions, the number of the target villages has been decided at 115. Figure 2-1 shows the flowchart of selection of the target villages and Table 2-4 shows the results of the field surveys and selection of target villages.

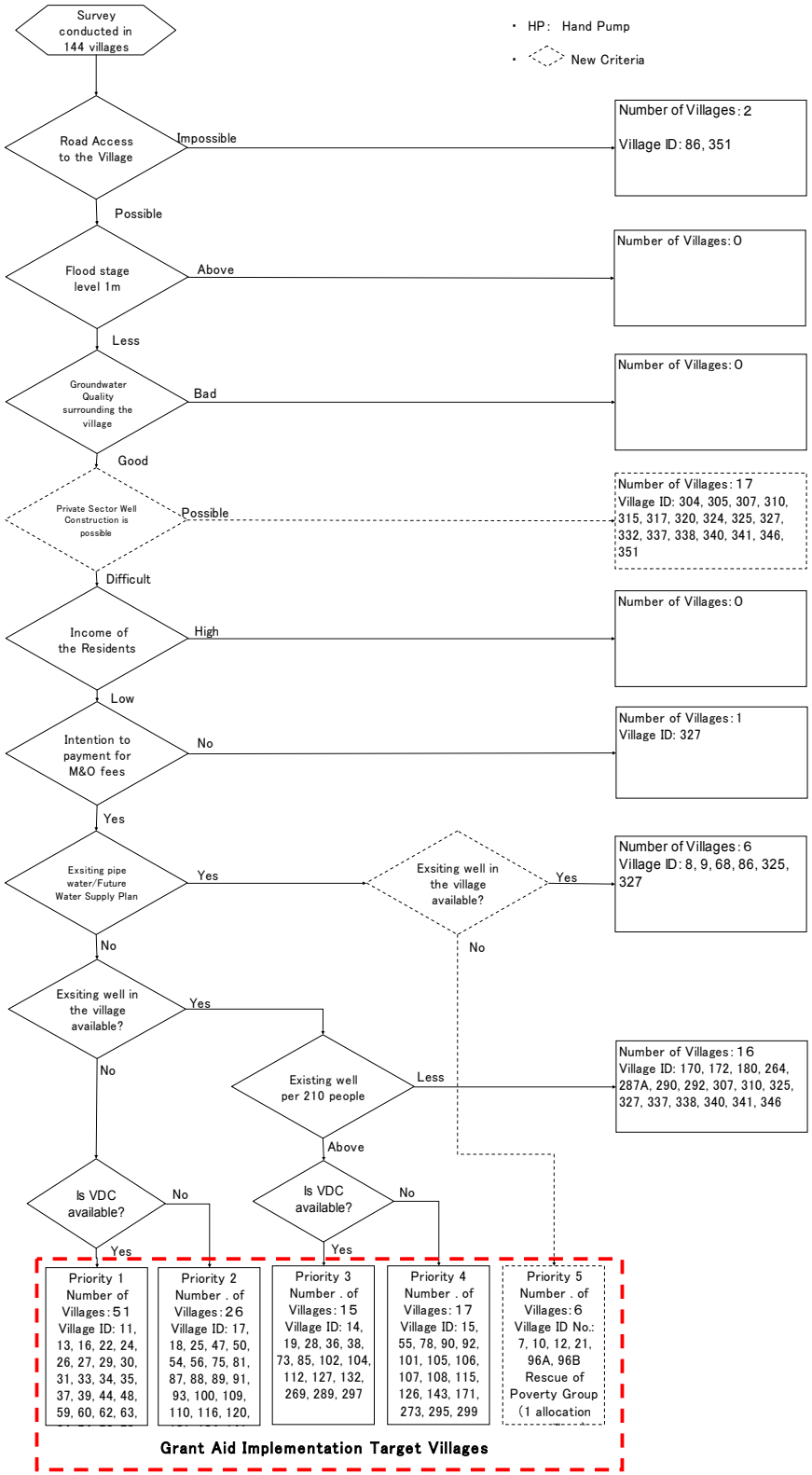

Figure 2-1: Flowchart of Selection of Target Villages

Table 2-4: Results of Field Surveys and Selection of Target Villages

District	Commune	ID	Village	Results in the study area													Selection Result	No. of Wells to be constructed		
				Population 2004	Access to Road	Flood level above 1m	Groundwater Quality	Possibility of Private Sector Wells	Amount of Residents' Income	Payable Repair Cost	Exsiting Water Supply Facility	Other Water Supply Plan	No. of Exsiting Wells 2004	No. of Required Wells 2010	No. of Required Additional Wells 2010	VDC's availability	Rank	Max of 5 allocations	Rescue of Poverty Group	Total
Memot	Dar	7	Dar Cheung	798	Y	N	OK		1,040,000	2,200	N	MIME	0	4	4	Y	5	0	1	1
Memot	Dar	8	Dar Lech	1,280	Y	N	OK		1,300,000	6,000	N	MIME	1	7	6	N	–	0	0	0
Memot	Dar	9	Dar Phsar	1,359	Y	N	OK		1,100,000	4,600	N	MIME	1	7	6	Y	–	0	0	0
Memot	Dar	10	Dar Kandaol	2,301	Y	N	OK		1,020,000	5,000	N	MIME	0	12	12	N	5	0	1	1
Memot	Dar	11	Prampir Meakkakra	1,100	Y	N	OK		1,400,000	6,800	N		0	6	6	Y	1	5	0	5
Memot	Dar	12	Dar Tboung	997	Y	N	OK		1,300,000	5,000	N	MIME	0	5	5	Y	5	0	1	1
Memot	Dar	13	Triek	448	Y	N	OK		940,000	2,200	N		0	2	2	Y	1	2	0	2
Memot	Dar	14	Spean	2,230	Difficult	N	OK		2,680,000	5,600	N		6	12	6	Y	3	5	0	5
Memot	Dar	15	Meaek Puk	590	Difficult	N	OK		1,460,000	1,100	N		1	3	2	N	4	2	0	2
Memot	Dar	16	Srae Chroam	945	Y	N	OK		860,000	1,800	N		0	5	5	Y	1	5	0	5
Memot	Dar	17	Chhngar Cheung	880	Y	N	OK		1,760,000	3,200	N		0	5	5	N	2	5	0	5
Memot	Dar	18	Chhngar Kandal	420	Y	N	OK		1,400,000	5,400	N		0	2	2	N	2	2	0	2
Memot	Dar	19	Samraong Cheung	550	Y	N	OK		2,700,000	4,400	N		1	3	2	Y	3	2	0	2
Memot	Dar	21	Beng	410	Y	N	OK		1,340,000	5,800	N	MIME	0	2	2	Y	5	0	1	1
Memot	Rung	22	Chambak	1,013	Y	N	OK		820,000	3,800	N		0	5	5	Y	1	5	0	5
Memot	Rung	24	Doun Roadth Ti Pir	527	Y	N	OK		1,230,000	4,200	N		0	3	3	Y	1	3	0	3
Memot	Rung	25	Bos	590	Y	N	OK		920,000	1,400	N		0	3	3	N	2	3	0	3
Memot	Rung	26	Choam Tuk	660	Difficult	N	OK		780,000	2,600	N		0	3	3	Y	1	3	0	3
Memot	Rung	27	Rung	577	Difficult	N	OK		620,000	1,800	N		0	3	3	Y	1	3	0	3
Memot	Rung	28	Taonh	380	Y	N	OK		880,000	5,200	N		1	2	1	Y	3	1	0	1
Memot	Rung	29	Doung	482	Difficult	N	OK		1,060,000	1,900	N		0	3	3	Y	1	3	0	3
Memot	Rung	30	Beng	579	Difficult	N	OK		600,000	2,200	N		0	3	3	Y	1	3	0	3
Memot	Rung	31	Masin	710	Y	N	OK		960,000	800	N		0	4	4	Y	1	4	0	4
Memot	Rung	33	Soutey	1,107	Y	N	OK		880,000	1,900	N		0	6	6	Y	1	5	0	5
Memot	Rung	34	Trapeang Ruessei	1,153	Difficult	N	OK		940,000	2,900	N		0	6	6	Y	1	5	0	5
Memot	Chan Mul	35	Thlok	780	Y	N	OK		720,000	700	N		0	4	4	Y	1	4	0	4
Memot	Chan Mul	36	Chan Mul	1,167	Y	N	OK		740,000	3,200	N		1	6	5	Y	3	5	0	5
Memot	Chan Mul	37	S'am	868	Y	N	OK		820,000	2,000	N		0	5	5	Y	1	5	0	5
Memot	Chan Mul	38	Srae Ta Nong Kaeut	362	Y	N	OK		880,000	3,000	N		1	2	1	Y	3	1	0	1
Memot	Chan Mul	39	Srae Ta Nong Lech	350	Difficult	N	OK		1,080,000	1,700	N		0	2	2	Y	1	2	0	2
Memot	Chan Mul	44	Kor	531	Y	N	OK		880,000	2,600	N		0	3	3	Y	1	3	0	3
Memot	Tonlung	47	Kdol Leu	426	Difficult	N	OK		840,000	1,300	N		0	2	2	N	2	2	0	2
Memot	Tonlung	48	Changkum Kandal	956	Y	N	OK		1,620,000	1,200	N		0	5	5	Y	1	5	0	5
Memot	Tonlung	50	Beng Kaong	520	Y	N	OK		1,350,000	900	N		0	3	3	N	2	3	0	3
Memot	Tonlung	54	Kdol Kraom	845	Y	N	OK		1,040,000	1,500	N		0	4	4	N	2	4	0	4
Memot	Tonlung	55	Sla Phnum	789	Y	N	OK		1,600,000	4,400	N		1	4	3	N	4	3	0	3
Memot	Tonlung	56	Pong Tuek	1,865	Y	N	OK		940,000	3,020	N		0	10	10	N	2	5	0	5
Memot	Rumchek	59	Pnov	550	Y	N	OK		1,956,000	7,400	N		0	3	3	Y	1	3	0	3
Memot	Rumchek	60	Kantuot	568	Y	N	OK		1,840,000	5,100	N		0	3	3	Y	1	3	0	3
Memot	Rumchek	62	Chheu Khloem	878	Y	N	OK		910,000	1,440	N		0	5	5	Y	1	5	0	5
Memot	Rumchek	63	Kampey	943	Y	N	OK		334,000	440	N		0	5	5	Y	1	5	0	5
Memot	Rumchek	64	Khpob	1,363	Y	N	OK		1,900,000	8,600	N		0	7	7	Y	1	5	0	5
Memot	Memot	68	Memot Phsar	3,155	Y	N	OK		3,200,000	10,000	Y	MIME	1	16	15	N	–	0	0	0
Memot	Memot	73	Choam M'aor	386	Y	N	OK		1,240,000	1,700	N		1	2	1	Y	3	1	0	1
Memot	Memot	74	Trabaek	975	Y	N	OK		1,300,000	4,900	N		0	5	5	Y	1	5	0	5
Memot	Memot	75	Nang Krapeu	362	Y	N	OK		1,040,000	5,000	N		0	2	2	N	2	2	0	2
Memot	Memot	76	Trapeang Reang	1,774	Y	N	OK		2,360,000	3,900	N		0	9	9	Y	1	5	0	5
Memot	Memot	78	Sangkom Mean Chey Chas	849	Y	N	OK		1,080,000	4,400	N		1	4	3	N	4	3	0	3
Memot	Memot	79	Chi Peh	997	Y	N	OK		1,740,000	3,100	N		0	5	5	Y	1	5	0	5
Memot	Memot	80	Chhngar Sala	370	Y	N	OK		1,000,000	3,200	N		0	2	2	Y	1	2	0	2
Memot	Memot	81	Mukh Kras	610	Y	N	OK		1,020,000	3,200	N		0	3	3	N	2	3	0	3
Memot	Tramung	82	Tramaeng Leu	378	Y	N	OK		760,000	2,000	N		0	2	2	Y	1	2	0	2
Memot	Tramung	85	Tramung	944	Y	N	OK		600,000	2,200	N		2	5	3	Y	3	3	0	3
Memot	Tramung	86	Choam Triek	1,198	N	N	OK		1,340,000	1,700	N	MIME	1	6	5	Y	–	0	0	0
Memot	Tramung	87	Roung Chakr Skar	307	Y	N	OK		1,196,000	2,400	N		0	2	2	N	2	2	0	2

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Memot	Tramung	88	Andoung Thma Leu	422	Difficult	N	OK		580,000	600	N		0	2	2	N	2	2	0	2
Memot	Tramung	89	Andoung Thma Kraom	294	Difficult	N	OK		600,000	340	N		0	2	2	N	2	2	0	2
Memot	Tramung	90	Doung	359	Y	N	OK		1,000,000	2,000	N		1	2	1	N	4	1	0	1
Memot	Tramung	91	Choam Trav	490	Y	N	OK		700,000	1,700	N		0	3	3	N	2	3	0	3
Memot	Tramung	92	Chhuk	661	Difficult	N	OK		1,340,000	8,600	N		1	3	2	N	4	2	0	2
Memot	Tramung	93	Ngeu Thum	645	Y	N	OK		1,140,000	700	N		0	3	3	N	2	3	0	3
Memot	Tramung	96A	Khnong Krapeu Kaeut	1,952	Y	N	OK		3,580,000	8,000	Y	MIME	0	10	10	N	5	0	1	1
Memot	Tramung	96B	Khnong Krapeu Lech	2,400	Y	N	OK		2,300,000	5,000	N	MIME	0	13	13	N	5	0	1	1
Memot	Tramung	100	Chrey	527	Difficult	N	OK		2,060,000	1,800	N		0	3	3	N	2	3	0	3
Memot	Kampoan	101	Lour	1,802	Y	N	OK		1,400,000	3,300	N		1	9	8	N	4	5	0	5
Memot	Kampoan	102	Kampoan	1,600	Y	N	OK		1,320,000	3,400	N		1	8	7	Y	3	5	0	5
Memot	Kampoan	104	Srae Saom Thmei	1,053	Y	N	OK		1,800,000	6,000	N		1	5	4	Y	3	4	0	4
Memot	Kampoan	105	Srae Saom Chas	602	Y	N	OK		1,560,000	1,320	N		2	3	1	N	4	1	0	1
Memot	Kampoan	106	Tuek Tum	1,000	Y	N	OK		1,660,000	3,800	N		1	5	4	N	4	4	0	4
Memot	Kampoan	107	Chhloung Muoy	1,278	Y	N	OK		4,100,000	5,800	N		5	7	2	N	4	2	0	2
Memot	Kampoan	108	Chhloung Pir	797	Y	N	OK		2,240,000	3,200	N		3	4	1	N	4	1	0	1
Memot	Kampoan	109	Chhloung Bei	560	Y	N	OK		1,660,000	3,400	N		0	3	3	N	2	3	0	3
Memot	Kokir	110	Srae Poul	799	Y	N	OK		1,242,000	1,600	N		0	4	4	N	2	4	0	4
Memot	Kokir	111	Kokir Cheung	1,498	Y	N	OK		916,000	820	N		0	8	8	Y	1	5	0	5
Memot	Kokir	112	Kokir Tboung	1,021	Y	N	OK		3,300,000	7,700	N		1	5	4	Y	3	4	0	4
Memot	Kokir	113	Tuol Thma	671	Y	N	OK		1,010,000	675	N		0	4	4	Y	1	4	0	4
Memot	Kokir	115	Kngaok	770	Difficult	N	OK		1,160,000	1,900	N		1	4	3	N	4	3	0	3
Memot	Kokir	116	Preaek Puoy	1,127	Y	N	OK		1,140,000	4,000	N		0	6	6	N	2	5	0	5
Memot	Choam Ta Mau	120	Thnal Kaeng	350	Y	N	OK		1,240,000	1,500	N		0	2	2	N	2	2	0	2
Memot	Choam Ta Mau	121	Thma Totueng Tboung	380	Difficult	N	OK		1,260,000	4,300	N		0	2	2	N	2	2	0	2
Memot	Choam Ta Mau	124	Sampov Lun	819	Difficult	N	OK		1,500,000	1,540	N		0	4	4	N	2	4	0	4
Memot	Choam Ta Mau	125	Chumnum Pol	665	Difficult	N	OK		860,000	1,600	N		0	3	3	Y	1	3	0	3
Memot	Choam Ta Mau	126	Kantuot	787	Difficult	N	OK		1,760,000	9,000	N		1	4	3	N	4	3	0	3
Memot	Choam Ta Mau	127	Angkam	437	Difficult	N	OK		1,680,000	1,900	N		1	2	1	Y	3	1	0	1
Memot	Choam Ta Mau	130	Bos Ta Oem	1,072	Difficult	N	OK		2,000,000	2,200	N		0	6	6	Y	1	5	0	5
Memot	Memong	132	Memong	1,456	Difficult	N	OK		1,100,000	1,200	N		1	8	7	Y	3	5	0	5
Memot	Memong	136	Triek	401	Difficult	N	OK		900,000	1,000	N		0	2	2	Y	1	2	0	2
Memot	Memong	137	Choam Khyang	405	Difficult	N	OK		1,180,000	1,100	N		0	2	2	Y	1	2	0	2
Memot	Memong	138	Sangkae Thmei	915	Difficult	N	OK		1,840,000	4,300	N		0	5	5	Y	1	5	0	5
Memot	Memong	139	Sangkae Chas	1,052	Difficult	N	OK		2,300,000	7,600	N		0	5	5	Y	1	5	0	5
Memot	Choam Kravien	141	Khcheay	600	Y	N	OK		1,280,000	2,700	N		0	3	3	N	2	3	0	3
Memot	Choam Kravien	143	Satum	1,195	Y	N	OK		720,000	3,200	N		1	6	5	N	4	5	0	5
Memot	Choam Kravien	144	Kravien Cheung	540	Y	N	OK		880,000	2,900	N		0	3	3	N	2	3	0	3
Memot	Choam Kravien	147	Chrey Laeung	350	Y	N	OK		560,000	2,000	N		0	2	2	N	2	2	0	2
Memot	Choam	159	Boeng Chroung	562	Y	N	OK		1,100,000	3,000	N		0	3	3	Y	1	3	0	3
Memot	Choam	160	Choam Ampil	489	Difficult	N	OK		720,000	2,400	N		0	3	3	Y	1	3	0	3
Memot	Choam	162	Cheung	490	Difficult	N	OK		620,000	4,400	N		0	3	3	Y	1	3	0	3
Memot	Choam	163	Leach Leu	602	Difficult	N	OK		790,000	1,800	N		0	3	3	Y	1	3	0	3
Memot	Choam	167	Ngiev	668	Difficult	N	OK		2,500,000	2,000	N		0	3	3	N	2	3	0	3
Memot	Choam	168	Leach Kraom	1,092	Under repair	N	OK		780,000	2,500	N		0	6	6	Y	1	5	0	5
Ponhea Kraek	Popel	169	Tuol Kandal	700	Y	N	OK		1,820,000	3,000	N		0	4	4	Y	1	4	0	4
Ponhea Kraek	Popel	170	Srah	725	Y	N	OK		1,520,000	800	N		10	4	-6	Y	-	0	0	0
Ponhea Kraek	Popel	171	khsak	1,453	Y	N	OK		2,500,000	4,300	N		1	8	7	N	4	5	0	5
Ponhea Kraek	Popel	172	Popel	1,349	Y	N	OK		1,500,000	2,000	N		11	7	-4	Y	-	0	0	0
Ponhea Kraek	Kandaol Chrum	179	Tuol Chamkar	821	Y	N	OK		1,300,000	1,040	N		0	4	4	Y	1	4	0	4
Ponhea Kraek	Kandaol Chrum	180	Sbaek Kueu	873	Y	N	OK		1,320,000	800	N		8	5	-3	Y	-	0	0	0
Dambae	Chong Cheach	227	Cheach Cheung	1,368	Y	N	OK		1,060,000	1,400	N		0	7	7	Y	1	5	0	5
Tboung Khmum	Kor	264	Veal Khmum	2,316	Y	N	OK		960,000	3,100	N		18	12	-6	Y	-	0	0	0
Tboung Khmum	Moung Rieng	267	Thnong	1,130	Y	N	OK		2,060,000	3,600	N		0	6	6	Y	1	5	0	5
Tboung Khmum	Moung Rieng	268	Mong Ti Prammuoy	660	Y	N	OK		1,660,000	1,800	N		0	3	3	Y	1	3	0	3

District	Commune	ID	Village	Results in the study area													Selection Result	No. of Wells to be constructed		
				Population 2004	Access to Road	Flood level above 1m	Groundwater Quality	Possibility of Private Sector Wells	Amount of Residents' Income	Payable Repair Cost	Exsiting Water Supply Facility	Other Water Supply Plan	No. of Exsiting Wells 2004	No. of Required Wells 2010	No. of Required Additional Wells 2010	VDC's availability	Rank	Max of 5 allocations	Rescue of Poverty Group	Total
Tboung Khmum	Moung Rieng	269	Mong Ti Prampir	797	Y	N	OK		1,300,000	1,100	N		1	4	3	Y	3	3	0	3
Tboung Khmum	Sralab	271	Trapeang Sangkae	588	Y	N	OK		1,180,000	1,200	N		0	3	3	Y	1	3	0	3
Tboung Khmum	Anhchaeum	272	Trapeang Chak	549	Y	N	OK		460,000	800	N		0	3	3	Y	1	3	0	3
Tboung Khmum	Anhchaeum	273	Chheu Teal Chrum	589	Y	N	OK		990,000	1,300	N		1	3	2	N	4	2	0	2
Tboung Khmum	Lngieng	284	Lvea Thum	755	Y	N	OK		1,340,000	3,400	N		4	4	0	Y	–	0	0	0
Tboung Khmum	Lngieng	285	Lngieng	868	Y	N	OK		1,220,000	2,700	N		0	5	5	Y	1	5	0	5
Tboung Khmum	Vihear Luong	287A	Pnov	658	Y	N	OK		2,200,000	5,700	N		4	3	−1	Y	–	0	0	0
Tboung Khmum	Vihear Luong	287B	Kien Rung	407	Y	N	OK		2,480,000	2,000	N		0	2	2	Y	1	2	0	2
Tboung Khmum	Vihear Luong	289	Prasrae Leu	547	Y	N	OK		2,660,000	1,900	N		1	3	2	Y	3	2	0	2
Tboung Khmum	Suong	290	Prey Totueng	643	Y	N	OK		1,480,000	1,100	N		4	3	−1	Y	–	0	0	0
Tboung Khmum	Suong	291	Chrak Poun	719	Y	N	OK		1,020,000	2,410	N		0	4	4	Y	1	4	0	4
Tboung Khmum	Suong	292	Ponnareay	1,503	Y	N	OK		2,400,000	11,000	N		26	8	−18	Y	–	0	0	0
Tboung Khmum	Thma Pechr	294	Chambak	1,216	Y	N	OK		1,520,000	6,400	N		0	6	6	Y	1	5	0	5
Tboung Khmum	Thma Pechr	295	Chies Ti Muoy	1,013	Y	N	OK		2,020,000	10,000	N		1	5	4	N	4	4	0	4
Tboung Khmum	Roka Po Pram	297	Trapeang Khla	2,220	Y	N	OK		1,560,000	6,000	N		1	12	11	Y	3	5	0	5
Tboung Khmum	Roka Po Pram	298	Ta Pav Bampenh Tes	2,700	Y	N	OK		1,140,000	3,200	N		0	14	14	N	2	5	0	5
Tboung Khmum	Roka Po Pram	299	Pong Tuek	1,712	Y	N	OK		1,620,000	1,400	N		1	9	8	N	4	5	0	5
Tboung Khmum	Chirou Pir	304	Srae Siem	2,436	Y	N	OK	Y	1,460,000	4,700	N		12	13	1	Y	–	0	0	0
Tboung Khmum	Chirou Pir	305	Tuol Vihear	2,299	Y	N	OK	Y	860,000	1,800	N		7	12	5	Y	–	0	0	0
Ou Reang Ov	Damrel	307	Tuol	377	Y	N	OK	Y	680,000	3,800	N		14	2	−12	Y	–	0	0	0
Ou Reang Ov	Mien	310	Prey Sambuor Lech	862	Y	N	OK	Y	860,000	2,000	N		12	5	−7	N	–	0	0	0
Ou Reang Ov	Kong Chey	315	Soeng	698	Y	N	OK	Y	940,000	5,000	N		1	4	3	Y	–	0	0	0
Ou Reang Ov	Kong Chey	317	Changva	312	Y	N	OK	Y	1,300,000	4,100	N		1	2	1	N	–	0	0	0
Ou Reang Ov	Kong Chey	320	Prum Khet	352	Y	N	OK	Y	1,060,000	1,400	N		0	2	2	Y	–	0	0	0
Ou Reang Ov	Kong Chey	324	Stueng Chey	647	Y	N	OK	Y	920,000	3,000	N		3	3	0	N	–	0	0	0
Ou Reang Ov	Chak	325	Chamlak	703	Y	N	OK	Y	680,000	1,800	N	MIME	7	4	−3	N	–	0	0	0
Ou Reang Ov	Chak	327	Pring	746	Y	N	OK	Y	1,860,000	0	N	MIME	15	4	−11	N	–	0	0	0
Ou Reang Ov	Tuol Sophi	332	Poung	862	Y	N	OK	Y	1,840,000	3,600	N		2	5	3	N	–	0	0	0
Ou Reang Ov	Tuol Sophi	337	Thma Da Lech	686	Y	N	OK	Y	1,720,000	8,320	N		11	4	−7	N	–	0	0	0
Ou Reang Ov	Tuol Sophi	338	Thma Da Kaeut	540	Y	N	OK	Y	1,200,000	1,100	N		6	3	−3	N	–	0	0	0
Ou Reang Ov	Preah Theat	340	Tuol Khleang	1,157	Y	N	OK	Y	880,000	700	N		28	6	−22	N	–	0	0	0
Ou Reang Ov	Preah Theat	341	Preah Theat Kandal	570	Y	N	OK	Y	760,000	3,220	N		13	3	−10	N	–	0	0	0
Ou Reang Ov	Ampil Ta Pok	346	Svay Roluos	800	Y	N	OK	Y	900,000	2,500	N		8	4	−4	N	–	0	0	0
Ou Reang Ov	Ampil Ta Pok	351	Meas Snae	897	N	N	OK	Y	1,760,000	1,100	N		0	5	5	N	–	0	0	0
Total				129,630					1,351,833	3,162								374	6	380
No. of villages			144														115	109	6	115

*: Well Construction Standard 1 allocation/210 people(round-ff)

**: Population increase rate 1.55 %/year

(3) Facilities Plan

1) Water Supply Plan

Based on the results of discussions with DRWS, a water supply plan has been formulated according to the following specifications:

A) Project target year : Year 2010
B) Project standard water supply volume : 40 liters/person/day
C) Practical pumping capacity of hand pump : 15 to 20 liters/min. (Afridev)
D) Operating hours of hand pump : 8 hours/day
E) Planned water supply volume of deep well with hand pump : 8,400 liters/day
F) Water supply population per deep well with hand pump : 210 persons/day

2) Number of Water Supply Facilities to Be Installed

The number of water supply facilities for the 115 target villages selected under the criteria was estimated according to the following conditions and is shown in Table 2-5:

A) The number of installations (rounded off) is estimated by dividing the planned water supplied population (in 2010) by the population per deep well with a hand pump (210 persons).

B) If the estimation method above is used, the number of installations in villages with a higher population will be higher. In general, if 6 or 7 or more wells with a hand pump are constructed in a village, the construction cost will be higher than that of one piped water supply facility. In this case, the piped water supply facility can reduce the construction cost per village, but it will be difficult to carry out maintenance of the pipe water supply facility under the present situation in the project area. Therefore, the number of hand-pump water supply facilities per village will be limited to 5 sites from the viewpoint of cost reduction and coverage of as many villages as possible within the given budget.

C) As there is no definite prospect at present of the MIME-WB piped water supply project being implemented in the candidate villages and the poor will not be able to receive the service, and considering the urgency and necessity of relieving the poor, these candidate villages will be covered by this Project and a minimum number of water supply facilities (one in villages with no existing well) will be installed in these candidate villages.

Table 2-5: Number of Water Supply Facilities to be constructed

District	Commune	ID	Village	Selection Result	Population	Estimated Population	No. of Exsiting Wells	No. of Required We;;s	No. of Additional Required Wells	No. of Wells to be constructed		
				Rank	2,004	2,010	2004	2010	2,010	Max of 5 wells	Rescue of the Poverty Group	Total
Memot	Dar	7	Dar Cheung	5	798	875	0	4	4	0	1	1
Memot	Dar	10	Dar Kandaol	5	2,301	2,523	0	12	12	0	1	1
Memot	Dar	11	Prampir Meakkakra	1	1,100	1,206	0	6	6	5	0	5
Memot	Dar	12	Dar Tboung	5	997	1,093	0	5	5	0	1	1
Memot	Dar	13	Triek	1	448	491	0	2	2	2	0	2
Memot	Dar	14	Spean	3	2,230	2,446	6	12	6	5	0	5
Memot	Dar	15	Meaek Puk	4	590	647	1	3	2	2	0	2
Memot	Dar	16	Srae Chroam	1	945	1,036	0	5	5	5	0	5
Memot	Dar	17	Chhngar Cheung	2	880	965	0	5	5	5	0	5
Memot	Dar	18	Chhngar Kandal	2	420	461	0	2	2	2	0	2
Memot	Dar	19	Samraong Cheung	3	550	603	1	3	2	2	0	2
Memot	Dar	21	Beng	5	410	450	0	2	2	0	1	1
Memot	Rung	22	Chambak	1	1,013	1,111	0	5	5	5	0	5
Memot	Rung	24	Doun Roadth Ti Pir	1	527	578	0	3	3	3	0	3
Memot	Rung	25	Bos	2	590	647	0	3	3	3	0	3
Memot	Rung	26	Choam Tuk	1	660	724	0	3	3	3	0	3
Memot	Rung	27	Rung	1	577	633	0	3	3	3	0	3
Memot	Rung	28	Taonh	3	380	417	1	2	1	1	0	1
Memot	Rung	29	Doung	1	482	529	0	3	3	3	0	3
Memot	Rung	30	Beng	1	579	635	0	3	3	3	0	3
Memot	Rung	31	Masin	1	710	779	0	4	4	4	0	4
Memot	Rung	33	Soutey	1	1,107	1,214	0	6	6	5	0	5
Memot	Rung	34	Trapeang Ruessei	1	1,153	1,264	0	6	6	5	0	5
Memot	Chan Mul	35	Thlok	1	780	855	0	4	4	4	0	4
Memot	Chan Mul	36	Chan Mul	3	1,167	1,280	1	6	5	5	0	5
Memot	Chan Mul	37	S'am	1	868	952	0	5	5	5	0	5
Memot	Chan Mul	38	Srae Ta Nong Kaeut	3	362	397	1	2	1	1	0	1
Memot	Chan Mul	39	Srae Ta Nong Lech	1	350	384	0	2	2	2	0	2
Memot	Chan Mul	44	Kor	1	531	582	0	3	3	3	0	3
Memot	Tonlung	47	Kdol Leu	2	426	467	0	2	2	2	0	2
Memot	Tonlung	48	Changkum Kandal	1	956	1,048	0	5	5	5	0	5
Memot	Tonlung	50	Beng Kaong	2	520	570	0	3	3	3	0	3
Memot	Tonlung	54	Kdol Kraom	2	845	927	0	4	4	4	0	4
Memot	Tonlung	55	Sla Phnum	4	789	865	1	4	3	3	0	3
Memot	Tonlung	56	Pong Tuek	2	1,865	2,045	0	10	10	5	0	5
Memot	Rumchek	59	Pnov	1	550	603	0	3	3	3	0	3
Memot	Rumchek	60	Kantuot	1	568	623	0	3	3	3	0	3
Memot	Rumchek	62	Chheu Khloem	1	878	963	0	5	5	5	0	5
Memot	Rumchek	63	Kampey	1	943	1,034	0	5	5	5	0	5
Memot	Rumchek	64	Khpob	1	1,363	1,495	0	7	7	5	0	5
Memot	Memot	73	Choam M'aor	3	386	423	1	2	1	1	0	1
Memot	Memot	74	Trabaek	1	975	1,069	0	5	5	5	0	5
Memot	Memot	75	Nang Krapeu	2	362	397	0	2	2	2	0	2
Memot	Memot	76	Trapeang Reang	1	1,774	1,946	0	9	9	5	0	5
Memot	Memot	78	Sangkom Mean Chey Chas	4	849	931	1	4	3	3	0	3
Memot	Memot	79	Chi Peh	1	997	1,093	0	5	5	5	0	5
Memot	Memot	80	Chhngar Sala	1	370	406	0	2	2	2	0	2
Memot	Memot	81	Mukh Kras	2	610	669	0	3	3	3	0	3
Memot	Tramung	82	Tramaeng Leu	1	378	415	0	2	2	2	0	2
Memot	Tramung	85	Tramung	3	944	1,035	2	5	3	3	0	3
Memot	Tramung	87	Roung Chakr Skar	2	307	337	0	2	2	2	0	2
Memot	Tramung	88	Andoung Thma Leu	2	422	463	0	2	2	2	0	2
Memot	Tramung	89	Andoung Thma Kraom	2	294	322	0	2	2	2	0	2
Memot	Tramung	90	Doung	4	359	394	1	2	1	1	0	1
Memot	Tramung	91	Choam Trav	2	490	537	0	3	3	3	0	3
Memot	Tramung	92	Chhuk	4	661	725	1	3	2	2	0	2
Memot	Tramung	93	Ngeu Thum	2	645	707	0	3	3	3	0	3
Memot	Tramung	96A	Khnong Krapeu Kaeut	5	1,952	2,141	0	10	10	0	1	1
Memot	Tramung	96B	Khnong Krapeu Lech	5	2,400	2,632	0	13	13	0	1	1

District	Commune	ID	Village	Selection Result	Population	Estimated Population	No. of Exsiting Wells	No. of Required We;;s	No. of Additional Required Wells	No. of Wells to be constructed		
				Rank	2,004	2,010	2004	2010	2,010	Max of 5 wells	Rescue of the Poverty Group	Total
Memot	Tramung	100	Chrey	2	527	578	0	3	3	3	0	3
Memot	Kampoan	101	Lour	4	1,802	1,976	1	9	8	5	0	5
Memot	Kampoan	102	Kampoan	3	1,600	1,755	1	8	7	5	0	5
Memot	Kampoan	104	Srae Saom Thmei	3	1,053	1,155	1	5	4	4	0	4
Memot	Kampoan	105	Srae Saom Chas	4	602	660	2	3	1	1	0	1
Memot	Kampoan	106	Tuek Tum	4	1,000	1,097	1	5	4	4	0	4
Memot	Kampoan	107	Chhloung Muoy	4	1,278	1,402	5	7	2	2	0	2
Memot	Kampoan	108	Chhloung Pir	4	797	874	3	4	1	1	0	1
Memot	Kampoan	109	Chhloung Bei	2	560	614	0	3	3	3	0	3
Memot	Kokir	110	Srae Poul	2	799	876	0	4	4	4	0	4
Memot	Kokir	111	Kokir Cheung	1	1,498	1,643	0	8	8	5	0	5
Memot	Kokir	112	Kokir Tboung	3	1,021	1,120	1	5	4	4	0	4
Memot	Kokir	113	Tuol Thma	1	671	736	0	4	4	4	0	4
Memot	Kokir	115	Kngaok	4	770	844	1	4	3	3	0	3
Memot	Kokir	116	Preaek Puoy	2	1,127	1,236	0	6	6	5	0	5
Memot	Choam Ta Mau	120	Thnal Kaeng	2	350	384	0	2	2	2	0	2
Memot	Choam Ta Mau	121	Thma Totueng Tboung	2	380	417	0	2	2	2	0	2
Memot	Choam Ta Mau	124	Sampov Lun	2	819	898	0	4	4	4	0	4
Memot	Choam Ta Mau	125	Chumnum Pol	1	665	729	0	3	3	3	0	3
Memot	Choam Ta Mau	126	Kantuot	4	787	863	1	4	3	3	0	3
Memot	Choam Ta Mau	127	Angkam	3	437	479	1	2	1	1	0	1
Memot	Choam Ta Mau	130	Bos Ta Oem	1	1,072	1,176	0	6	6	5	0	5
Memot	Memong	132	Memong	3	1,456	1,597	1	8	7	5	0	5
Memot	Memong	136	Triek	1	401	440	0	2	2	2	0	2
Memot	Memong	137	Choam Khyang	1	405	444	0	2	2	2	0	2
Memot	Memong	138	Sangkae Thmei	1	915	1,003	0	5	5	5	0	5
Memot	Memong	139	Sangkae Chas	1	1,052	1,154	0	5	5	5	0	5
Memot	Choam Kravien	141	Khcheay	2	600	658	0	3	3	3	0	3
Memot	Choam Kravien	143	Satum	4	1,195	1,311	1	6	5	5	0	5
Memot	Choam Kravien	144	Kravien Cheung	2	540	592	0	3	3	3	0	3
Memot	Choam Kravien	147	Chrey Laeung	2	350	384	0	2	2	2	0	2
Memot	Choam	159	Boeng Chroung	1	562	616	0	3	3	3	0	3
Memot	Choam	160	Choam Ampil	1	489	536	0	3	3	3	0	3
Memot	Choam	162	Cheung	1	490	537	0	3	3	3	0	3
Memot	Choam	163	Leach Leu	1	602	660	0	3	3	3	0	3
Memot	Choam	167	Ngiev	2	668	733	0	3	3	3	0	3
Memot	Choam	168	Leach Kraom	1	1,092	1,198	0	6	6	5	0	5
Ponhea Kraek	Popel	169	Tuol Kandal	1	700	768	0	4	4	4	0	4
Ponhea Kraek	Popel	171	khsak	4	1,453	1,593	1	8	7	5	0	5
Ponhea Kraek	Kandaol Chrum	179	Tuol Chamkar	1	821	900	0	4	4	4	0	4
Dambae	Chong Cheach	227	Cheach Cheung	1	1,368	1,500	0	7	7	5	0	5
Tboung Khmum	Moung Rieng	267	Thnong	1	1,130	1,239	0	6	6	5	0	5
Tboung Khmum	Moung Rieng	268	Mong Ti Prammuoy	1	660	724	0	3	3	3	0	3
Tboung Khmum	Moung Rieng	269	Mong Ti Prampir	3	797	874	1	4	3	3	0	3
Tboung Khmum	Sralab	271	Trapeang Sangkae	1	588	645	0	3	3	3	0	3
Tboung Khmum	Anhchaeum	272	Trapeang Chak	1	549	602	0	3	3	3	0	3
Tboung Khmum	Anhchaeum	273	Chheu Teal Chrum	4	589	646	1	3	2	2	0	2
Tboung Khmum	Lngieng	285	Lngieng	1	868	952	0	5	5	5	0	5
Tboung Khmum	Vihear Luong	287B	Kien Rung	1	407	446	0	2	2	2	0	2
Tboung Khmum	Vihear Luong	289	Prasrae Leu	3	547	600	1	3	2	2	0	2
Tboung Khmum	Suong	291	Chrak Poun	1	719	789	0	4	4	4	0	4
Tboung Khmum	Thma Pechr	294	Chambak	1	1,216	1,334	0	6	6	5	0	5
Tboung Khmum	Thma Pechr	295	Chies Ti Muoy	4	1,013	1,111	1	5	4	4	0	4
Tboung Khmum	Roka Po Pram	297	Trapeang Khla	3	2,220	2,435	1	12	11	5	0	5
Tboung Khmum	Roka Po Pram	298	Ta Pav Bampenh Tes	2	2,700	2,961	0	14	14	5	0	5
Tboung Khmum	Roka Po Pram	299	Pong Tuek	4	1,712	1,878	1	9	8	5	0	5
Total					98,872	108,431	45	517	472	374	6	380

*: Well Construction Standard 1 allocation/210 people(round-ff)

**: Population increase rate 1.55 %/year

3) Composition of Water Supply Facilities

The water supply facilities to be constructed in this Project are described as below.

Type of Work	Specification	No. of sites	Description of Work	Responsible Organization
Well	4"PVC Screen Casing Depth：25～80m	380	Preparation work（Physical prospecting, ground leveling, drilling rig setup）,drilling work, well dogging, insert casing/ screen, aggregate fillings, cleaning of wells, pumping test, water quality test, backfilling, stopping water, construction remove work（clearance, removal）	Japanese Contractor
Filling Soil	30cm above Ground Level	380	Provision of filling soil materials	Japanese Contractor
			Filling soil and surface compaction	Residents
Platform/Drainage	Reinforced Concrete	380	Ground leveling, molding form work, reinforcing work, concrete placing/ curing	Japanese Contractor
Hand Pump	Afridev type	380	Installation	Japanese Contractor
Sodding for the Slop	Grasses surrounding the sites	380	Protection of slope by planting	Residents
Iron Removal Equipment	Stainless Portable Equipment	27	Provision of the equipment	Japanese Contractor
	Filter materials and Setup	27	Procurement and setup of filling materials, i.e. charcoal, aggregate, etc	Residents
Hygienically Education Billboard	Stainless	380	Installation	Japanese Contractor

4) Design Conditions

A) Well construction sites

As the results of the field surveys have shown the project area to be an area with a good aquifer, no survey of natural conditions to select construction sites will be made in the implementation stage. The construction sites will be determined by organizing residents in the implementation stage, taking into account the social conditions including the configuration of the village and the requests of village residents.

B) Required yielding capacity of well: 900 liters/hour or more

The practical pumping capacity of an Afridev hand pump is 15 to 20 liters/minute, but the required yielding capacity of the well shall be 15 liters/minute (at 900 liters/hour) or more in consideration of the operation rate.

C) Water quality conditions

The following items will be set as the water quality standards in this Project based on examination of the results of the water quality surveys in the field surveys and Development Study. A comparison with WHO drinking water quality guidelines and Cambodian drinking water quality standards is shown in Table 2-6. As the volume of water supplied per day from the water supply facilities is planned to be 8.4m3 in this Project, it is equivalent to small-scale water supply standards in the Cambodian drinking water quality standards.

- Arsenic (As): 0.05mg/l (in accordance with Cambodian small-scale water supply standards)
- Chloride (Cl): 250mg/l (in accordance with Cambodian general standards)
- Fluoride (F): 1.5mg/l (in accordance with Cambodian general standards and WHO guidelines)
- Manganese (Mn): 0.4mg/l (in accordance with WHO guidelines)
- Total dissolved solid (TDS): 800mg/l (in accordance with Cambodian small-scale water supply standards)
- Iron (Fe): 2.0mg/l (for the following reason)

In the project area, there are presumed to be some districts where the iron concentration exceeds Cambodian drinking water standards.

Iron is not a water quality item that affects health, but if the concentration of iron is high, users shun the water because of the color, smell and taste. In WHO guidelines, an iron content of 0.3mg/l is given as the critical level above which complaints arise. However, there is no fixed level which is acceptable to residents and the standard depends upon the water quality of the existing water source in each village. In the monitoring survey of the pilot water supply facilities in the Study on Groundwater Development in Southern Cambodia, some residents replied that the water tasted good even when the iron concentration was 2.0mg/l. On the other hand, iron removal equipment (iron concentration of 0.2mg/l after removing iron) was installed in the pilot water supply facilities in the Development Study and used by the residents in Cheung Voat village (ID321) in Ou Rieng Ov District covered by this Project.

However, the monitoring results of the Study on Groundwater Development in Southern Cambodia showed that the iron removal equipment installed was little used by the village residents

notwithstanding its de-ironizing effect. The main reason for this is that, if an alternative good-tasting water source is available in the vicinity of the villages, the residents rely on the alternative water source for their drinking water.

Therefore, in the case of water quality standards, it is desirable for the raw water to contain an iron concentration that is allowable to residents. Thus, an iron concentration of 2.0mg/l, which is a rough standard for the taste of raw water for village residents, is one of the water quality standards in this Project.

- Nitrate (NO_3): 50mg/l (in accordance with Cambodian general standards and WHO guidelines)
- Turbidity: 5 NTU (in accordance with Cambodian small-scale water supply standards)
- pH: Not fixed (for the following reason)

A pH standard value has been established in Cambodian water quality standards, but the water quality in the project area generally exceeds this criterion. The pH value is one of the water quality items that have an effect on the water supply facilities, such as corrosion, but no impact on the health of residents, so it is not specified in WHO drinking water quality guidelines. Therefore, the pH standard value is not specified in this Project.

Table 2-6: Comparison of Water Quality Standards

	WHO Guidelines for Drinking-water Quality（3rd Edition）		Drinking Water Quality Standards, January 2004 (Ministry of Industry Mines and Energy)		**Proposed Water Quality Standard for Succeessful Wells for the Project**
	Value (mg/l)	Acceptability Aspect (mg/l) [a)]	Standard Value (mg/l)	Small water supply (less than 100 persons or $100m^3$/day）(mg/l)	**Value (mg/l)**
1. Microbial aspects					
Total coliform	0 in 100ml sample	-	0 in 100ml sample	0 in 100ml sample	**-**
Thermotolerant coliform					
E.Coli.					
Faecal streptcoques					
2. Naturally occurring chemicals					
Arsenic (As)	0.01	-	0.05	0.05	**0.05**
Barium (Ba)	0.7	-	0.7	-	**-**
Boron (B)	0.5	-	-	-	**-**
Chloride (Cl)	-	250	250	-	**250**
Chromium (Cr_6^+)	0.05	-	0.05	-	**-**
Fluoride (F)	1.5	-	1.5	-	**1.5**
Hardness	-	-	300	-	**-**
Hydrogen sulfide (H_2S)	-	0.05	0.05	-	**-**
Manganese (Mn)	0.4	0.1	0.1	-	**0.4**
Molybdenum (Mo)	0.07	-	-	-	**-**
pH	-	-	6.5 - 8.5	6.5 - 8.5	**-**
Selenium (Se)	0.01	-	0.01	-	**-**
Sodium (Na)	-	200	200	-	**-**
Sulfate (SO_4)	-	250	250	-	**-**
Total dissolved solid (TDS)	-	1000	800	800	**800**
Uranium (U)	0.015	-	-	-	**-**
Silver (Ag)	-	-	-	-	**-**
Aluminium (Al)	-	0.2	0.2	-	**-**
Iron (Fe)	-	0.3	0.3	0.3	**2.0**
Zinc (Zn)	-	3	3	-	**-**
Antimony (Sb)	0.02	-	-	-	**-**
Copper (Cu)	2	1	1	-	**-**
Lead (Pb)	0.01	-	0.01	-	**-**
Nickel (Ni)	0.02	-	0.02	-	**-**
3. Chemicals from agricultural activities					
Ammonium (NH_4)	-	1.5	1.5	-	**-**
Nitrate (NO_3)	50	-	50	-	**50**
Nitrite (NO_2) (long/short term)	3/0.2	-	3	-	**-**
4. Others					**-**
Taste	-	-	Acceptable	-	**-**
Color	-	15 TCU[b)]	5 TCU	-	**-**
Odor	-	-	Acceptable	-	**-**
Turbidity	-	5 NTU[c)]	5 NTU	5 NTU	**5 NTU**
Magnesium (Mg)	-	-	-	-	**-**
Calcium (Ca)	-	-	-	-	**-**
Anionic detergent	-	-	-	-	**-**
Potassium (K)	-	-	-	-	**-**
Bicarbonate (HCO_3)	-	-	-	-	**-**
Carbonate (CO_3^-)	-	-	-	-	**-**
Free carbon dioxide (CO_2)	-	-	-	-	**-**
Electric Conductivity	-	-	-	-	**-**

a) Value is not confirmed. It is valuable depend on the situation.
b) TCU: true colour unit
c) NTU: nephelometric turbidity unit

5) Standard Well

A) Classification of stratum for drilling

The strata that appear at the well drilling depth in the 115 target villages are mainly categorized into four types: unconsolidated layer, soft rock, medium hard rock and hard rock. The estimated stratum structure of each category is shown in Table 2-7.

Table 2-7: Stratum Classification and Expected Stratum Structure

District	Commune	ID	Village	Depth of Well	Depth by Formation Faces				Expected Geological Composition
					Unconsolidated Formation	Soft Rock	Medium-hard Rock	Hard Rock	
				(m)	Depth (m)	Depth (m)	Depth (m)	Depth (m)	
Memot	Dar	7	Dar Cheung	40	10	25	5	0	Silt with fine sand, Basalt, Weathered sandstone
Memot	Dar	10	Dar Kandaol	40	5	25	10	0	Thin basalt, Silt, Weathered sandstone
Memot	Dar	11	Prampir Meakkakra	40	10	10	10	10	Sand, Sandstone partially cracky
Memot	Dar	12	Dar Tboung	40	10	30	0	0	Basalt
Memot	Dar	13	Triek	40	10	20	10	0	Basalt
Memot	Dar	14	Spean	40	10	10	10	10	Basalt
Memot	Dar	15	Meaek Puk	40	8	11	11	10	Basalt
Memot	Dar	16	Srae Chroam	40	8	12	10	10	Basalt
Memot	Dar	17	Chhngar Cheung	60	15	15	20	10	Thich laterite, Basalt
Memot	Dar	18	Chhngar Kandal	40	15	15	10	0	Basalt, Sandy silt ～ Silty sand ～ Fine sand
Memot	Dar	19	Samraong Cheung	30	0	7	18	5	Clay, Basalt, Weathered Sandstone
Memot	Dar	21	Beng	40	15	20	5	0	Basalt, Sandy silt ～ Silty sand ～ Fine sand
Memot	Rung	22	Chambak	35	0	17	6	12	Basalt, Medium ～ Coarse sand
Memot	Rung	24	Doun Roadth Ti Pir	30	17	13	0	0	Gravel, Coarse sand, Gravelly sand
Memot	Rung	25	Bos	30	30	0	0	0	Fine ～ medium sand, Coarse sand
Memot	Rung	26	Choam Tuk	30	22	6	2	0	Basalt, Fine ～ Medium sand
Memot	Rung	27	Rung	30	27	3	0	0	Laterite, Basalt, Coarse sand, Fine ～ Medium sand
Memot	Rung	28	Taonh	30	17	8	5	0	Basalt, Fine ～ Medium sand
Memot	Rung	29	Doung	30	20	5	4	1	Basalt, Fine ～ Medium sand
Memot	Rung	30	Beng	30	27	3	0	0	Laterite, Basalt, Coarse sand, Fine ～ Medium sand
Memot	Rung	31	Masin	30	15	8	2	5	Basalt, Fine ～ Medium sand
Memot	Rung	33	Soutey	30	4	4	7	15	Basalt, Fine ～ Medium sand
Memot	Rung	34	Trapeang Ruessei	55	35	5	5	10	Silty sand, Fine ～ Medium sand, Silt, Weathered sandstone
Memot	Chan Mul	35	Thlok	70	60	10	0	0	Basalt, Clay ～ Silt (thick), Medium sand
Memot	Chan Mul	36	Chan Mul	65	40	10	13	2	Basalt, Fine sand, Medium ～ Coarse sand
Memot	Chan Mul	37	S'am	40	30	5	3	2	Basalt, Fine sand, Silt with sand
Memot	Chan Mul	38	Srae Ta Nong Kaeut	75	60	5	2	8	Basalt, Clay ～ Silt (thick), Fine ～ Medium sand
Memot	Chan Mul	39	Srae Ta Nong Lech	70	50	12	5	3	Basalt, Clay (thick), Sandstone (Basement rock)
Memot	Chan Mul	44	Kor	40	22	5	8	5	Basalt, Silt with sand, Fine ～ Medium sand
Memot	Tonlung	47	Kdol Leu	75	5	10	15	45	Thin basalt, Medium sand, Silt, Sandstone (Basement Rock)
Memot	Tonlung	48	Changkum Kandal	40	15	10	15	0	Medium ～ Coarse sand, Silt, Weathered sandstone
Memot	Tonlung	50	Beng Kaong	40	40	0	0	0	Medium sand, Silt with sand, Medium ～ Coarse sand
Memot	Tonlung	54	Kdol Kraom	40	20	20	0	0	Fine ～ medium sand, Silt, Weathered sandstone (Basement rock)
Memot	Tonlung	55	Sla Phnum	50	30	5	10	5	Laterite, Basalt, Fine sand, Clay, Sandstone
Memot	Tonlung	56	Pong Tuek	55	50	5	0	0	Thin basalt, Silt with fine sand, Fine to medium sand
Memot	Rumchek	59	Pnov	55	55	0	0	0	Sand with gravel, Silt, Medium ～ Coarse sand
Memot	Rumchek	60	Kantuot	40	40	0	0	0	Gravelly sand, Clay ～ Silt, Medium sand
Memot	Rumchek	62	Chheu Khloem	55	55	0	0	0	Sand with gravel, Fine sand, Clay ～ Silt, Medium ～ Coarse sand
Memot	Rumchek	63	Kampey	30	30	0	0	0	Coarse sand with gravel, Clay ～ Silt, Medium ～ Coarse sand
Memot	Rumchek	64	Khpob	45	45	0	0	0	Fine sand, Clay ～ Silt, Medium sand
Memot	Memot	73	Choam M'aor	30	0	25	3	2	Basalt, Medium ～ Coarse sand, Fine sand
Memot	Memot	74	Trabaek	30	5	5	10	10	Medium sand, Basalt, Medium sand
Memot	Memot	75	Nang Krapeu	50	43	5	2	0	Basalt, Fine sand, Silt, Fine ～ Medium sand
Memot	Memot	76	Trapeang Reang	30	23	5	2	0	Basalt, Fine sand, Medium ～ Coarse sand
Memot	Memot	78	Sangkom Mean Chey Chas	40	25	13	2	0	Basalt, Clay ～ Silt, Medium ～ Coarse sand
Memot	Memot	79	Chi Peh	50	37	5	3	5	Basalt, Clay ～ Silt, Fine sand, Silt with sand
Memot	Memot	80	Chhngar Sala	40	30	10	0	0	Laterite, Basalt, Clay, Fine ～ Medium sand
Memot	Memot	81	Mukh Kras	40	35	5	0	0	Laterite, Basalt, Silt, Fine ～ Medium sand

District	Commune	ID	Village	Depth of Well	Depth by Formation Faces				Expected Geological Composition
					Unconsolidated Formation	Soft Rock	Medium-hard Rock	Hard Rock	
				(m)	Depth (m)	Depth (m)	Depth (m)	Depth (m)	
Memot	Tramung	82	Tramaeng Leu	30	20	5	5	0	Basalt, Coarse sand and gravel
Memot	Tramung	85	Tramung	30	5	15	5	5	Basalt, Coarse sand
Memot	Tramung	87	Roung Chakr Skar	30	5	20	3	2	Basalt, Coarse sand, Fine ～ Medium sand
Memot	Tramung	88	Andoung Thma Leu	55	35	10	5	5	Basalt, Medium ～ Coarse sand, Silt with fine sand, Fine ～ Medium sand
Memot	Tramung	89	Andoung Thma Kraom	65	38	10	13	4	Basalt, Silt, Medium ～ Coarse sand
Memot	Tramung	90	Doung	40	0	19	6	15	Basalt, Medium ～ Coarse sand
Memot	Tramung	91	Choam Trav	40	20	8	8	4	Laterite, Basalt, Medium ～ Coarse sand
Memot	Tramung	92	Chhuk	30	15	5	5	5	Laterite, Basalt, Fine ～ Coarse sand with gravel
Memot	Tramung	93	Ngeu Thum	40	30	4	3	3	Laterite, Basalt, Clay ～ Silt, Fine ～ Medium sand
Memot	Tramung	96A	Khnong Krapeu Kaeut	30	12	4	9	5	Basalt, Fine ～ Medium sand, Fine sand with silt
Memot	Tramung	96B	Khnong Krapeu Lech	30	12	4	9	5	Basalt, Fine ～ Medium sand, Fine sand with silt
Memot	Tramung	100	Chrey	30	0	22	4	4	Basalt, Medium ～ Coarse sand, Fine sand with silt
Memot	Kampoan	101	Lour	30	4	4	10	12	Laterite, Basalt, Weathered sandstone
Memot	Kampoan	102	Kampoan	40	25	5	5	5	Laterite, Basalt, Fine ～ Medium sand, Silt with sand
Memot	Kampoan	104	Srae Saom Thmei	30	10	5	10	5	Gravel and sand, Clay ～ Silt, Weathered sandstone
Memot	Kampoan	105	Srae Saom Chas	30	17	2	5	6	Basalt, Fine ～ Medium sand with silt
Memot	Kampoan	106	Tuek Tum	40	40	0	0	0	Clay, Silt, Medium sand with silt
Memot	Kampoan	107	Chhloung Muoy	80	25	42	9	4	Laterite, Basalt, Clay ～ Silt (thick), Fine ～ Medium sand
Memot	Kampoan	108	Chhloung Pir	40	0	28	8	4	Laterite, Basalt, Fine ～ Medium sand with silt
Memot	Kampoan	109	Chhloung Bei	65	0	48	17	0	Laterite, Basalt, Silt (thich), Weathered sandstone
Memot	Kokir	110	Srae Poul	60	50	5	5	0	Laterite, Basalt, Silt, Medium sand, Silt, Fine ～ medium sand
Memot	Kokir	111	Kokir Cheung	45	35	5	5	0	Basalt, Silt, Fine ～ Medium sand
Memot	Kokir	112	Kokir Tboung	70	50	20	0	0	Basalt, Fine ～ Medium sand, Silt (thick), Coarse sand (Weathered sandstone)
Memot	Kokir	113	Tuol Thma	70	60	5	5	0	Basalt, Silt, Medium sand
Memot	Kokir	115	Kngaok	45	20	10	10	5	Laterite, Basalt
Memot	Kokir	116	Preaek Puoy	50	40	5	5	0	Laterite, Basalt, Clay ～ Silt, Weathered sandstone
Memot	Choam Ta Mau	120	Thnal Kaeng	70	52	5	5	8	Basalt, Clay, Silt (thick), Weathered sandstone
Memot	Choam Ta Mau	121	Thma Totueng Tboung	30	10	10	5	5	Laterite, Basalt, Silt with sand
Memot	Choam Ta Mau	124	Sampov Lun	30	0	20	10	0	Laterite, Weathered sandstone
Memot	Choam Ta Mau	125	Chumnum Pol	30	0	5	20	5	Laterite, Weathered sandstone
Memot	Choam Ta Mau	126	Kantuot	30	30	0	0	0	Clay, Silt, Fine sand, Coarse sand, Clay, Silt with sand, Gravel, Clay
Memot	Choam Ta Mau	127	Angkam	50	10	10	24	6	Basalt, Silt, Clay, Weathered sandstone
Memot	Choam Ta Mau	130	Bos Ta Oem	30	5	10	15	0	Laterite, Sandstone weathered to soil, Weathered sandstone
Memot	Memong	132	Memong	30	10	15	5	0	Basalt, Silt with fine ～ medium sand, Medium ～ Coarse sand
Memot	Memong	136	Triek	35	25	5	5	0	Basalt, Fine ～ medium sand, Fine sand
Memot	Memong	137	Choam Khyang	30	5	8	7	10	Basalt, Medium sand
Memot	Memong	138	Sangkae Thmei	65	55	5	5	0	Laterite, Basalt, Silt with fine ～ medium sand, Silt with fine sand
Memot	Memong	139	Sangkae Chas	30	0	20	10	0	Laterite, Weathered basalt, Medium sand
Memot	Choam Kravien	141	Khcheay	30	0	2	3	25	Laterite, Basalt, Fine ～ medium sand
Memot	Choam Kravien	143	Satum	30	0	30	0	0	Coarse sand with gravel, Medium ～ Coarse sand, Sandstone
Memot	Choam Kravien	144	Kravien Cheung	30	5	6	9	10	Laterite, Basalt
Memot	Choam Kravien	147	Chrey Laeung	30	10	7	3	10	Laterite, Basalt, Silt, Medium ～ Coarse sand
Memot	Choam	159	Boeng Chroung	30	30	0	0	0	Coarse sand with gravel, Coarse sand, Fine ～ Medium sand
Memot	Choam	160	Choam Ampil	40	40	0	0	0	Coarse sand with gravel, Silt with sand, Medium ～ Coarse sand
Memot	Choam	162	Cheung	40	40	0	0	0	Coarse sand with gravel, Fine ～ medium sand, Medium ～ Coarse sand
Memot	Choam	163	Leach Leu	30	30	0	0	0	Medium sand, Medium ～ Coarse sand, Gravel, Coarse sand
Memot	Choam	167	Ngiev	30	5	5	10	10	Laterite, Basalt, Fine ～ Medium sand
Memot	Choam	168	Leach Kraom	30	25	5	0	0	Coarse sand with gravel, Fine ～ medium sand

District	Commune	ID	Village	Depth of Well	Depth by Formation Faces				Expected Geological Composition
					Unconsolidated Formation	Soft Rock	Medium-hard Rock	Hard Rock	
				(m)	Depth (m)	Depth (m)	Depth (m)	Depth (m)	
Ponhea Kraek	Popel	169	Tuol Kandal	75	75	0	0	0	Sand and gravel, Coarse sand, Silt (thick), Fine ～ Medium sand
Ponhea Kraek	Popel	171	khsak	40	40	0	0	0	Sand and gravel, Clay and Silt, Medium ～ Coarse sand
Ponhea Kraek	Kandaol Chrum	179	Tuol Chamkar	45	32	5	8	0	Sand, Basalt, Silt ～ Clay, atternation of sand and silt dominated by silt
Dambae	Chong Cheach	227	Cheach Cheung	25	5	10	10	0	Medium ～ Coarse sand, Basalt, Clay Alternation of silt and fine sand dominated by silt
Tboung Khmum	Moung Rieng	267	Thnong	45	35	5	5	0	Clay and Silt, Fine sand with silt, Clay, Basalt (thin), Fine sand
Tboung Khmum	Moung Rieng	268	Mong Ti Prammuoy	35	35	0	0	0	Clay, Sand with Silt, Fine ～ medium sand
Tboung Khmum	Moung Rieng	269	Mong Ti Prampir	40	40	0	0	0	Clay, Silt ～ clay, Fine ～ Medium ～ Coarse sand, Fine sand
Tboung Khmum	Sralab	271	Trapeang Sangkae	30	25	5	0	0	Basalt, Silt, Alternation of silt and Fine ～ Coarse sand dominated by medium sand
Tboung Khmum	Anhchaeum	272	Trapeang Chak	30	15	10	5	0	Silt, Clay, Basalt, Fine ～ medium sand
Tboung Khmum	Anhchaeum	273	Chheu Teal Chrum	30	15	5	5	5	Clay, Silt with sand, Basalt, Fine sand, Silt with sand
Tboung Khmum	Lngieng	285	Lngieng	30	20	5	5	0	Brecciated Basalt, Fine sand with silt
Tboung Khmum	Vihear Luong	287B	Kien Rung	30	20	5	2	3	Basalt, Clay, Fine ～ medium sand
Tboung Khmum	Vihear Luong	289	Prasrae Leu	30	25	2	3	0	Basalt, Clay, Alternation of silt and fine ～ coarse sand dominated by fine sand
Tboung Khmum	Suong	291	Chrak Poun	30	25	5	0	0	Basalt, Silt ～ Clay, Fine ～ Medium sand
Tboung Khmum	Thma Pechr	294	Chambak	30	20	5	5	0	Basalt, Fine sand with silt, Fine ～ Medium sand
Tboung Khmum	Thma Pechr	295	Chies Ti Muoy	40	40	0	0	0	Silt with fine ～ medium sand, Alternation of silt and fine ～ medium sand dominated by silt
Tboung Khmum	Roka Po Pram	297	Trapeang Khla	70	65	5	0	0	Basalt, Silt (thich), Fine ～ medium sand
Tboung Khmum	Roka Po Pram	298	Ta Pav Bampenh Tes	30	20	3	2	5	Basalt, Silt with sand, Fine ～ medium sand
Tboung Khmum	Roka Po Pram	299	Pong Tuek	30	0	5	20	5	Laterite, Basalt

B) Well drilling method

There are two quick drilling methods: (1) DTH drilling method using an air hammer (hereinafter called DTH hammering) and (2) mud circulating rotary drilling method (hereinafter called mud drilling). In the project area, both methods will be used, but mud drilling will be mainly used because there will be a lot of drilling of soft sediment. (Mud drilling: 80%, DTH hammering: 20%)

The strata in the project area are mainly categorized into three types, unconsolidated sediment stratum, basalt lava and foundation rock (sandstone), but the strata that appear at the planned drilling depth as described in (1) above is dominantly soft sediment containing a laterite layer. (Soft sediment: 60%, bedrock containing soft rock, medium hard rock or hard rock: 40%)

The soft sediment, in which the borehole wall is easily broken during drilling, should be drilled using the DTH hammering method while lowering protective service casing to prevent breakdown. (Drilling is performed with a large aperture for installing the service casing and the lower part of the borehole is drilled using a hammer bit with a smaller diameter than that of the casing.) With mud drilling, the specific weight of the circulated mud is adjusted so that the mud functions as a borehole wall stabilizer.

In a practical manner, from the viewpoint of drilling efficiency, it is more effective to drill the bedrock by the DTH hammering method and the soft sediment by the mud drilling method. At sites where both strata are mixed, it is more effective to use one or the other method uniformly than to change the drilling method halfway. Therefore, mud drilling and DTH hammering will be adopted for the stratum structure as described below.

The drilling length rate is approximately 80% for mud drilling and 20% for DTH hammer drilling.

- Mud drilling
  - Where the soft sediment continues up to the borehole bottom
  - Where the soft sediment extends the greater part of the depth and lava with a thickness of 5m or less appears
  - Where the soft sediment is drilled to a depth of 40m or more and foundation rock appears
- DTH hammering
  - Where lava dominates the entire depth except the surface layer
  - Where the foundation rock appears within a depth of 20m below the surface

The total drilling depths of both drilling methods for the stratum structures presumed from the results of existing hydraulic geological surveys and the specific resistance distribution obtained from the electrical logging results are summarized in Table 2-8 and Table 2-9.

Table 2-8: Drilling Method by Formation Faces and Drilling Length

Applied drilling method	Number of villages	Number of wells	Total length of drilling	（ratio）	Unconsolidated formation	Soft rock	Medium-hard rock	Hard rock
DTH Hammering	24	76	2,970m	(19%)	516m	839m	924m	691m
Mud Water Drilling	91	304	12,565m	(81%)	9,117m	1,897m	1,042m	509m
Total	115	380	15,535m		9,633m	2,736m	1,966m	1,200m

Table 2-9: Drilling Method by Stratum Classification and Total Length of Drilling by Villages

District	Commune	ID	Village	Drilling Method	No. of Wells	Drilling Length		Drilling Length by Formation Faces							
								Unsolidated Formation		Soft Rock		Midium-hard Rock		Hard Rock	
						Depth (m)	Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)
Memot	Dar	7	Dar Cheung	DTH	1	40	40	10	10	25	25	5	5	0	0
Memot	Dar	10	Dar Kandaol	DTH	1	40	40	5	5	25	25	10	10	0	0
Memot	Dar	11	Prampir Meakkakra	DTH	5	40	200	10	50	10	50	10	50	10	50
Memot	Dar	12	Dar Tboung	DTH	1	40	40	10	10	30	30	0	0	0	0
Memot	Dar	13	Triek	DTH	2	40	80	10	20	20	40	10	20	0	0
Memot	Dar	14	Spean	DTH	5	40	200	10	50	10	50	10	50	10	50
Memot	Dar	15	Meaek Puk	DTH	2	40	80	8	16	11	22	11	22	10	20
Memot	Dar	16	Srae Chroam	DTH	5	40	200	8	40	12	60	10	50	10	50
Memot	Dar	17	Chhngar Cheung	DTH	5	60	300	15	75	15	75	20	100	10	50
Memot	Dar	18	Chhngar Kandal	MUD	2	40	80	15	30	15	30	10	20	0	0
Memot	Dar	19	Samraong Cheung	DTH	2	30	60	0	0	7	14	18	36	5	10
Memot	Dar	21	Beng	MUD	1	40	40	15	15	20	20	5	5	0	0
Memot	Rung	22	Chambak	MUD	5	35	175	0	0	17	85	6	30	12	60
Memot	Rung	24	Doun Roadth Ti Pir	MUD	3	30	90	17	51	13	39	0	0	0	0
Memot	Rung	25	Bos	MUD	3	30	90	30	90	0	0	0	0	0	0
Memot	Rung	26	Choam Tuk	MUD	3	30	90	22	66	6	18	2	6	0	0
Memot	Rung	27	Rung	MUD	3	30	90	27	81	3	9	0	0	0	0
Memot	Rung	28	Taonh	MUD	1	30	30	17	17	8	8	5	5	0	0
Memot	Rung	29	Doung	MUD	3	30	90	20	60	5	15	4	12	1	3
Memot	Rung	30	Beng	MUD	3	30	90	27	81	3	9	0	0	0	0
Memot	Rung	31	Masin	MUD	4	30	120	15	60	8	32	2	8	5	20
Memot	Rung	33	Soutey	DTH	5	30	150	4	20	4	20	7	35	15	75
Memot	Rung	34	Trapeang Ruessei	MUD	5	55	275	35	175	5	25	5	25	10	50
Memot	Chan Mul	35	Thlok	MUD	4	70	280	60	240	10	40	0	0	0	0
Memot	Chan Mul	36	Chan Mul	MUD	5	65	325	40	200	10	50	13	65	2	10
Memot	Chan Mul	37	S'am	MUD	5	40	200	30	150	5	25	3	15	2	10
Memot	Chan Mul	38	Srae Ta Nong Kaeut	MUD	1	75	75	60	60	5	5	2	2	8	8
Memot	Chan Mul	39	Srae Ta Nong Lech	MUD	2	70	140	50	100	12	24	5	10	3	6
Memot	Chan Mul	44	Kor	MUD	3	40	120	22	66	5	15	8	24	5	15
Memot	Tonlung	47	Kdol Leu	DTH	2	75	150	5	10	10	20	15	30	45	90
Memot	Tonlung	48	Changkum Kandal	DTH	5	40	200	15	75	10	50	15	75	0	0
Memot	Tonlung	50	Beng Kaong	MUD	3	40	120	40	120	0	0	0	0	0	0
Memot	Tonlung	54	Kdol Kraom	MUD	4	40	160	20	80	20	80	0	0	0	0
Memot	Tonlung	55	Sla Phnum	MUD	3	50	150	30	90	5	15	10	30	5	15
Memot	Tonlung	56	Pong Tuek	MUD	5	55	275	50	250	5	25	0	0	0	0
Memot	Rumchek	59	Pnov	MUD	3	55	165	55	165	0	0	0	0	0	0
Memot	Rumchek	60	Kantuot	MUD	3	40	120	40	120	0	0	0	0	0	0
Memot	Rumchek	62	Chheu Khloem	MUD	5	55	275	55	275	0	0	0	0	0	0
Memot	Rumchek	63	Kampey	MUD	5	30	150	30	150	0	0	0	0	0	0
Memot	Rumchek	64	Khpob	MUD	5	45	225	45	225	0	0	0	0	0	0
Memot	Memot	73	Choam M'aor	MUD	1	30	30	0	0	25	25	3	3	2	2
Memot	Memot	74	Trabaek	DTH	5	30	150	5	25	5	25	10	50	10	50
Memot	Memot	75	Nang Krapeu	MUD	2	50	100	43	86	5	10	2	4	0	0
Memot	Memot	76	Trapeang Reang	MUD	5	30	150	23	115	5	25	2	10	0	0
Memot	Memot	78	Sangkom Mean Chey Chas	MUD	3	40	120	25	75	13	39	2	6	0	0
Memot	Memot	79	Chi Peh	MUD	5	50	250	37	185	5	25	3	15	5	25
Memot	Memot	80	Chhngar Sala	MUD	2	40	80	30	60	10	20	0	0	0	0
Memot	Memot	81	Mukh Kras	MUD	3	40	120	35	105	5	15	0	0	0	0
Memot	Tramung	82	Tramaeng Leu	MUD	2	30	60	20	40	5	10	5	10	0	0
Memot	Tramung	85	Tramung	MUD	3	30	90	5	15	15	45	5	15	5	15
Memot	Tramung	87	Roung Chakr Skar	MUD	2	30	60	5	10	20	40	3	6	2	4
Memot	Tramung	88	Andoung Thma Leu	MUD	2	55	110	35	70	10	20	5	10	5	10
Memot	Tramung	89	Andoung Thma Kraom	MUD	2	65	130	38	76	10	20	13	26	4	8
Memot	Tramung	90	Doung	DTH	1	40	40	0	0	19	19	6	6	15	15
Memot	Tramung	91	Choam Trav	MUD	3	40	120	20	60	8	24	8	24	4	12
Memot	Tramung	92	Chhuk	MUD	2	30	60	15	30	5	10	5	10	5	10
Memot	Tramung	93	Ngeu Thum	MUD	3	40	120	30	90	4	12	3	9	3	9
Memot	Tramung	96A	Khnong Krapeu Kaeut	MUD	1	30	30	12	12	4	4	9	9	5	5
Memot	Tramung	96B	Khnong Krapeu Lech	MUD	1	30	30	12	12	4	4	9	9	5	5
Memot	Tramung	100	Chrey	MUD	3	30	90	0	0	22	66	4	12	4	12

District	Commune	ID	Village	Drilling Method	No. of Wells	Drilling Length		Drilling Length by Formation Faces							
								Unsolidated Formation		Soft Rock		Midium-hard Rock		Hard Rock	
						Depth (m)	Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)
Memot	Kampoan	101	Lour	DTH	5	30	150	4	20	4	20	10	50	12	60
Memot	Kampoan	102	Kampoan	MUD	5	40	200	25	125	5	25	5	25	5	25
Memot	Kampoan	104	Srae Saom Thmei	DTH	4	30	120	10	40	5	20	10	40	5	20
Memot	Kampoan	105	Srae Saom Chas	MUD	1	30	30	17	17	2	2	5	5	6	6
Memot	Kampoan	106	Tuek Tum	MUD	4	40	160	40	160	0	0	0	0	0	0
Memot	Kampoan	107	Chhloung Muoy	MUD	2	80	160	25	50	42	84	9	18	4	8
Memot	Kampoan	108	Chhloung Pir	MUD	1	40	40	0	0	28	28	8	8	4	4
Memot	Kampoan	109	Chhloung Bei	MUD	3	65	195	0	0	48	144	17	51	0	0
Memot	Kokir	110	Srae Poul	MUD	4	60	240	50	200	5	20	5	20	0	0
Memot	Kokir	111	Kokir Cheung	MUD	5	45	225	35	175	5	25	5	25	0	0
Memot	Kokir	112	Kokir Tboung	MUD	4	70	280	50	200	20	80	0	0	0	0
Memot	Kokir	113	Tuol Thma	MUD	4	70	280	60	240	5	20	5	20	0	0
Memot	Kokir	115	Kngaok	MUD	3	45	135	20	60	10	30	10	30	5	15
Memot	Kokir	116	Preaek Puoy	MUD	5	50	250	40	200	5	25	5	25	0	0
Memot	Choam Ta Mau	120	Thnal Kaeng	MUD	2	70	140	52	104	5	10	5	10	8	16
Memot	Choam Ta Mau	121	Thma Totueng Tboung	MUD	2	30	60	10	20	10	20	5	10	5	10
Memot	Choam Ta Mau	124	Sampov Lun	MUD	4	30	120	0	0	20	80	10	40	0	0
Memot	Choam Ta Mau	125	Chumnum Pol	DTH	3	30	90	0	0	5	15	20	60	5	15
Memot	Choam Ta Mau	126	Kantuot	MUD	3	30	90	30	90	0	0	0	0	0	0
Memot	Choam Ta Mau	127	Angkam	DTH	1	50	50	10	10	10	10	24	24	6	6
Memot	Choam Ta Mau	130	Bos Ta Oem	DTH	5	30	150	5	25	10	50	15	75	0	0
Memot	Memong	132	Memong	MUD	5	30	150	10	50	15	75	5	25	0	0
Memot	Memong	136	Triek	MUD	2	35	70	25	50	5	10	5	10	0	0
Memot	Memong	137	Choam Khyang	MUD	2	30	60	5	10	8	16	7	14	10	20
Memot	Memong	138	Sangkae Thmei	MUD	5	65	325	55	275	5	25	5	25	0	0
Memot	Memong	139	Sangkae Chas	MUD	5	30	150	0	0	20	100	10	50	0	0
Memot	Choam Kravien	141	Khcheay	DTH	3	30	90	0	0	2	6	3	9	25	75
Memot	Choam Kravien	143	Satum	DTH	5	30	150	0	0	30	150	0	0	0	0
Memot	Choam Kravien	144	Kravien Cheung	DTH	3	30	90	5	15	6	18	9	27	10	30
Memot	Choam Kravien	147	Chrey Laeung	MUD	2	30	60	10	20	7	14	3	6	10	20
Memot	Choam	159	Boeng Chroung	MUD	3	30	90	30	90	0	0	0	0	0	0
Memot	Choam	160	Choam Ampil	MUD	3	40	120	40	120	0	0	0	0	0	0
Memot	Choam	162	Cheung	MUD	3	40	120	40	120	0	0	0	0	0	0
Memot	Choam	163	Leach Leu	MUD	3	30	90	30	90	0	0	0	0	0	0
Memot	Choam	167	Ngiev	MUD	3	30	90	5	15	5	15	10	30	10	30
Memot	Choam	168	Leach Kraom	MUD	5	30	150	25	125	5	25	0	0	0	0
Ponhea Kraek	Popel	169	Tuol Kandal	MUD	4	75	300	75	300	0	0	0	0	0	0
Ponhea Kraek	Popel	171	khsak	MUD	5	40	200	40	200	0	0	0	0	0	0
Ponhea Kraek	Kandaol Chrum	179	Tuol Chamkar	MUD	4	45	180	32	128	5	20	8	32	0	0
Dambae	Chong Cheach	227	Cheach Cheung	MUD	5	25	125	5	25	10	50	10	50	0	0
Tboung Khmum	Moung Rieng	267	Thnong	MUD	5	45	225	35	175	5	25	5	25	0	0
Tboung Khmum	Moung Rieng	268	Mong Ti Prammuoy	MUD	3	35	105	35	105	0	0	0	0	0	0
Tboung Khmum	Moung Rieng	269	Mong Ti Prampir	MUD	3	40	120	40	120	0	0	0	0	0	0
Tboung Khmum	Sralab	271	Trapeang Sangkae	MUD	3	30	90	25	75	5	15	0	0	0	0
Tboung Khmum	Anhchaeum	272	Trapeang Chak	MUD	3	30	90	15	45	10	30	5	15	0	0
Tboung Khmum	Anhchaeum	273	Chheu Teal Chrum	MUD	2	30	60	15	30	5	10	5	10	5	10
Tboung Khmum	Lngieng	285	Lngieng	MUD	5	30	150	20	100	5	25	5	25	0	0
Tboung Khmum	Vihear Luong	287B	Kien Rung	MUD	2	30	60	20	40	5	10	2	4	3	6
Tboung Khmum	Vihear Luong	289	Prasrae Leu	MUD	2	30	60	25	50	2	4	3	6	0	0
Tboung Khmum	Suong	291	Chrak Poun	MUD	4	30	120	25	100	5	20	0	0	0	0
Tboung Khmum	Thma Pechr	294	Chambak	MUD	5	30	150	20	100	5	25	5	25	0	0
Tboung Khmum	Thma Pechr	295	Chies Ti Muoy	MUD	4	40	160	40	160	0	0	0	0	0	0
Tboung Khmum	Roka Po Pram	297	Trapeang Khla	MUD	5	70	350	65	325	5	25	0	0	0	0
Tboung Khmum	Roka Po Pram	298	Ta Pav Bampenh Tes	MUD	5	30	150	20	100	3	15	2	10	5	25
Tboung Khmum	Roka Po Pram	299	Pong Tuek	DTH	5	30	150	0	0	5	25	20	100	5	25
Total					380		15,535		9,358		2,969		2,008		1,200
Average							40.88		24.63		7.81		5.28		3.16

C) Well drilling depth

The depth of each of the 380 wells to be drilled in the 115 target villages has been determined depending upon the depth and quality of the aquifer and taking into account the three points described below. It is planned to use 2 screen casings (6~8m section) in general and 3 screen casings (9~12m section) at sites where the aquifer is expected to be poor.

The minimum drilling depth will be 25m to prevent wastewater in the surface layer from penetrating the borehole. In other words, this is the minimum depth at which one bottom-closing blind casing (sand trap) at the bottom of the borehole and one blind casing of about 10m long above two screen casings can be installed.

Sites where a good aquifer is shown to exist will be drilled to the depth at which 2 screen casings can be installed at the depth of the aquifer and up to a further depth of 4~5m for installing a sand trap.

Sites where minor aquifers are thought to exist at intervals will be drilled up to the depth at which 3 screen casings can be installed to meet the individual aquifer depths. (For instance, sites with alternate clay and sand layers or bedrock with irregular joints and cracks) The sand trap will be installed as

described above.

The planned well depth in the project area will range from 25m to 80m, and the planned total well length will be 15,535m. The planned drilling length by well depth is shown in Table 2-10.

Table 2-10: Planned Drilling Length by Depth and Number of Screen Casing

Planned Depth of wells（m）	Number of wells	Drilling length （m）	Total No. of Planned Screen Casing
25	5	125	10
30	162	4,860	329
35	10	350	20
40	96	3,840	198
45	17	765	45
50	11	550	35
55	25	1,375	67
60	9	540	22
65	15	975	40
70	21	1,470	63
75	7	525	21
80	2	160	6
Total	380	15,535	856

D) Screen casing

As a rule, 2 screen casings per well will be installed at the 380 wells, because all the wells are hand pump wells with a low pumping volume of 20 to 30 liters/min. However, 3 screen casings will be installed at sites with poor aquifers, such as sites where a thin layer of fine sand exists between silt layers or where water is pumped from fissures in the foundation rock. There are 96 sites where such minor aquifers are predicted to exist. The total quantity of screen casings allows for about 1% of spares. The casings that can be procured locally are available in two types: 3m and 4m long. Both types will be procured in the same total quantity, whichever may be used, provided that 2 and 3 casings per well are used respectively.

The screen is made of PVC pipes provided with 1mm-wide horizontal slits, and the aperture rate shall be 2% or more.

E) Well structure and drilling aperture

In the project area, there are several scores of bedrock wells where fissure water will be pumped up from the basalt lava or foundation rock (sand rock), but groundwater that originates in the soft sediment will be pumped up at most wells. Therefore, sand filling around the screens is indispensable to maintain the long service life of the wells (by filling the stabilizer to maintain the water paths but prevent

sand penetration and breakdown of the borehole walls). For easy sand filling, it is necessary to keep a ring-shaped space of 3 to 4cm wide between the well casing with an aperture of 4 inches and the drilled borehole wall and to make the aperture of the drilled borehole about 18cm or more. It is also necessary to fit the casing with a centralizer so that the casing can be installed at the center of the drilled borehole.

Well drilling can be carried out by two methods: drilling with the same aperture from top to bottom (open hole drilling method) and drilling while lowering an outer casing to protect the hole wall from breakdown (telescopic method). In either method, the final aperture shall be 18cm or more to allow sand filling around the well screens.

Sand filling will be performed in the section from the borehole bottom to 5m above the uppermost screen, and the remaining ring-shaped space will be filled with rough sand and drilled surplus soil. A 3m zone on the surface around the well will be filled with cement milk and sealed to protect the well against penetration of contaminated water.

F) Well drilling success rate

The drilling success rate by water volume and water quality will be set at 95% based on the results of the field surveys and the Study on Groundwater Development in Central Cambodia. The overall success rate will be 95% x 95% = 90.5%. The success rate is set on the following grounds:

- Grounds for estimating a success rate of 95% in water volume

The failure rate of 5% in water volume has been estimated based on the fact that there are nine villages (with 32 planned wells) that have the following inferior aquifer conditions:

1) Sites where there is a thick deposit of thin layers of fine-particle sand between layers of silt and conditions are not expected to improve by drilling deeper. (30 sites in 8 villages)
2) Sites where foundation rock (sand rock) with few fissures appears just below a silt layer. (2 sites in 1 village)

Regarding the sites in 1), it is a close decision as to whether the water volume pumped up from the sand layer between the silt layers will exceed the required yielding capacity of 15 liters/minute, but a success rate of about 50% can be expected. The probability of yielding water from the fresh foundation rock at the sites in 2) is also expected to be about 50%.

If the success rate of the other 348 wells (380 – 32 = 348) is 100%, the total success rate is estimated to be about 96% (failure rate of 4%). However, it is difficult to estimate that the success rate of the other wells will be 100% because of uncertain factors at well construction sites far from the prospecting sites and also because the reliability of the electric prospecting results is doubtful.

Therefore, it is reasonable to expect a failure rate of about 1% at the 348 wells in 106 villages which can be reliably expected to yield water based on various survey results.

- Grounds for estimating a success rate of 95% in water quality

The water quality items that affect the success rate for water quality are iron and fluorine.

The groundwater zone distribution map in which the project area is divided into groundwater zones based on the hydraulic geological map obtained from the Development Study is shown in Figure 2-2.

With regard to iron, the success rate has been estimated by dividing the number of wells in each groundwater zone that exceed the standard value by the number of surveys. With regard to fluorine, no wells were detected in which the fluorine content exceeded the standard value, but the success rate was estimated based on the data in the Development Study because there are some wells where the fluorine content exceeds the standard value in the Development Study data. The success rate of 95% was estimated by combining the success rates for iron and fluorine. The grounds for estimation of the success rate for water quality are shown in Table 2-11.

Table 2-11: Grounds for Estimation of Success Rate for Water Quality

Groundwater District	No. of Survey Wells		>2mg/ℓ		Success Rate		No. of Target Wells		
	Deep Well	Shallow Well	Deep Well	Shallow Well	Ferrum	Fluorine	No. of Planned Wells	No. of Drilling Wells Required	
								Ferrum	Ferrum+ Fluorine
1	2	3	0	0	100.0%	97.5%	24	24.0	24.6
4B	2	10	1	0	91.7%	97.5%	0	0.0	0.0
5A	8	13	0	1	95.2%	97.5%	50	52.5	53.8
5C	1	2	0	1	66.7%	97.5%	17	25.5	26.2
5D	4	-	0	-	100.0%	97.5%	28	28.0	28.7
5E	3	1	0	0	100.0%	97.5%	88	88.0	90.3
6A	1	-	0	-	100.0%	97.5%	24	24.0	24.6
6B	7	3	0	0	100.0%	97.5%	95	95.0	97.4
6C	4	-	0	-	100.0%	97.5%	22	22.0	22.6
6D	1	-	0	-	100.0%	97.5%	9	9.0	9.2
6E	1	3	0	0	100.0%	97.5%	17	17.0	17.4
6F	2	2	1	0	75.0%	97.5%	0	0.0	0.0
6H	1	1	0	0	100.0%	97.5%	6	6.0	6.2
Total	37	38	2	2	94.7%	97.5%	380	391.0	401.0
								97.2%	94.8%

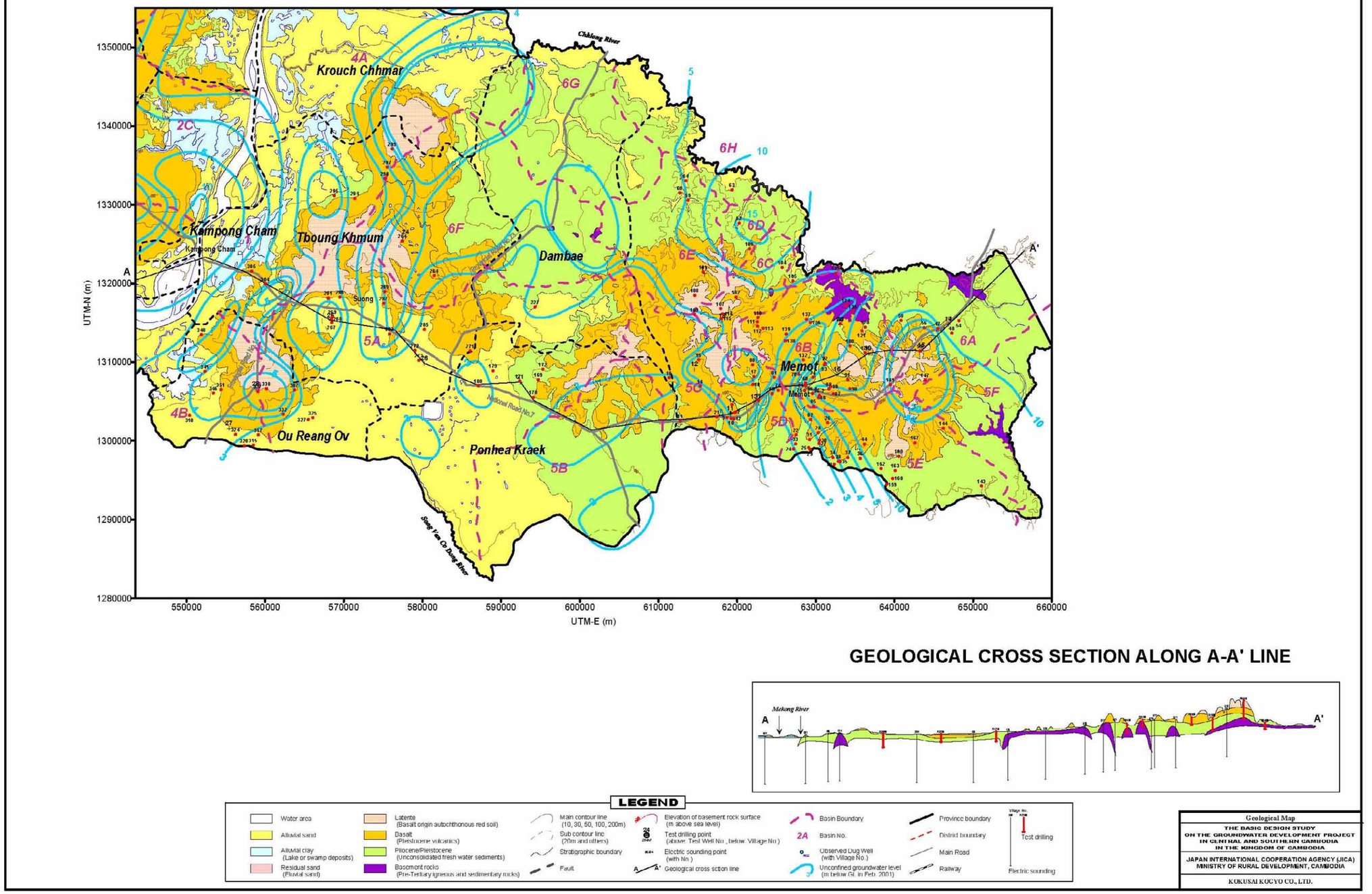


Figure 2-2: Groundwater Zone Distribution Map

G) Considerations regarding unsuccessful wells

The unsuccessful wells are viewed as follows:

■ Unsuccessful wells in respect of water volume

When using the DTH hammering method, it is possible to judge whether the well is successful or not during drilling. Therefore, the drilling costs for unsuccessful work shall be accompanied in the cost estimation.

In mud drilling, success or failure can only be judged through works after drilling is completed, such as borehole logging, insertion of screen casings, gravel filling, well development and pumping tests. Therefore, it is necessary to reckon the costs of these works including the cost of materials for unsuccessful wells.

■ Unsuccessful wells in respect of water quality

In the case of unsuccessful wells in respect of water quality, success or failure can only be judged through works after drilling is completed, such as borehole logging, insertion of screen casings, gravel filling, well development, pumping tests and water quality analysis. Therefore, it is necessary to reckon the costs of these works including the cost of materials for unsuccessful wells.

■ Countermeasures for unsuccessful wells

As it is dangerous to leave the drilled boreholes as they are, the holes should be filled in. The drilled holes are filled up with sand and well compacted with water to prevent settling in the future.

■ Alternative drilling sites

If a well is unsuccessful, an alternative site within the same village will be selected for drilling. However, if two sites are unsuccessful in the same village, drilling in the same village will be abandoned and another well will be drilled in an alternative village. The alternative village will be selected on the recommendation of DRWS from the same commune as the village in which drilling was abandoned.

Well drilling plan in phases

Well drilling work will start in Memot District which has great need for a water supply and the well drilling plan in phases is described below. Table 2-12 shows the number of wells to be drilled by phase.

Phase 1: South and East of Memot District (173 wells to be constructed in 56 villages)

Phase 2: Remaining Area of Memot District, Ponhea Kraek District, Dambae District and Tboung Khmun District (207 wells to be constructed in 59 villages)

Table 2-12: Well Drilling Plan by Phase

Phase	District	Commune	ID	Name of Villages	No. of Wells Drilled	Drilling Method	Extended Length of Well	
							Depth (m)	Extended Length (m)
Phase 1	Memot	Dar	17	Chhngar Cheung	5	DTH	60	300
	Memot	Dar	18	Chhngar Kandal	2	MUD	40	80
	Memot	Dar	19	Samraong Cheung	2	DTH	30	60
	Memot	Rung	22	Chambak	5	MUD	35	175
	Memot	Rung	24	Doun Roadth Ti Pir	3	MUD	30	90
	Memot	Rung	25	Bos	3	MUD	30	90
	Memot	Rung	26	Choam Tuk	3	MUD	30	90
	Memot	Rung	27	Rung	3	MUD	30	90
	Memot	Rung	28	Taonh	1	MUD	30	30
	Memot	Rung	29	Doung	3	MUD	30	90
	Memot	Rung	30	Beng	3	MUD	30	90
	Memot	Rung	31	Masin	4	MUD	30	120
	Memot	Rung	33	Soutey	5	DTH	30	150
	Memot	Rung	34	Trapeang Ruessei	5	MUD	55	275
	Memot	Chan Mul	35	Thlok	4	MUD	70	280
	Memot	Chan Mul	36	Chan Mul	5	MUD	65	325
	Memot	Chan Mul	37	S'am	5	MUD	40	200
	Memot	Chan Mul	38	Srae Ta Nong Kaeut	1	MUD	75	75
	Memot	Chan Mul	39	Srae Ta Nong Lech	2	MUD	70	140
	Memot	Chan Mul	44	Kor	3	MUD	40	120
	Memot	Tonlung	47	Kdol Leu	2	DTH	75	150
	Memot	Tonlung	48	Changkum Kandal	5	DTH	40	200
	Memot	Tonlung	50	Beng Kaong	3	MUD	40	120
	Memot	Tonlung	54	Kdol Kraom	4	MUD	40	160
	Memot	Tonlung	55	Sla Phnum	3	MUD	50	150
	Memot	Tonlung	56	Pong Tuek	5	MUD	55	275
	Memot	Memot	73	Choam M'aor	1	MUD	30	30
	Memot	Memot	74	Trabaek	5	DTH	30	150
	Memot	Memot	75	Nang Krapeu	2	MUD	50	100
	Memot	Memot	76	Trapeang Reang	5	MUD	30	150
	Memot	Memot	78	Sangkom Mean Chey Chas	3	MUD	40	120
	Memot	Memot	79	Chi Peh	5	MUD	50	250
	Memot	Memot	80	Chhngar Sala	2	MUD	40	80
	Memot	Memot	81	Mukh Kras	3	MUD	40	120
	Memot	Tramung	82	Tramaeng Leu	2	MUD	30	60
	Memot	Tramung	85	Tramung	3	MUD	30	90
	Memot	Tramung	87	Roung Chakr Skar	2	MUD	30	60
	Memot	Tramung	88	Andoung Thma Leu	2	MUD	55	110
	Memot	Tramung	89	Andoung Thma Kraom	2	MUD	65	130
	Memot	Tramung	90	Doung	1	DTH	40	40
	Memot	Tramung	91	Choam Trav	3	MUD	40	120
	Memot	Tramung	92	Chhuk	2	MUD	30	60
	Memot	Tramung	93	Ngeu Thum	3	MUD	40	120
	Memot	Tramung	96A	Khnong Krapeu Kaeut	1	MUD	30	30
	Memot	Tramung	96B	Khnong Krapeu Lech	1	MUD	30	30
	Memot	Tramung	100	Chrey	3	MUD	30	90
	Memot	Choam Kravien	141	Khcheay	3	DTH	30	90
	Memot	Choam Kravien	143	Satum	5	DTH	30	150
	Memot	Choam Kravien	144	Kravien Cheung	3	DTH	30	90
	Memot	Choam Kravien	147	Chrey Laeung	2	MUD	30	60
	Memot	Choam	159	Boeng Chroung	3	MUD	30	90
	Memot	Choam	160	Choam Ampil	3	MUD	40	120
	Memot	Choam	162	Cheung	3	MUD	40	120
	Memot	Choam	163	Leach Leu	3	MUD	30	90
	Memot	Choam	167	Ngiev	3	MUD	30	90
	Memot	Choam	168	Leach Kraom	5	MUD	30	150
	Subtotal			56 villages	173			6,915

Phase	District	Commune	ID	Name of Villages	No. of Wells Drilled	Drilling Method	Extended Length of Well	
							Depth (m)	Extended Length (m)
Phase 2	Memot	Dar	7	Dar Cheung	1	DTH	40	40
	Memot	Dar	10	Dar Kandaol	1	DTH	40	40
	Memot	Dar	11	Prampir Meakkakra	5	DTH	40	200
	Memot	Dar	12	Dar Tboung	1	DTH	40	40
	Memot	Dar	13	Triek	2	DTH	40	80
	Memot	Dar	14	Spean	5	DTH	40	200
	Memot	Dar	15	Meaek Puk	2	DTH	40	80
	Memot	Dar	16	Srae Chroam	5	DTH	40	200
	Memot	Dar	21	Beng	1	MUD	40	40
	Memot	Rumchek	59	Pnov	3	MUD	55	165
	Memot	Rumchek	60	Kantuot	3	MUD	40	120
	Memot	Rumchek	62	Chheu Khloem	5	MUD	55	275
	Memot	Rumchek	63	Kampey	5	MUD	30	150
	Memot	Rumchek	64	Khpob	5	MUD	45	225
	Memot	Kampoan	101	Lour	5	DTH	30	150
	Memot	Kampoan	102	Kampoan	5	MUD	40	200
	Memot	Kampoan	104	Srae Saom Thmei	4	DTH	30	120
	Memot	Kampoan	105	Srae Saom Chas	1	MUD	30	30
	Memot	Kampoan	106	Tuek Tum	4	MUD	40	160
	Memot	Kampoan	107	Chhloung Muoy	2	MUD	80	160
	Memot	Kampoan	108	Chhloung Pir	1	MUD	40	40
	Memot	Kampoan	109	Chhloung Bei	3	MUD	65	195
	Memot	Kokir	110	Srae Poul	4	MUD	60	240
	Memot	Kokir	111	Kokir Cheung	5	MUD	45	225
	Memot	Kokir	112	Kokir Tboung	4	MUD	70	280
	Memot	Kokir	113	Tuol Thma	4	MUD	70	280
	Memot	Kokir	115	Kngaok	3	MUD	45	135
	Memot	Kokir	116	Preaek Puoy	5	MUD	50	250
	Memot	Choam Ta Mau	120	Thnal Kaeng	2	MUD	70	140
	Memot	Choam Ta Mau	121	Thma Totueng Tboung	2	MUD	30	60
	Memot	Choam Ta Mau	124	Sampov Lun	4	MUD	30	120
	Memot	Choam Ta Mau	125	Chumnum Pol	3	DTH	30	90
	Memot	Choam Ta Mau	126	Kantuot	3	MUD	30	90
	Memot	Choam Ta Mau	127	Angkam	1	DTH	50	50
	Memot	Choam Ta Mau	130	Bos Ta Oem	5	DTH	30	150
	Memot	Memong	132	Memong	5	MUD	30	150
	Memot	Memong	136	Triek	2	MUD	35	70
	Memot	Memong	137	Choam Khyang	2	MUD	30	60
	Memot	Memong	138	Sangkae Thmei	5	MUD	65	325
	Memot	Memong	139	Sangkae Chas	5	MUD	30	150
	Ponhea Kraek	Popel	169	Tuol Kandal	4	MUD	75	300
	Ponhea Kraek	Popel	171	khsak	5	MUD	40	200
	Ponhea Kraek	Kandaol Chrum	179	Tuol Chamkar	4	MUD	45	180
	Dambae	Chong Cheach	227	Cheach Cheung	5	MUD	25	125
	Tboung Khmum	Moung Rieng	267	Thnong	5	MUD	45	225
	Tboung Khmum	Moung Rieng	268	Mong Ti Prammuoy	3	MUD	35	105
	Tboung Khmum	Moung Rieng	269	Mong Ti Prampir	3	MUD	40	120
	Tboung Khmum	Sralab	271	Trapeang Sangkae	3	MUD	30	90
	Tboung Khmum	Anhchaeum	272	Trapeang Chak	3	MUD	30	90
	Tboung Khmum	Anhchaeum	273	Chheu Teal Chrum	2	MUD	30	60
	Tboung Khmum	Lngieng	285	Lngieng	5	MUD	30	150
	Tboung Khmum	Vihear Luong	287B	Kien Rung	2	MUD	30	60
	Tboung Khmum	Vihear Luong	289	Prasrae Leu	2	MUD	30	60
	Tboung Khmum	Suong	291	Chrak Poun	4	MUD	30	120
	Tboung Khmum	Thma Pechr	294	Chambak	5	MUD	30	150
	Tboung Khmum	Thma Pechr	295	Chies Ti Muoy	4	MUD	40	160
	Tboung Khmum	Roka Po Pram	297	Trapeang Khla	5	MUD	70	350
	Tboung Khmum	Roka Po Pram	298	Ta Pav Bampenh Tes	5	MUD	30	150
	Tboung Khmum	Roka Po Pram	299	Pong Tuek	5	DTH	30	150
	Subtotal			59 villages	207			8,620
Total				115 villages	380			15,535

6) Hand Pumps

- Hand pump specifications and materials

In some places, a dynamic water level maintained between 2m and 5m is expected; however, it would not be maintained for a long time in wells. Therefore, all of the hand pumps to be installed for the wells in this Project are designed for deep boreholes.

All the pump parts to be submerged in water, including the pumping pipes, pump rods and pump cylinders, shall be of rustproof material because the groundwater in the greater part of the project area is acid water. The pumping pipes will be of PVC pipe, and the rods and cylinders will be of stainless steel.

- Pumping pipe length

The pumping pipe length will be determined depending upon the static water level of the well and the drop in water level during pumping. The static water level in the dry season in the project area is in the range of 2m to 15m. The drop in water level when pumping with a hand pump continuously for several hours varies from a few centimeters to about 10m depending upon the quality of the aquifer at the site. The pumping pipe length is planned to be 24m (3m x 8 pipes) at sites where the drop in water level is as great as 8m to 10m. The sites with an expected large drop in water level virtually correspond to the 96 sites with inferior aquifers. The pumping pipe length at other well sites is planned to be 21m (3m x 7 pipes) because the drop in water level at each of the wells is unpredictable.

7) Platform

The zone around the wells will be covered with concrete and provided with an adequate length of drainage to prevent contaminated water flowing from the surface into the well. The surrounding zone will be raised by banking to ensure a draining slope and the concrete zone and drainage ditch will be reinforced with reinforcing bars so that no cracks will appear in future due to uneven settling. The banking will be covered with plants to prevent soil erosion and the banking and planting work will be carried out with the participation of local residents.

8) Iron Removal Equipment

The results of monitoring the iron removal equipment installed in the Study on Groundwater Development in Southern Cambodia show that the installed equipment has not always been used by local residents despite its de-ironizing effect. The main reason for this is that residents rely on alternative water sources for drinking water if such sources of good-tasting water that do not require a lot of time and effort are available nearby. According to the same monitoring results, continued maintenance of many of the pilot water supply facilities has not been performed despite maintenance

training being provided to residents, because the maintenance procedures are complicated. In many cases, maintenance has not been sustained for reasons such as low water volume because the water is passed through a filter. In addition, the iron removal equipment installed in the pilot water supply facilities in the project area has not been used because the iron concentration in the groundwater has decreased as time has passed since the construction of the facilities.

For the above reasons, there is the possibility that maintenance of the iron removal equipment may not be kept up. If maintenance is not continued in future, the iron removal equipment will be of a portable type that can be collected by PDRD, as recommended in the Development Study.

In this Project, iron removal equipment will be installed at the request of users if the iron concentration exceeds the standard value of 1.0mg/l. The iron removal equipment will be supplied by Japan, the cost of the absorbing and filtering materials such as carbon and gravel which are used to fill the equipment will be borne by residents, and the equipment will be installed with the participation of residents. Guidance and training in installation and maintenance of the equipment will be conducted as part of the soft component.

The required number of iron removal equipment has been estimated based on the results of the water quality surveys as shown in Table 2-13. If the number to be installed does not meet the required number, the cost of the equipment will be reduced through design changes at the execution stage.

Table 2-13: Estimated No. of Iron Removal Equipment Required

Groundwater District	No. of Survey Wells		＞1.0mg/ℓ		% of Survey Wells (Fe: ＞1.0mg/ℓ)	No. of Target Wells	
	Deep Well	Shallow Well	Deep Well	Shallow Well		No. of Planned Wells	No. of Drilling Wells Required Iron Removal Equipment
1	2	3	0	0	0.0%	24	0.0
4B	2	10	1	0	8.3%	0	0.0
5A	8	13	0	1	4.8%	50	2.4
5C	1	2	0	1	33.3%	17	5.7
5D	4	－	1	－	25.0%	28	7.0
5E	3	1	0	0	0.0%	88	0.0
6A	1	－	0	－	0.0%	24	0.0
6B	7	3	1	0	10.0%	95	9.5
6C	4	－	0	－	0.0%	22	0.0
6D	1	－	0	－	0.0%	9	0.0
6E	1	3	0	0	0.0%	17	0.0
6F	2	2	0	0	0.0%	0	0.0
6H	1	1	0	0	0.0%	6	0.0
合計	37	38	3	2	6.7%	380	24.5
							6.5%

(4) Materials and Equipments Procurement Plan

1) Selection of Equipment for Grant Aid Project

The equipment requested by Cambodia has been prioritized based on the following evaluation categories:

1. Necessity for the Project

2. Compatibility with the equipment possessed by DRWS

3. Technical capability of DRWS personnel

The results of the evaluation are shown in Table 2-14.

Table 2-14: Selection of Equipment for the Project

Equipment No.	Name of Equipment	Purpose	Specification	Emergency Requirement	DRWS Equipment Possessed	Technical Capacity of DRWS	Priority in DRWS	Requested Quantity (Final Confirmation)	Priority	Final Plan	Remarks
1. Well Drilling											
1-1	Drilling Rig	Drilling Well		B Procurement of the item is indispensible. It is not available in the	A 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	C	0	Japan explained for not supplying new materials, and Cambodia accepted.
1-2	High Pressure Compressor	Supplying Pressured Air in DTH Drilling		B Procurement of the item is indispensible. It is not available in the	A 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	C	0	Japan explained for not supplying new materials, and Cambodia accepted.
1-3	Drilling Tools	Fitting for Well Drilling		B Procurement of the item is indispensible. It is not available in the	A 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	C	0	Japan explained for not supplying new materials, and Cambodia accepted.
1-4	Truck with Cranes	Transport of Construction Materials		B Procurement of the item is indispensible. It is not available in the	A 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	C	0	Japan explained for not supplying new materials, and Cambodia accepted.
1-5	Water Tanker	Supplying Water in Mud Water Drilling		B Procurement of the item is indispensible. It is not available in the	A 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	C	0	Japan explained for not supplying new materials, and Cambodia accepted.
1-6	Oil Tanker	Fuel supply for Drilling Materials		B Procurement of the item is indispensible. It is not available in the	A 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	C	0	Japan explained for not supplying new materials, and Cambodia accepted.
1-7	Pickup Truck	Work Supervision		B Procurement of the item is indispensible. It is not available in the	A 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	C	0	Japan explained for not supplying new materials, and Cambodia accepted.
2. Well Survey											
2-1	Pumping Test Equipments	Pumping Test	Pump (Well Diameter 4 inch.) and surrounding materials	A Procurement of the item is indispensible. It is not available in the	B 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	A	1	Pump (Well Diameter 4 inch.) and surrounding materials. 2 sets in total are necessary (1 set provided by Grant Aid last time already).
2-2	Low Pressure Compressor	Cleaning Well Before Pumping Test, O&M of Well	Skid Type, 7.0kg/cm2(100psi), 8.5m3/min (300psi)	A Procurement of the item is indispensible. It is not available in the	B 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	A	1	Low Pressure Compressor. Skid Type is suitable for Truck with Cranes. 2 sets in total are necessary (1 set provided by Grant Aid last time already).
2-3	Well Logging Equipment	Well Logging	Logging Depth above 150m, Specific Resistance, Self-Potential(SP), SP-γ Logging Equipment	A Procurement of the item is indispensible. It is not available in the	B 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	A	1	Logging of Aquifer and depth of screen installation, Logging Depth above 150m. 2 sets in total are necessary (1 set provided by Grant Aid last time already).
2-4	Electrical Prospection	Physical Prospection	Inspection Depth above 150m	A Procurement of the item is indispensible. It is not available in the	B 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	C	0	Inspection of Aquifer. One set provided by Grant Aid last time is substitutable in this project.
2-5	Water Quality Analyzer	Water Quality Test	Water Quality Analyzing Materials. Chemical reagents are added up in construction costs.	A Procurement of the item is indispensible. It is not available in the	B 1 set is available (provided by Grant Aid last time)	B OJT Technical Transfer is necessary in	A	2	A	1	For water quality test for drilling wells and daily checkup of water. 2 sets in total are necessary (1 set provided by Grant Aid last time already).
2-6	Truck with Cranes	Transport of Construction Materials	4WD 2 ton Truc with Cranes	A Indispensible for OJT Work	B Equipment required to this project is not available.	A No problem	A	2	A	2	Transport of Testing Materials
2-7	Pickup Truck	Transport of Staff/Materials	Double Cabin Pickup (4WD)	A Indispensible for OJT Work	B Equipment required to this project is not available.	A No problem	A	2	A	2	Transport of Survey Staff and Materials
2-8	Station Wagon	Transport of Statt	4WD (above 5 passengers)	B The Pickup above(2-7) is substitute for Station Wagon.	B Equipment required to this project is not available.	A No problem	A	2	C	0	The Pickup above(2-7) is substitute for Station Wagon.
3. O&M											
3-1	Pickup Truck	Transport of OM Staff/ Materials	Double Cabin Pickup (4WD)	A Indispensible for PDRD's O&M Activities	B Equipment required to this project is not available.	A No problem	A	2	A	1	For PDRD's O&M Support Activities. The item acts also as a transport of HP repair materials.
3-2	Motor Bike	Transport of OM Staff	Above 100cc, Familiy Type, Popular Model in the area	A Indispensible for DOD's O&M Activities	B Equipment required to this project is not available.	A No problem	A	0	A	5	For DOD's O&M Support Activities.
3-3	Video Set	OM Strengthening Activities/ Sanitation Education	Video Camera, Video Player, TV, Video Cassettes	B Needed in Trainers Training	B Equipment required to this project is not available.	B Instruction&manner of utilization of Soft Component is	A	1	B	1	For O&M Strengthening Activities/ Sanitation Education/Trainers Training in DRWS, PDRD, and DOD
3-4	Projector with Accessories	OM Strengthening Activities/ Sanitation Education	Note PC, Projector, Softwares	B Needed in Trainers Training	B Equipment required to this project is not available.	B Instruction&manner of utilization of Soft Component is	A	2	B	1	For O&M Strengthening Activities/ Sanitation Education/Trainers Training in DRWS, PDRD, and DOD
3-5	Computer with Accessories	Database Creation of Wells	Desktop PC, Printer, Softwares	A Indispensible for OJT Work	B Equipment required to this project is not available.	B Instruction&manner of utilization of Soft Component is	A	1	A	1	For Database Creation of O&M/Monitoring Wells.

NB) Criteria(Priority Order) : A>B>C

2) List of the Equipment

The procured equipment shall be categorized into survey and testing equipment and operation and maintenance equipment. The breakdown of major equipment, specification and purpose are shown in Table 2-15.

Table 2-15: Major Equipment List

Equipment No.	Name of Equipment	Specification/Ability	Qty	Purpose of use
A Survey and Testing Equipment				
A.1	Well logging equipment			
A.1.1	Well logger	Logging depth 150m or more, specific resistance, Self-Potential (SP), SP-γ logging equipment	1	Development of casing program, and data collection of the geological figure
A.1.2	Note PC for the site use	Anti-shock, dust and drip proof	1	Analysis of well logging results on-site, and development of casing program
A.2	Well cleaning equipment and material			
A.2.1	Low pressure compressor	Skid Type, Out put Pressure 7.0kg/cm^2(100psi), Out put air volume 8.5m^3/min (300psi)	1	Cleaning of the well for pumping test
A.2.2	Well cleaning parts	Raiser pipes, flange etc.	1	Cleaning of the well for pumping test
A.3	Test pumping equipment			
A.3.1	Underwater motor pump	Suit for 4 inch. Casing type Pump displacement 80 L/min or more Pump head 80m or more	1	Pumping test
A.3.2	Diesel generator	Output rating 10KVA or more, Frequency 50Hz,380V, Three-phase	1	Pumping test
A.3.3	Triangular weir	Measurable water volume 200L/min or more	1	Mesurement of Water volume in pumping test
A.3.4	Water level gauge	Measurable depth 100m or more	1	Mesurement of Ground water level in pumping test
A.4	Water quality analyzing equipment			
A.4.1	Water quality analyzer	Portable spectroscope type	1	Water quality analysis at site office
A.4.2	Turbidity meter	Measurable Range from 0 to 1000NTU or more	1	On-site water quality analysis (Turbidity meter)
A.4.3	Conductivity meter/TDS mete	Conductivity : Measurable Range from 0 to 19.9mS/cm and 3 range or more TDS : mesurable range 0~1999 mg/L	1	On-site water quality analysis (Conductivity meter/TDS meter)
A.4.4	pH meter	Measurable range 0-14	1	On-site water quality analysis (pH meter)
A.4.5	ORP meter	Measurable range ±2000mv	1	On-site water quality analysis (oxidation reduction potential)
A.4.6	Incubator	Mini desktop type, preset temperature 30-40℃	1	Germ culture for water quality analysis
A.5	Truck with cane	4WD Left hand Draive, crane lifting capacity 3t or more, GVW 10t or more	2	Transport of testing equipment and material
A.6	Pickup	4WD Left hand Drive, Seat 5 persons or more, Double cabin	2	Transport of testing staff/materials to testing site
B Equipment for Operation and Maintenance				
B.1	Pickup	4WD Left hand Drive, Seat 5 persons or more, Double cabin	1	Transport of personnel for O&M, Strengthening activity and material for Hand Pump repairing
B.2	Motor bike	Engine 125cc or more, family type	4	Sanitary education and strengthening activities of O&M staff
B.3	Video set			
B.3.1	Video camera	Degital Video, PAL system, AC 220V / Battery	1	Sanitary education/strengthening activities/workshops
B.3.2	Video player	VHS,PAL system, AC 220V	1	Sanitary education/strengthening activities/workshops
B.3.3	Television	20 inch., color, stereo sound, AC 220V	1	Sanitary education/strengthening activities/workshops
B.4	Projector set			
B.4.1	Desktop computer	Pentium M 1.5GHz or more, HDD 40G or more, CDRW-DVD Compatible, 14.1 inch TFT or more, MS office XP Professional, AC220V	1	Sanitary education/strengthening activities/workshops
B.4.2	Projector	SVGA 800x600, Multi system, AC 100V~220V	1	Sanitary education/strengthening activities/workshops
B.4.3	Screen	60 inch x 60 inch or more, Tripod stand	1	Sanitary education/strengthening activities/workshops
B.4.4	Portable generator	0.9kVA, Gasoline type	1	For projector in village use
B.5	Computer set			
B.5.1	Desktop computer	Pentium IV 2.4GHz or more, HDD 40G or more, CDRW-DVD Compatible, 14.1 inch TFT or more, MS office XP Professional, AC220V	1	Database development of well drilling
B.5.2	UPS	Max. capacity 1200VA or more	1	Stabilizing of the Alternating current
B.5.3	Printer	Color laser printer, A3 size printable AC 220V	1	Database development of well drilling

3) Grounds for the necessity, quantity and required performance of the procured equipment

A. Survey and testing equipment

A.1 Borehole logging equipment

The borehole logging equipment will be used for checking the aquifer depth after drilling deep wells and determining the installation location of the pumps and screens. In this Project, two sets of loggers are required because two borehole logging teams will be formed. One of the sets, procured in the Peri-Urban Project, is owned by DRWS and will be used in this Project. Another new set will be procured for use in this Project.

A.1.1 Borehole logger: 1 set

The planned maximum drilling depth in this Project is 80m, but the new set to be procured will be used by DRWS for other projects in other areas after this Project is completed. Therefore, the borehole logging equipment to be procured will have similar specifications (for measuring specific resistance, natural potential and natural gamma rays) to the type used in the Peri-Urban Project. The equipment will have a measuring capability of 150m, estimated to cover almost the entire country of Cambodia.

A.1.2 Notebook computer for field use: one set

The results of borehole logging have to be analyzed immediately and reflected in the preparation of the casing program. For this purpose, one notebook computer will be procured for data analysis in the field. It will be of a shockproof and dustproof type in consideration of on-site use.

A.2 Well developing and repair equipment

The well developing equipment will be used for cleaning the well prior to the pumping test and also for maintenance in the event of floods. As two well-cleaning teams will be formed in this Project, two sets of well cleaning equipment are required. One of the two sets, procured in the Peri-Urban Project, is owned by DRWS and will be used and another new set will be procured in this Project. The new set will have similar specifications to the type used in the Peri-Urban Project because these sets will be used by DRWS for other projects in other areas after completion of this Project.

A.2.1 Low-pressure compressor: 1 set

In this Project, it is presumed that the compressor will be transported by a truck with a crane and it is planned to procure a skid type of compressor. The specifications will be similar to

those of the compressor used in the Peri-Urban Project in consideration of universal use, but they have been determined considering the following conditions.

Assuming that the maximum drilling depth of the well is 80m, the static water level of the deepest well is GL-15m (considering that the maximum pumping pipe length for the hand pump is 24m), the maximum drop in water level by air lift is 20m, and the minimum water penetration rate is 40%, H and Hs in the figure and table shown below shall be: H = 35m and Hs = 40m, and the pump head = 75m.

In this case, the required air discharge volume can be seen to be 8.0m3/min. or more by drawing a vertical line upwards from the point of intersection of the pump head (H) at 35m and 40% of the left-rising water penetration curve. Therefore, the air discharge volume is planned to be 8.5m3/min. or more for safety, which is equivalent to the value for the Peri-Urban Project. The air discharge volume has been calculated with reference to the Illustrated Table of Air Compressors ("Hot Springs, Development and Design" issued by Chijin Shokan Co., Ltd.)

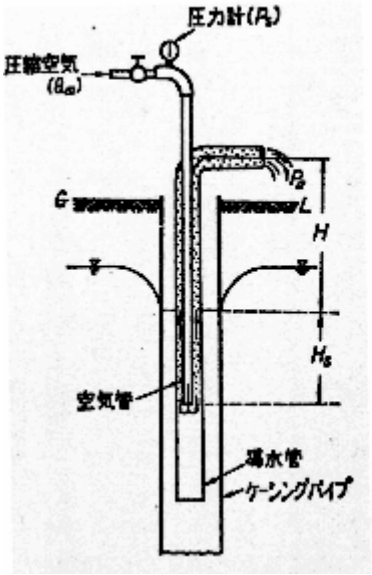


Figure 2-3: Structure of Air Pipe

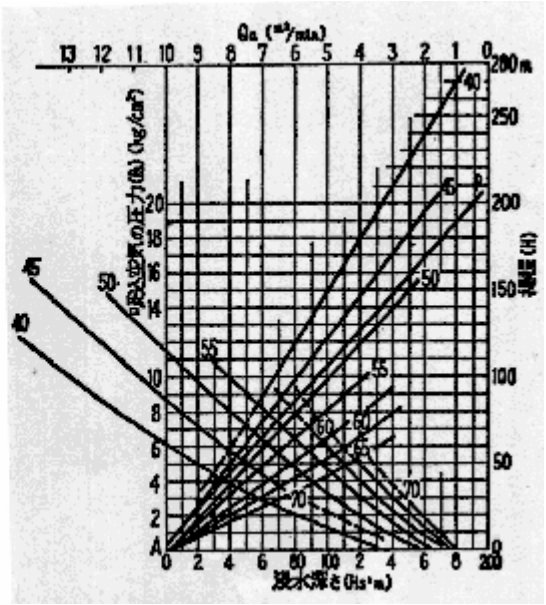


Figure 2-4: Relation between Intake Air Pressure, Pumping Capacity and the Depth of Water Table Decline by Pressurization

On the other hand, the compressed air pressure when developing the well with a compressor is raised to "normally 7 to 10kg/cm2" as described in the Groundwater Handbook (issued by the Construction Industry Research Association). Therefore, the compressed air pressure has been set at 7.0kg/cm2 or more in this Project, because the drilling aperture is small and the air pipe and water pipe have small apertures.

Pressure: 7.0kg/cm2 (100psi) or more

Discharge volume: 8.5m3/min. (300cfm) or more

A2.2 Well development and repair parts: 1 set

These parts will be used to fix the space between the low-pressure compressor and the drilled well when developing and repairing the well. The specifications will ensure easy transportation, assembling and disassembling and the composition of the parts will be as shown in Figure 2-5.

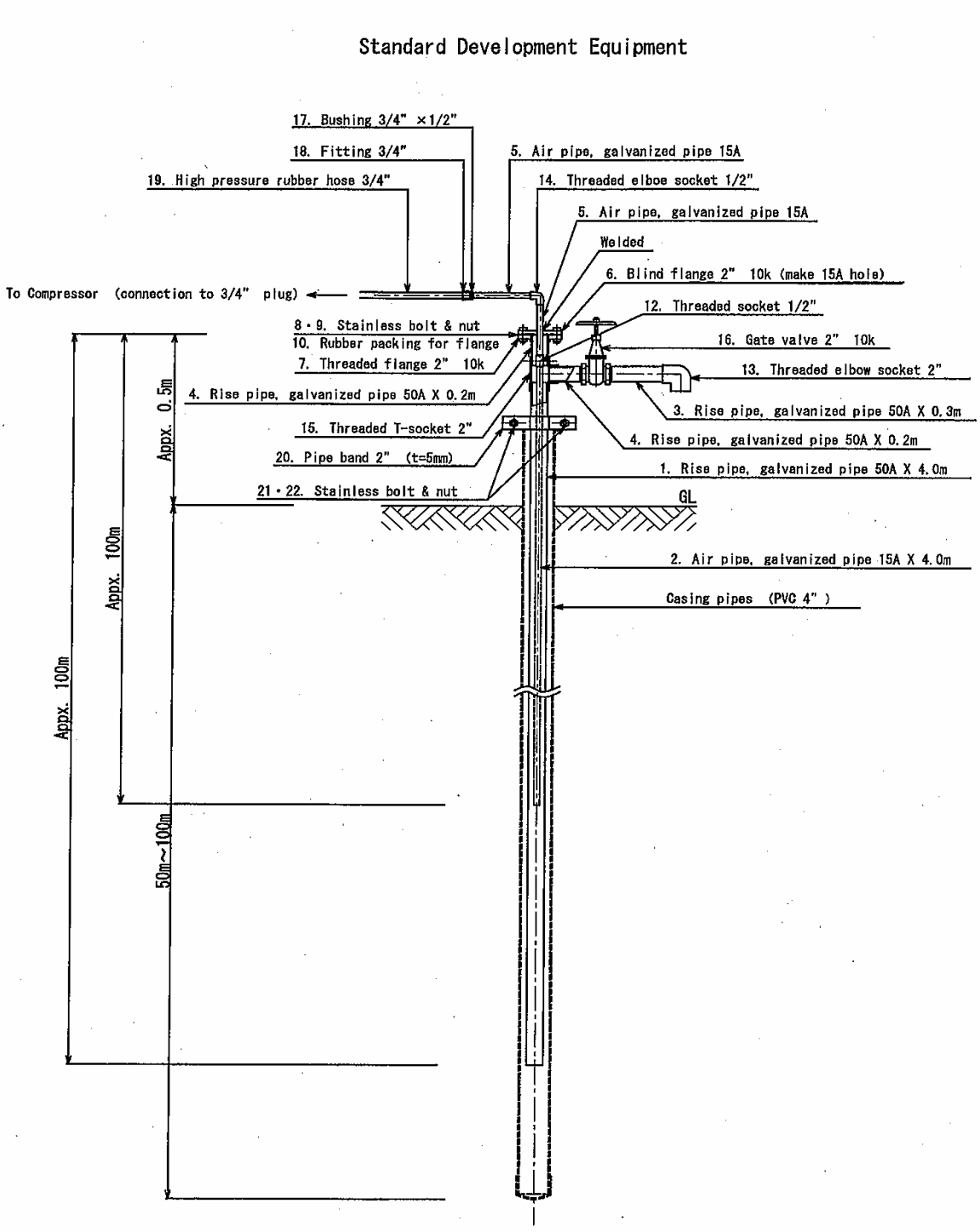


Figure 2-5: Well Cleaning Parts

A.3 Pumping test equipment

The equipment for pumping tests consists of a submergible motor pump, diesel generator and triangular weir. Two sets of pumping test equipment are required for this Project because two pumping test teams will be formed. One of the two sets, procured in the Peri-Urban Project, is

owned by DRWS and will also be used for this Project. Another new set will be procured for use in this Project. The pumping test equipment will have similar specifications to that used in the Peri-Urban Project because DRWS will use the equipment for other projects after completion of this Project.

A.3.1 Submergible motor pump: 1 unit

The pumping test will be carried out after the drilling work and casing insertion work are finished. Therefore, the outer diameter of the submergible motor pump is planned to be smaller than the inner diameter (4 inches) of the casing in this Project. The pump head will be 80m or more (for safety reasons, though 75m is presumed adequate). The specifications of the motor pump will enable a pump-up performance of 80L/min., which is at least double the pumping rate in the pumping test because the pumping rate of the hand pump is presumed to be 20 to 30L/min.

A.3.2 Diesel generator: 1 unit

The diesel generator will be used to secure the power supply for the submergible motor pump. Most villages in the project area are not electrified. It is, therefore, necessary to plan the installation of generators in order to use the submergible motor pump for the pumping tests. The generation capacity will be about 10KVA, enough to drive the submergible motor pump.

A.3.3 Triangular weir: 1 unit

The triangular weir will be used to measure the water quantity in the pumping tests. It enables easy measurement with high accuracy and is indispensable for pumping tests. The triangular weir for this Project will have a capacity of 200L/min., the minimum measuring capacity of widely used triangular weirs.

A.3.4 Water level gauge: 1 unit

The water level gauge will be used to measure the water level in the borehole during pumping tests. The standard specifications of water level gauges of any manufacturer are 50m long or 100m long. The 100m-long water level gauge will be adopted because the maximum drilling depth in this Project is estimated to be 80m.

A.4 Water quality analyzing equipment

Those water quality analysis items for which accurate values can only be obtained when the sample water is analyzed immediately after it is pumped up will be measured at the site. Other water quality analysis items will be analyzed in DRWS site offices. Two sets of water quality analyzers are required because two borehole logging teams will be formed in this Project. One of

the two sets, procured in the Peri-Urban Project, is owned by DRWS and will also be used for this Project, but another new set will be procured in this Project. The specifications of the new set will be equivalent to those of the set for the Peri-Urban Project.

The reagents will be procured considering the limit of their validity and reckoned in the testing costs budgeted for construction of the facilities.

A.4.1 Water quality analyzer: 1 unit

The water quality analyzer will be a spectrophotometer capable of measuring general water quality items. The water quality analyzer will be capable of analyzing many substances including metallic compounds, minerals and organic compounds, and the planned analysis items are listed below. The analyzer will be of a simple desktop type for use in DRWS site offices.

Analysis items: Arsenic (As), Barium (Ba), Chromium (Cr6+), Chloride (Cl), Fluoride (F), Hardness, Hydrogen Sulfide (H2S), Manganese (Mn), Selenium (Se), Sodium (Na), Sulfate (So42-), Aluminum (Al), Iron (Fe), Zinc (Zn), Copper (Cu), Lead (Pb), Nickel (Ni), Ammonia (NH4), Nitrate (No3), Color, etc.

A.4.2 Turbid meter: 1 unit

The turbidity is apt to change immediately after coming into contact with the atmosphere and is one of the water quality items for which on-site measurement is desirable. This analyzer is specially designed for turbidity analysis and is capable of measuring up to 1,000 NTU. The turbid meter will be of a portable type in consideration of on-site use.

A.4.3 Electric conductivity/TDS meter: 1 unit

The electric conductivity (EC) value is apt to change immediately after coming into contact with the atmosphere and is one of the water quality items for which on-site measurement is desirable. The meter will be capable of measuring 0 to 19.9mS/cm. The TDS meter will be used to measure the total dissolved solids and will be capable of measuring 0 to 1999mg/L. The meter will be of a portable type in consideration of on-site use.

A4.4 pH meter: 1 unit

The pH value is one of the typical analysis items that show the nature of groundwater; but since it is apt to change immediately after coming into contact with the atmosphere, it is desirable to measure it on-site. This meter is specially designed for pH analysis and will be capable of measuring pH 0 to 14 as the general standard. It will be of a portable type in consideration of on-site use.

A.4.5 ORP meter: 1 unit

The oxidation-reduction potential (ORP) shows the oxidized or reduced state of water and is closely related to water quality items such as iron and arsenic. Since its value is apt to change on coming into contact with the atmosphere, on-site measurement is desirable. The ORP meter is specially designed for analysis of oxidation-reduction potential and will be capable of measuring a range of ±2,000mV. It will of a portable type in consideration of on-site use.

A.4.6 Incubator: 1 unit

Bacteria and Bacillus coli are important items of analysis for measuring water quality. The incubator will be used to maintain the sample bacilli and colon bacilli on test sheets at a constant temperature. The equipment for this Project will be capable of maintaining a temperature of 30 to 40°C and will be a compact desktop type for use in DRWS offices.

A.5 Truck with crane: 2 units

The trucks with cranes will be mainly used for transportation of equipment and materials and 2 units will be procured for use by the 2 teams to be formed for the surveys and tests, including borehole logging and pumping tests. The longest materials to be transported in this Project will be casings for well construction. The total length of the casing will be 4.0m, so the loading platforms of the trucks will be longer than that.

The trucks will be four-wheel drive models because roads are muddy in the rainy season and access will be poor to some sites. The vehicle's dead weight will have no impact on access to any site such as when passing over small suspension bridges. The lifting capacity of the crane will be 3 tons or more because the weight of the low-pressure compressor planned in this Project is assumed to be 2 tons or more.

A.6 Pickup truck: 2 units

The pickup trucks will be used for transportation of personnel and equipment for surveys and tests, such as borehole logging and pumping tests, similar to the trucks with cranes. Two units will be procured for two working teams. The pickup trucks will be four-wheel drive models in consideration of poor road access in the rainy season and will have a double cabin for transporting 4 to 5 workers at a time.

B. Maintenance equipment

B.1 Pickup truck: 1 unit

In this Project, PDRD and DOD will undertake the maintenance work. The pickup truck will be used for maintenance support activities, education activities and transportation of equipment and materials for repair of hand pumps undertaken by PDRD. The pickup truck will be a four-wheel drive model in consideration of poor road access in the rainy season and have a double cabin for transporting 4 to 5 workers at a time.

B.2 Motorbikes: 4 units

The work of DOD maintenance personnel will be very important for maintenance activities at the village level. Motorbikes will be procured to support the wide-ranging maintenance activities of the maintenance personnel including hygiene education, education of residents and equipment maintenance. The motorbikes are planned to be of the 100cc-class family type, the most popular type in Cambodia, bearing in mind maintenance, the availability of spare parts and the level of repair skills. A total of 4 units will be procured for the use of each DOD unit in the 4 districts of the project area and used for their activities in the field.

B.3 Video set:

DRWS will undertake not only well drilling works but also the training and guidance of DRWS, PDRD and DOD staff. The video equipment will be used for maintenance activities, hygiene education and training of staff. It will also be used to record on-site resident organization activities and hygiene education on video tapes and to train the staff members as trainers using the recorded video tapes.

B.3.1 Video camera: 1 unit

The video camera will be of a digital video type that is popular in Cambodia. The digital video camera will be used to record the education activities for residents and sampling work in the villages and the recorded images will serve as training materials. The camera will be of a compact type for use in the field. The digital video camera can be connected directly to image display equipment (such as a TV or projector) for playing the recorded images, so it has the advantage of not requiring a video player. The digital video camera will be of the PAL type in consideration of the locality, and 10 video cassettes will be supplied.

B.3.2 Video player: 1 unit

The video player will be procured for playing VHS tapes. The digital video camera will be

capable of recording and displaying the education activities in the villages as described above, but most of the video tapes of education activities created by other donors and related agencies in the past are of the VHS type. Therefore, it is necessary to procure a video player that is compatible with the VHS system. The video player will be of the PAL type in consideration of the locality.

B.3.3 TV set: 1 unit

The TV will be used to display images for training that will be played using the digital video camera and video player. The TV will be installed at the DRWS office and will be an ordinary TV with no particular consideration given to portability. It will have a 20-inch monitor or so to enable about 10 trainees at most to watch at one time. The TV will also be of the PAL type in consideration of the locality.

B.4 Projector set:

The projector will be used for workshops, seminars and training of trainers held by DRWS (or in some cases, PDRD or DOD) as part of their maintenance training activities and hygiene education for staff or beneficiaries. The training programs will be held for a large number of trainees at one time, so the model and specifications of the equipment must be selected with this in mind. One projector will be procured for the DRWS office.

B.4.1 Notebook computer: 1 unit

The notebook computer will be used to project digital data such as water quality analysis results and on-site photos, and also for the task of editing raw digital data. It can also be used to prepare training materials to be distributed to trainees and is expected to be used in a wide range of applications. It will be of the portable notebook type in consideration of ease for carrying to the sites.

B.4.2 Projector: 1 unit

Visual education is the most effective and easiest method of conducting education activities for beneficiaries. The projector can provide images to a large audience and is expected to be very effective in the training and guidance programs in this Project. The projector is designed to connect to a personal computer or digital video camera and project digital images onto a screen. As training sessions will be held not only in the DRWS office but also in the villages, the projector will be of a compact portable type.

B.4.3 Screen: 1 unit

The screen will be used to project images from the projector. It will be approximately 60 x

60 inches in size in order to display images to a large number of trainees at one time and will be equipped with a tripod.

B.4.4 Diesel generator: 1 unit

It is assumed that education activities will be held in the villages, but most of the villages are not electrified. A compact type diesel generator will be procured to provide the necessary power supply. The diesel generator will have a capacity of about 900VA because it will be used to drive small electrical appliances.

B.5 Computer set: 1 set

The computer set will consist of a desktop computer and a printer and will be mainly used to create a database of drilled well and water quality analysis data in this Project. It will also be used for maintenance and monitoring activities. One set will be procured and installed at the DRWS office.

B.5.1 Desktop computer: 1 unit

It will be necessary for DRWS to provide centralized management of the data (well inventory) on the well drilling works implemented by DWRS and reflect the data in water supply programs to be developed in the future. The sampling of the water quality in deep wells after completion of the well construction works will lead to the supply of safe water to the beneficiaries and it is essential to ensure centralized management of the acquired data. Therefore, one desktop computer will be procured for centralized data management.

B.5.2 UPS: 1 unit

The area in which the DRWS office is located is electrified, but the voltage is unstable and power failures occur very often. The desktop computer will store important data including well management inventory, water quality analysis data and materials for training and hygiene education activities, so damage to the computer due to power failure must be minimized.

Therefore, one UPS will be procured to provide temporary backup of the power supply to the computer. The UPS will have a capacity of about 1,200VA for the exclusive use of the computer.

B.5.3 Printer: 1 unit

The printer will be used to output database data or training materials. The printer will be a color laser printer up to A3 size in consideration of visual effectiveness when preparing training materials.

2.2.3 Drawings

The basic design drawing is shown below.

Figure 2-6: Location Map of Project Site,

Figure 2-7: Well Structure

Figure 2-8: Platform

Figure 2-9: Iron Reducing Equipment

Figure 2-10: Sign Board

2.2.4 Implementation Plan

2.2.4.1 Implementation Plan

(1) Project Implementation System

One well drilling construction team will be formed of trainees trained in on-the-job training (OJT) using the well drilling equipment provided by Japan in the Peri-Urban Project and owned by DRWS. In addition, three well drilling teams will be formed by local well drilling constructors as subcontractor teams. The well drilling works to be constructed by a total of four teams will be supervised by a Japanese contractor. Works relating to the quality control of the well drilling works, including geophysical prospecting, borehole logging, well development, pumping tests and water quality analysis, will be implemented by two working teams organized through OJT under the supervision of the Japanese contractor.

The Equipment provided under Peri-urban project

Drilling rig (YBM-YTD45B)

Fuel tank track (Isuzu)

Tools track (Isuzu)

Drilling bit

Track for compressor

Compressor (Airman)

(2) Utilization of Equipment Owned by Implementing Agency

The Department of Rural Water Supply (DRWS) under the Ministry of Rural Development (MRD), the implementing agency, agreed to lend the following equipment, which was procured under Grant Aid in "The Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh" (hereinafter, "the Peri-Urban Project"), without charge for implementation of the project. Regarding the volume of equipment to be lent, the period, conditions, etc., the details will be confirmed with DRWS in writing at the time of the general explanation.

1) Well drilling equipment and supporting vehicles

- ♦ Drilling rig 1 unit
- ♦ Drilling tools 1 set
- ♦ High pressure air compressor 1 unit
- ♦ Cargo track with crane 1 unit
- ♦ Water tank track 1 unit
- ♦ Fuel tank track 1 unit
- ♦ Pick-up track for personnel and material transportation 2 units

2) Testing and Survey Equipment

- ♦ Resistivity survey equipment 1 set
- ♦ Borehole logging equipment 1 set
- ♦ Well development equipment (low pressure air compressor) 1 unit
- ♦ Pumping test equipment 1 set
- ♦ Water analysis kit 1 set

3) Equipment for Oparation and Maintenance

- ♦ Pick-up for Operation and maintenance 1 unit

(3) Utilization of local resources

The existing local drilling equipment (equipment owned by local private drilling companies) is considered to be capable of carrying out well drilling suitable to the scale and specifications of the project. There are three companies with adequate drilling rigs for the project. They possess a total of 10 drilling rigs, with a minimum of two rigs each. Assuming the need for replacement due to the break down of equipment during the construction period, half of the minimum equipment owned will be used. Therefore, three drilling teams will be organized to carry out the drilling works using the locally procured equipment. However, DRWS does not have quality control techniques (geophysical survey, borehole logging, well development, pumping tests, water analysis, etc.) or equipment for well drilling.

Therefore, OJT for quality control of well drilling works will be provided to DRWS for a period of six months. After that, DRWS shall implement quality control on its own. Two teams for quality control will be organized and for the necessary equipment, the plan is to use the equipment procured under the Peri-Urban Project. However, any lacking equipment will be procured under this project.

(4) Technology transfer

1) Technologies for well drilling

A) Testing and survey techniques for well drilling

The items to be covered in the transfer of testing and survey techniques for well drilling are as follows:

Item	Contents
Geophysical survey	Theory, method, and analysis of geophysical survey; analysis and determination of hydrogeological conditions based on comparison of geophysical survey data prior to drilling and actual data after drilling
Borehole logging	Theory, method, and analysis of electric logging and determination of location for installation of screen
Pumping test	Theory, method, analysis of step-by-step test, continuous test, and recovery test after drilling; determination of aquifer capacity
Water analysis	Acquisition of knowledge on water quality parameters; method of sampling and water analysis after drilling
Database development	Method for dev elopement and O&M of database, in order to effectively use the above test data in future groundwater development

B) Work schedule control

The national water supply and sanitation plan, approved in February 2002, includes the policy to promote private sector participation, and importance is placed on DRWS's role as project facilitator to carry out project management. However, although the DRWS has carried out drilling works on its own with equipment and materials provided by other donors, the works were implemented without time restrictions, etc. Therefore, DRWS, lacks the skills for implementing schedule control.

As the DRWS will be responsible for project management in the future, the DRWS needs to acquire general techniques for schedule control and build its capacity for providing proper guidance to private companies. In this project, technology transfer for schedule control will be conducted. The contents and items to be covered in the technology transfer are described below.

Stage	Item	Contents
Planning	Construction Plan	Deciding on basic policy for construction sequence and method.
	Construction schedule	Understanding of work sequence, works that can be done in parallel, minimum duration for works, and relationship between the various works; adjustment of schedule and preparation of construction schedule
	Planning	Planning of procurement schedule for machinery, labour and materials
Construction	Instruction	Instruction and supervision of construction
	Work volume	Recording of actual work volume and consumption
	Progress	Comparing actual schedule and plan, monitoring of progress
	Arrangement	Arrangement of machinery, labour and materials
	Revision	Modification and revision of plan

2) Oparation and maintenance

Technologies transfer for operation and maintenance shall be conducted under the soft component to the implementing agency, PDRD and DOD. The contents of technologies transfer shown in 2.5.1 Soft Component.

2.2.4.2 Implementation Conditions

(1) Access Conditions

In Memot District, there are some villages that have poor access conditions and it is predicted that workers and vehicles will have difficulty in entering these villages in the rainy season. Therefore, the implementing schedules will be formulated in such detail that construction works in the villages with poor access will be implemented in the dry season while works will be implemented in the villages with good access in the rainy season.

(2) Cooperation with DRWS, PDRD and DOD

The best implementing organization to support residents' organizations and provide the hygiene education necessary for sustainable maintenance of the wells is PDRD from the viewpoint of its existing organization and personnel, and DOD should play an assisting role for PDRD. On the other hand, the implementing organization to provide maintenance support after the forming of residents' organizations should be DOD as its activities place it closer to the villages. However, although both PDRD and DOD have a sufficient number of personnel, reinforcement of their capabilities is necessary, including technology transfer and maintenance of equipment and materials.

(3) Interaction with Soft Component

The soft component relating to maintenance and operation and hygiene education during implementation of the Peri-Urban Project has been highly evaluated in Cambodia: "It is very effective and will be a model for other future projects". A soft component relating to operation and maintenance and hygiene education will also be introduced in this Project in order to enhance the technical level of DRWS as the facilitator and implement technology transfer to PDRD and DOD, the local agencies of MRD.

(4) Positive Use of Local Constructors and Equipment and Materials

Local well drilling constructors can be judged capable of implementing the well drilling works to meet the scale and specifications of this Project and of acting as the subcontractors for this Project. Therefore, it is planned to make positive use of these constructors in this Project.

The equipment and materials necessary for the construction works will be procured locally whenever possible. However, equipment and materials that are impossible to procure locally, that present problems of quality or distribution, or that are difficult to obtain within a certain period will be imported from Japan or a third country. The cost of procuring such equipment and materials that are impossible to procure locally from Japan or a third country will be compared and the cheaper option will be adopted.

2.2.4.3 Scope of Works

The scope of works to be implemented by the Japanese and Cambodian sides in this Project is shown in Table 2-16.

Table 2-16: Scope of Works by Japanese and Cambodian Sides

Work Item	Japan	Cambodia	Abstract
Securing construction plot		○	WSUG
Securing equipment storage space		○	DRWS/PDRD/DOD
Access improvement to well construction sites		○	PDRD/WSUG
Wells construction	○		
Filling solid surrounding wells	○	○	Materials to be provided by Japan
Platform/ Drainage construction	○		
Installation work of hand pumps	○		
Foreslope planting		○	WSUG
Installation work of Iron removal equipment	○	○	Equipments to be provided by Japan
Sanitation education billboard	○		
Drainage canal construction		○	WSUG

2.2.4.4 Consultant Supervision

This Project will be implemented under Grant Aid for general projects by the Government of Japan, and the Government of Cambodia will enter into an agreement with a consultant recommended by the Japan International Cooperation Agency (JICA) for detailed design and construction supervision. The construction of facilities and the procurement of equipment and materials will be undertaken by the construction contractor and equipment suppliers on the Japanese side that will enter into an agreement with the Cambodian side. The consultant and the contractor on the Japanese side will dispatch the supervision/management personnel shown in Table 2-17.

Table 2-17: Installation and Procurement Supervision Personnel on Japanese Side

Criteria	Supervisor/ Manager	No. of Staff	Responsibility	Dispatch Period
Consultants	Project Manager	1	General Supervision of the Project	Spot
	Supervisor	1	Supervision of Construction Work	Full term
Construction Work Contractor	Director	1	Construction Control Manager	Full term
	Accounting	1	Accounting	Full term
	Drilling Engineer	2	Conducting drillings	Full term
	Technician	2	Instructing drilling wells and machine maintenance	Full term/ Spot
Equipments Procurement Supplier	Technician A	1	Inspection of equipment	Short term
	Technician B	1	Inspection of equipment	Short term

2.2.4.5 Procurement Plan

(1) Procurement Plan

The equipment to be procured for this Project is not manufactured in Cambodia but in Japan, and will basically be procured from Japan. This is because it has been confirmed in the Peri-Urban Project that the equipment made in Japan presents no problems in respect of supply of spare parts, local agents and after-sales service by manufacturers, which will be important for future maintenance. However, procurement from a third country will be examined in the case of equipment of a Japanese manufacturer which has relocated its production base to overseas, or any Japanese product that is manufactured only by a single manufacturer.

Procurement of the computers and video camera from local agents, which is convenient for after-sales service, will also be examined. The suppliers of equipment and the country of origin by equipment are shown in Table 2-18.

Table 2-18: Country Origin of Equipments

Criteria	Name of Equipment	Japan	Cambodia	Other countries	Remarks
Equipment	Well logging equipment	○			
	Low pressure compressor	○			
	Pumping test equipment	○			
	Water quality analyzer	○			
	Truck with crane	○			
	Pickup truck	○			
	Motorbike		○		
	Video with accessories		○		
	Projector with accessories		○		
	Computer with accessories		○		

(2) Transportation Plan

The equipment and materials to be procured in this Project will be shipped from main ports (such as Yokohama) in Japan and transported by freight liner to Sihanoukville port, the port of entry to Cambodia, where it will be unloaded (after a sea transportation period of about 3 weeks). Unloading and customs clearance of the procured equipment will be conducted at Sihanoukville port, from where all the equipment will be transported overland to the project sites in Kampong Cham Province and delivered to the implementing agency.

(3) Procurement Schedule

It is estimated that the period of manufacturing the testing equipment and vehicles will be 30 days and the period required for sea transportation, customs clearance, inland transportation and handover 60 days; therefore, the total period from the contract with the contractors to the handover will be 90 days.

(4) Equipment Procurement Supervision by Consultant

The consultant will undertake the following works relating to equipment procurement supervision: (1) final confirmation of procurement plan; (2) review of specifications and preparation of tender documents; (3) acquisition of approval of tender documents; (4) announcement of tender, site explanation and delivery of drawings; (5) attendance at tender and evaluation; (6) attendance at signing of contracts with contractors; (7) negotiations with contractors; (8) factory inspection; (9) inspection before shipment (referred to a third-party organization); and (10) acceptance inspection of procured equipment.

(5) Procurement Control by Contractors

The contractors will dispatch their local procurement managers (who will also serve as initial

operation instructors) to the local ports upon arrival of the procured equipment and materials. In this plan, the managers will provide technical guidance on machine operation and maintenance with regard to the vehicles, testing equipment and maintenance equipment. Technical guidance will be conducted at DRWS in consideration of the receiving agencies and the maintenance system.

2.2.4.6 Quality Control Plan

(1) Method and Standards of Quality Control

1) Concrete works

There is no intention to use ready mixed concrete for this project. All of the concrete shall be mixed by concrete mixing machine on site.

The measurement method of concrete materials would affect the concrete compressive strength; therefore, the measurement method of concrete materials is described in Table 2-19.

Table 2-19 Measurement method of concrete materials

Description	Specification		Method of Measurement
Cement	For super structure (G21)	Min. cement content 300kg/m^3	By Weight
	For sub structure (G18)	Min. cement content 250kg/m^3	By Weight
Aggregate	Sand		By Weight
	Aggregate		By Weight
Water			By Volume
Admixture			By Volume

2) Testing method of Quality Control

a. Concrete

A compressive strength test shall be conducted by each casing of concrete. Three samples shall be taken in each test and the test shall be conducted after the samples have aged 28 days.

b. Reinforcement Bar

A tensile strength test shall be conducted by each diameter and type in one lot of manufacturer production.

c. Water Quality Test

The water quality test shall be conducted in three stages: (1) water quality tests on site, (2) indoor water quality tests at the site office, and (3) detailed water quality tests. The water quality shall be determined based on (1) water quality tests on site and (2) indoor water quality tests at the

site office. The results shall be checked by (3) detailed water quality tests.

◆ Water Quality Test on Site

The objective of this test is to determine the water quality in a short time (within 5 to 10 minute). The test shall be conducted by DWRS under supervision of the Japanese contractor using equipment provided by this project and the Peri-Urban Project for the water volume test. The testing items are shown in Table 2-20. Tests shall be conducted using (1) a pack test, (2) a portable turbidity meter and (3) a portable EC/TDS meter. The judgment criteria are shown in Table 2-20.

The pack test determines water quality by comparing the resulting color against the standard color; the results are not expressed in figures. Therefore, judgment shall be made in two categories: clear success or clear fail. The portable turbidity meter and portable EC/TDS meter can produce numerical results. Therefore, judgment shall be made with numerical results.

◆ Indoor Water Quality Test at Site Office

Object of this test are (1) to make figure of results of Water quality test on site, (2) to confirm the test result tested by (2) Portable turbidity meter and (3) Portable EC/TDS meter, and testing other items which descried in Cambodian standards. The other items are not included in judgment criteria. However those items are very important for drinking water, therefore to conduct testing for other items.

◆ Detailed Water Quality Test

Object of this test is to confirm the results of (1) water quality test on site and (2) Indoor water quality test at site office. The test shall be carried out third party testing firm.

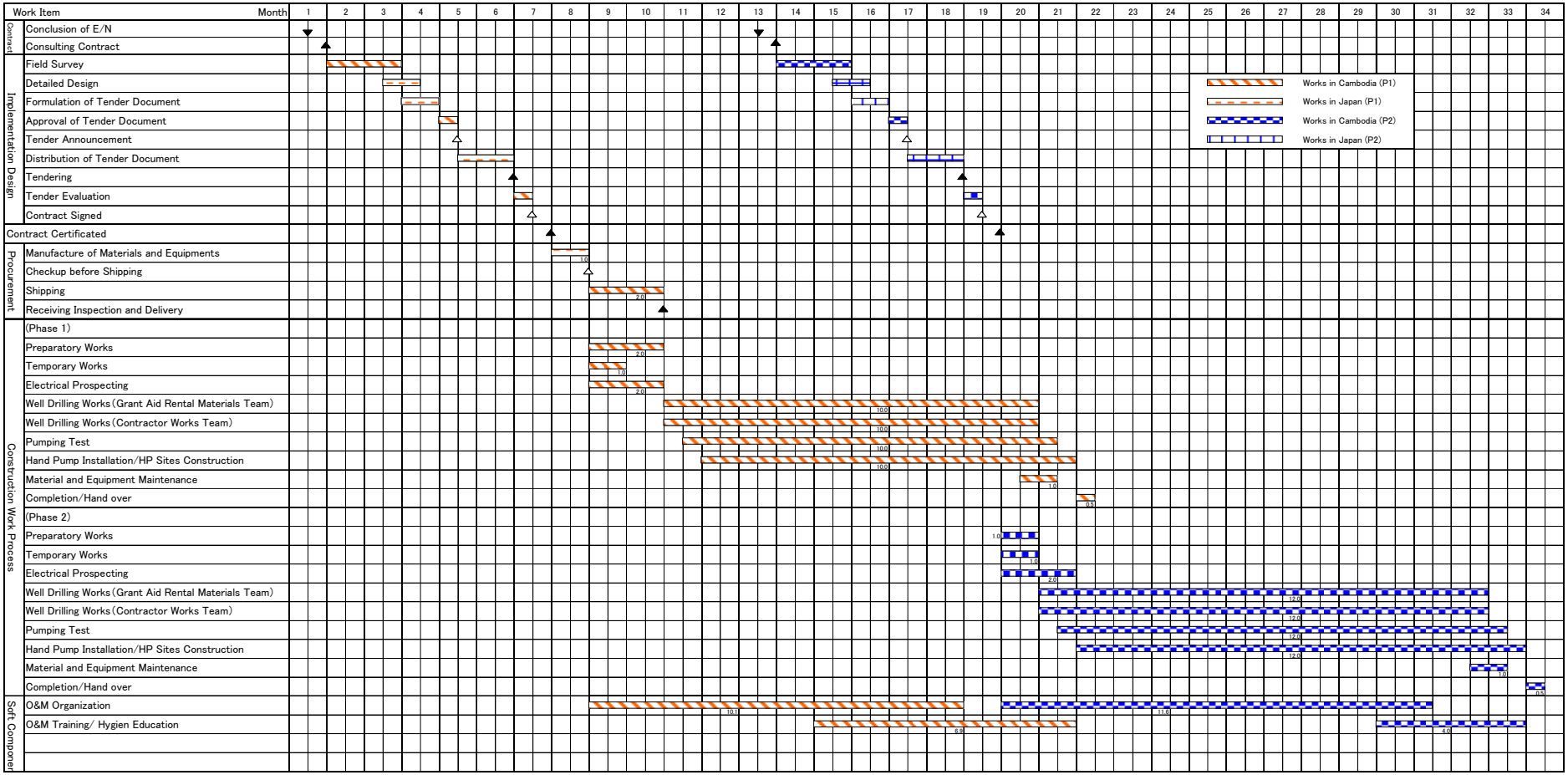
Table 2-20 Judgment Criteria of Water Quality

Analysis Item		Drinking Water Quality Standards, January 2004 (Ministry of Industry Mines and Energy)		**The project Judgment Guideline**	Water Quality Test on Site		Indoor Water Quality Test at Site Office		Detailed Water Quality Test
		Standard Value (mg/l)	Small water supply (less than 100 persons or $100m^3$/day) (mg/l)	**Standard Value (mg/l)**					
					Relevant	Measurement Method	Relevant	Measurement Method	Relevant
Judgment Category	Arsenic (As)	0.05	0.05	**0.05**	○	Field kit	○	Water quality analyzer	○
	Chloride (Cl)	250	-	**250**	○	Pack Test	○	Water quality analyzer	○
	Fluoride (F)	1.5	-	**1.5**	○	Pack Test	○	Water quality analyzer	○
	Manganese (Mn)	0.1	-	**0.4**	○	Pack Test	○	Water quality analyzer	○
	Total dissolved solid (TDS)	800	800	**800**	○	Portable EC Meter			○
	Iron (Fe)	0.3	0.3	**2.0**	○	Pack Test	○	Water quality analyzer	○
	Nitrate (NO_3)	50	-	**50**	○	Pack Test	○	Water quality analyzer	○
	Turbidity	5 NTU	5 NTU	**5 NTU**	○	Portable Turbidity Meter			○
Other relevant standards in Cambodia	Total coliform	0 in 100ml sample	0 in 100ml sample	-			○	Coliform testing paper	○
	Thermotolerant coliform								
	E.Coli.								
	Faecal streptcoques								
	Barium (Ba)	0.7	-	-			○	Water quality analyzer	
	Chromium (Cr_6^+)	0.05	-	-			○	Water quality analyzer	○
	Hardness	300	-	-			○	Water quality analyzer	○
	Hydrogen sulfide (H_2S)	0.05	-	-			○	Water quality analyzer	
	pH	6.5 - 8.5	6.5 - 8.5	-	○	Portable pH Meter			
	Selenium (Se)	0.01	-	-			○	Water quality analyzer	
	Sodium (Na)	200	-	-			○	Water quality analyzer	
	Sulfate (SO_4)	250	-	-			○	Water quality analyzer	○
	Aluminium (Al)	0.2	-	-			○	Water quality analyzer	○
	Zinc (Zn)	3	-	-			○	Water quality analyzer	○
	Copper (Cu)	1	-	-			○	Water quality analyzer	○
	Lead (Pb)	0.01	-	-			○	Water quality analyzer	○
	Nickel (Ni)	0.02	-	-			○	Water quality analyzer	○
	Ammonium (NH_4)	1.5	-	-			○	Water quality analyzer	○
	Nitrate (NO_3)	3	-	-			○	Water quality analyzer	○
	Color	5 TCU	-	-			○	Water quality analyzer	
reference	Water Temperature				○	Portable pH Meter			
	Electric Conductivity				○	Portable EC Meter			
	Electric oxidation resolution				○	Portable ORP Meter			

2.2.4.7 Implementation Schedule

The project implementation schedule is shown in Table 2-21.

Table 2-21: Project Implementation Schedule



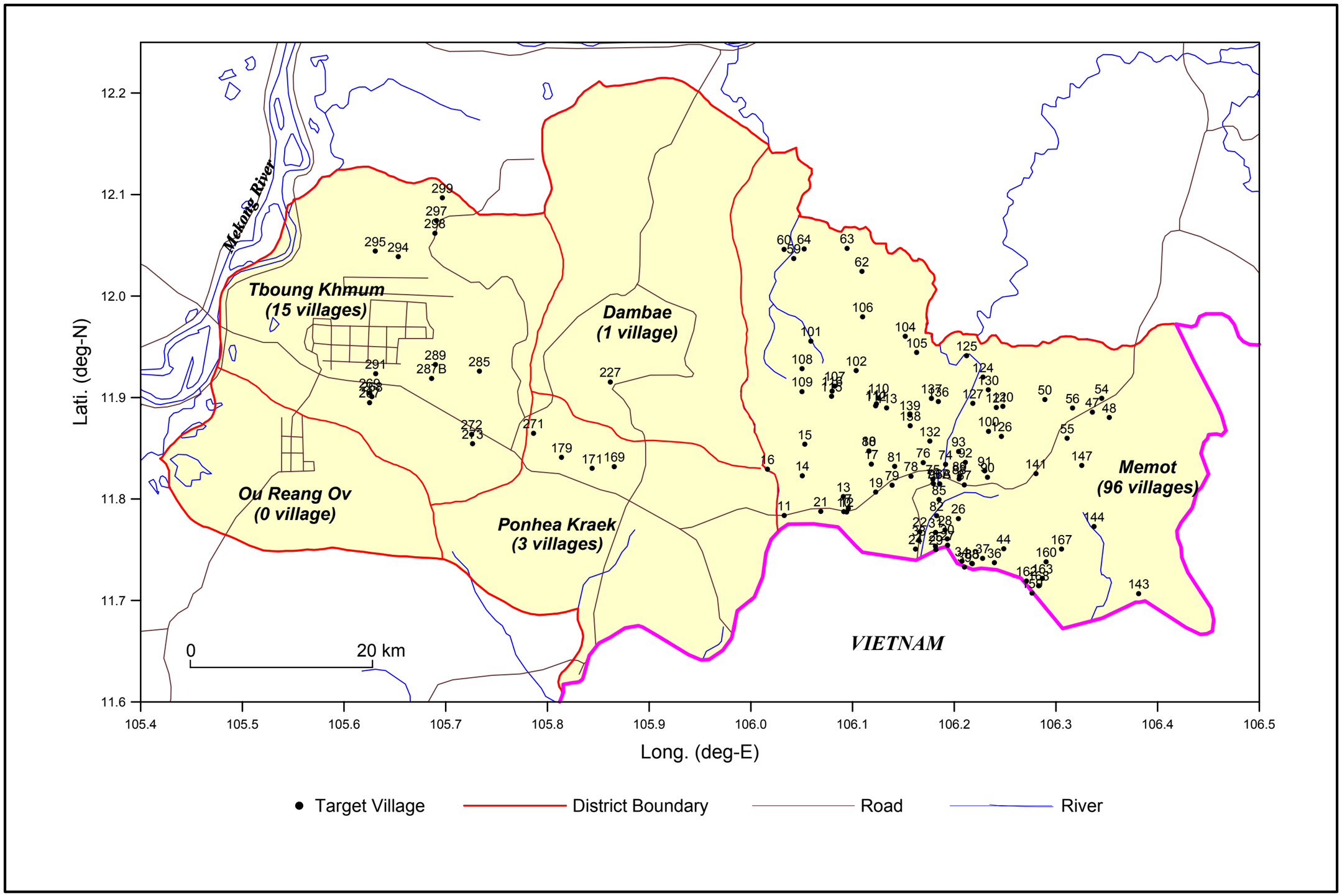


Figure 2-6: Location Map of Project Site

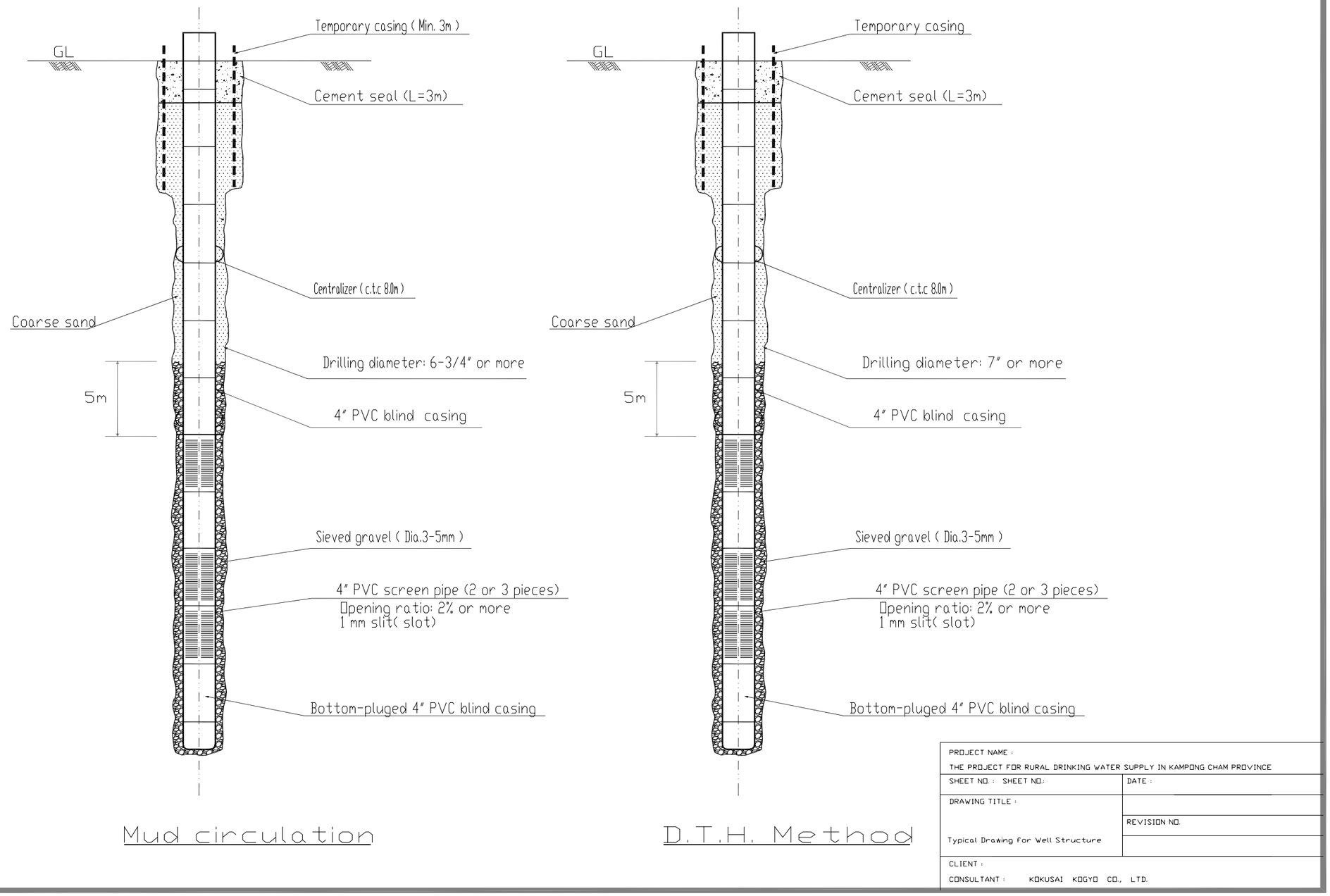
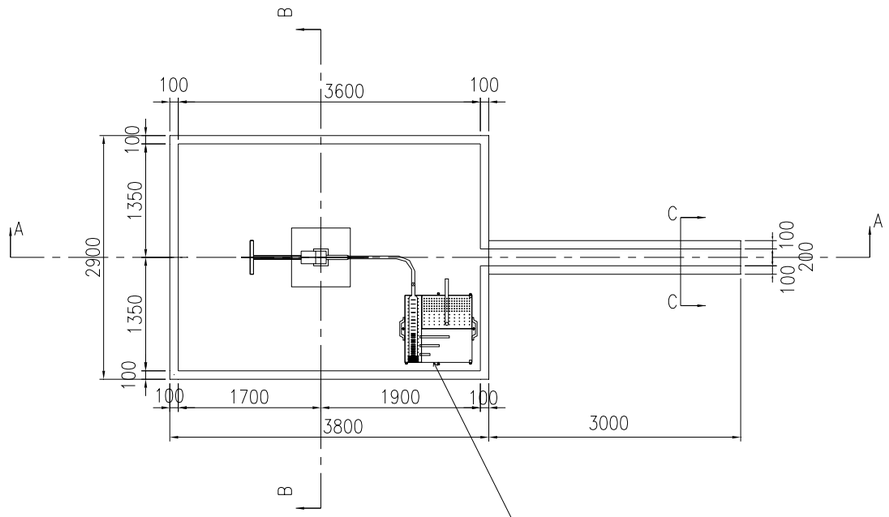
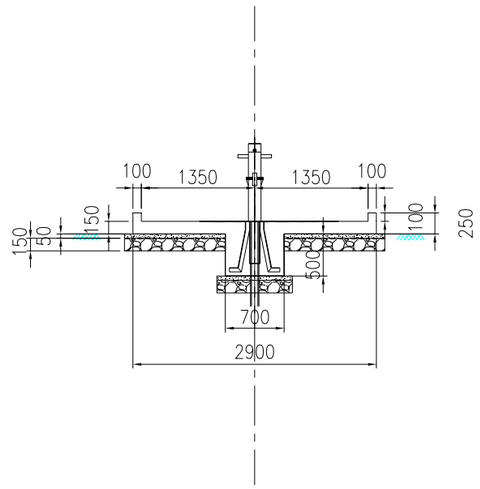
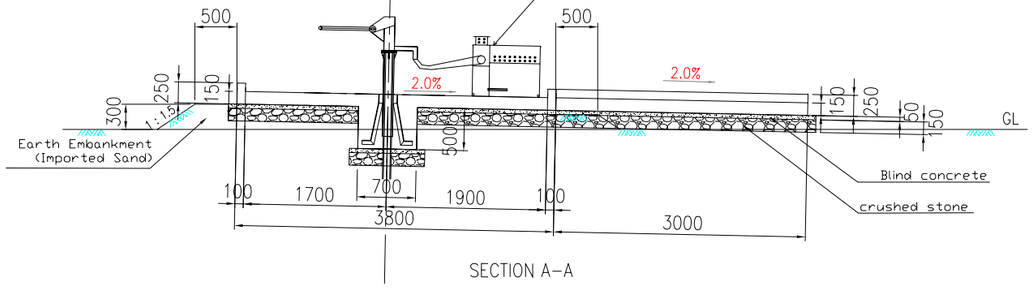


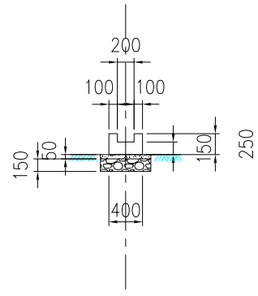
Figure 2-7: Well Structure





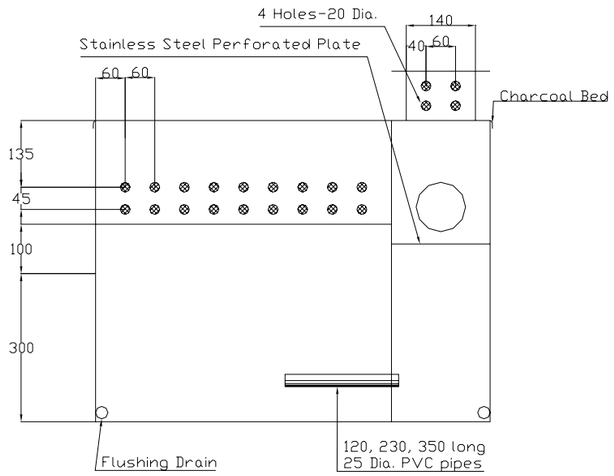
Iron Contents Reduce unit



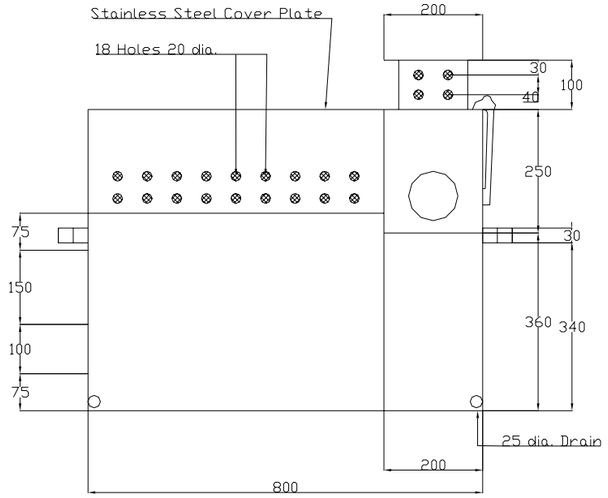


PROJECT NAME : THE PROJECT FOR RURAL DRINKING WATER SUPPLY IN KAMPONG CHAM PROVINCE	
SHEET NO. : SHEET NO.:	DATE :
DRAWING TITLE : PLATFORM Design	REVISION NO.
	Scale S=1/60
CLIENT :	
CONSULTANT : KOKUSAI KOGYO CO., LTD.	

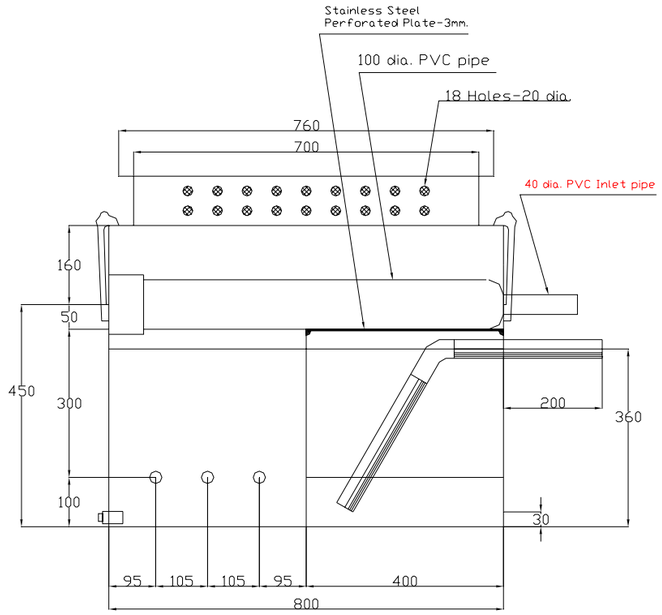
Figure 2-8: Platform



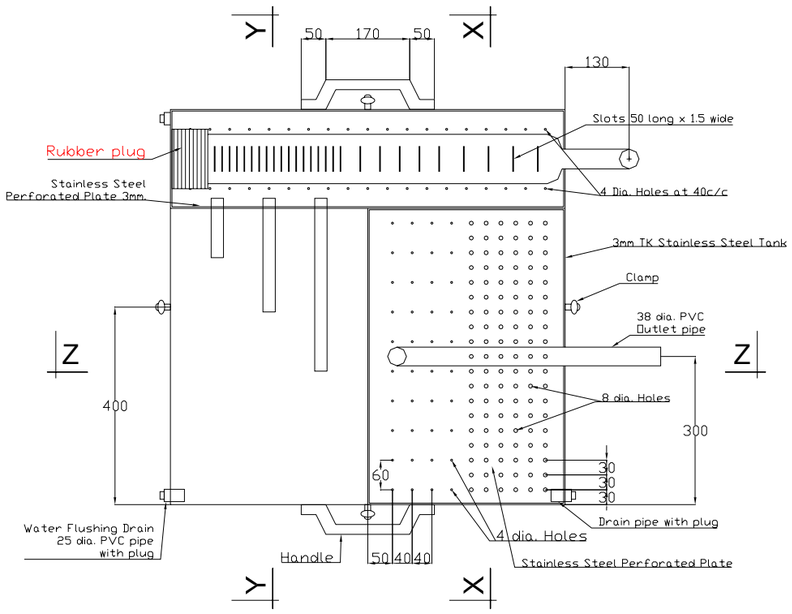
SECTION YY



SECTION XX



SECTION ZZ



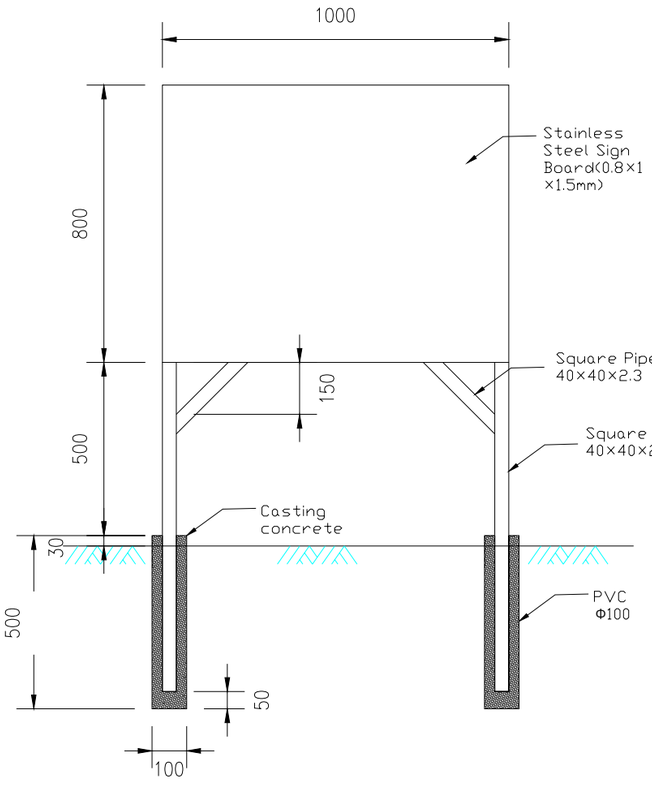
PLAN

NOTES :-

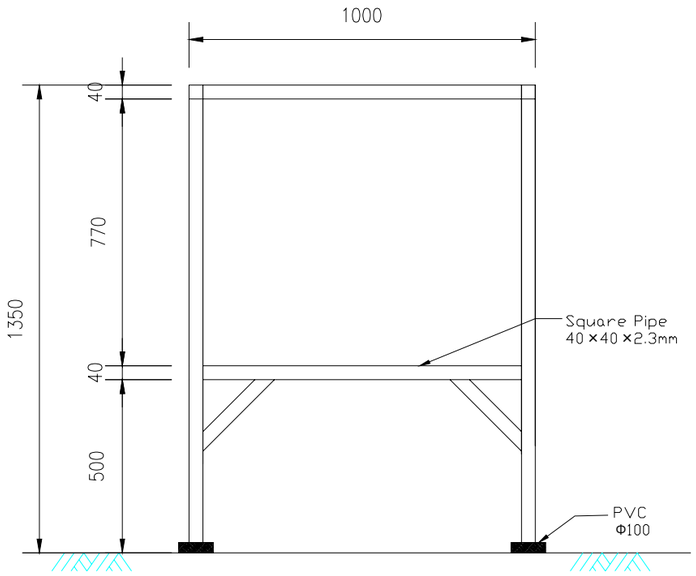
- The 100mm dia. PVC pipe should have slots on top of pipe.
  The size of slots shall be 50mm ctc in the first third, 40mm ctc in the middle third, and 10 ctc in the last third of the pipe measuring from inlet.
- All floors are to be slope towards the outlet.
- All 20 mm. dia. holes should be covered with PVC mesh.
- All dimensions are showing in millimeters.

PROJECT NAME : THE PROJECT FOR RURAL DRINKING WATER SUPPLY IN KAMPONG CHAM PROVINCE	
SHEET NO. : SHEET NO.:	DATE :
DRAWING TITLE : Iron Contents Reduce unit	REVISION NO.
	Scale : S=1/10
CLIENT :	
CONSULTANT : KOKUSAI KOGYO CO., LTD.	

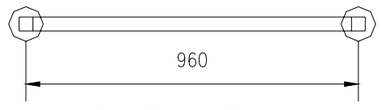
Figure 2-9: Iron Reducing Equipment



Sign Board Section



Sign Board Frame



Sign Board Top View

PROJECT NAME : THE PROJECT FOR RURAL DRINKING WATER SUPPLY IN KAMPONG CHAM PROVINCE	
SHEET NO. : SHEET NO.:	DATE :
DRAWING TITLE : SIGN BOARD PLAN	REVISION NO.
	Scale : 1/15
CLIENT :	
CONSULTANT : KOKUSAI KOGYO CO., LTD.	

Figure 2-10: Sign Board

2.2.4.8 Estimated Project Cost Covered by Japan's Grant Aid

(1) Estimated Project Cost Covered by Japan's Grant Aid

The estimated project cost covered by Japan's Grant Aid is as shown in Table 2-22 .

Table 2-22: Estimated Project Cost Covered by Japan's Grant Aid

The Project For Rural Drinking Water Supply in Kampong Cham Province in the Kingdom of Cambodia (Well Drilling Project)

Estimated Total Project Cost Approx. 868 million yen *

Kampong Cham Province 380 sites（380 wells）

Item		Estimated project cost (million yen)	
Facility	Well construction work, pumping test, water quality test, platform construction work, HP installation work, installation work of iron removal equipment, installation work of strengthening billboard	674	723
Equipment and material	Well logger, well cleaning equipment, pumping test materials, water quality equipment, truck with crane, pickup, motorbike, video set, projector set, computer set	49	
Detail design , Implementation/ Supervision of supplies, and Soft component			145

* This cost estimate is provisional and would be further examined by the Government of Japan for approval of the Grant.

(2) Estimation Conditions

Estimation of the cost of the project is based on the exchange rate and prices as of the end of October 2004.

1 US $ = 111.06 YEN (average for six months from May to end of October 2004)

2.3 Obligations of Recipient Country

2.3.1 Outline

The agency responsible for the project is DRWS. As long as the project is implemented by Japan's Grant Aid, it needs to follow the budgetary system of the Government of Japan. For official works to proceed smoothly, organizations concerned in Cambodia need to conduct the following works without delay.

(1) Procedures

- Contract based on Exchange of Notes (E/N) with Japanese consulting company
- Contracts based on E/N with Japanese contractors
- Prompt making of banking arrangements (B/A) at a Japanese foreign exchange bank and issuing of authorization to pay (A/P)
- Prompt payment of charges relating to B/A and A/P
- Permission for entry and issuing of long stay visas of Japanese nationals (consultants and contractors) working on the project
- Prompt customs clearance for equipment and materials procured under the project
- Exemption from tax for procured equipment and materials and for equipment and materials brought into the country by the Japanese parties concerned
- Prompt issuing of required certificates for completion in every phase of the project
- Acquisition of vehicle registration numbers for vehicles procured under the project
- Setup of an office for the Cambodian side and an allocation of supervisory staff

(2) Project

- Free lending of DRWS's equipment relating to drilling work to contractors
- Free lending of procured equipment to contractors
- Free provision of drilling staff to contractors
- Free provision of survey staff relating to drilling work to contractors
- Free provision of schedule supervision staff relating to drilling work to contractors
- Allocation of soft component staff for O&M and Hygiene Education (DRWS/ PDRD/DOD)
- Personnel costs for personnel from Cambodian Government
- Securing of well construction sites, leveling of land (WSUG)
- Road construction enabling trucks of drilling materials to access the sites (WSUG)
- Banking work around the constructed wells (WSUG)
- Tree-planting on the slope faces (WSUG)
- Procurement of filling material and installation of the iron-removal equipment (WSUG)

- Construction of terminal drainage channels from the well drainage ditches for water supply facilities (WSUG)
- Securing of the storage space for procured equipment
- Operational check of procured equipment on the spot (as per request by consultants)

(3) Organization and Institution

- Setup and securing of organization/ staff/ budget for O&M system of water supply facility (DRWS/ PDRD/ DOD)
- Development of system for monitoring O&M status of water supply facility
- Setup and securing of organization/ staff/ budget for O&M of procured equipment

2.3.2 Project Cost Covered by the Cambodian Government

Cambodia's obligations which Project Cost Covered by the Cambodian Government are as below Table 2-23.

Table 2-23: Project Cost Covered by the Cambodian Government

(Unit: US$)

Project Expenses	Phase 1	Phase 2	Total	Remarks
Drilling Material Depletion Cost	—	—	—	Material provided by Japan previously
Personnel Cost(drilling work)	23,400	23,400	46,800	9 staffs
Personnel Cost (Quality supervision)	26,000	26,000	52,000	5 staffs x 2 teams
Personnel Cost (Work schedule supervision)	2,600	2,600	5,200	1 staff
Personnel Cost (Soft Component)	7,800	7,800	15,600	3 staffs
Site Acquisition and Ground Leveling	—	—	—	WSUG resident participation
Preparation of Access Road	—	—	—	WSUG resident participation
Filling Soil for Platform	—	—	—	WSUG resident participation
Soil Foreslope Planting	—	—	—	WSUG resident participation
Iron Removal Equipment Installation and filling of filter Costs	—	—	—	WSUG resident participation
Drainage Construction Cost	—	—	—	WSUG resident participation
Bank Charge	4,000	4,000	8,000	Opening of B/P, Issuing of A/P
Total (US$)	63,800	63,800	127,600	
Total (Japanese yen)	7,100,000	7,100,000	14,200,000	

* Bank charge is based on the assumption of 0.05 % of estimated project cost.

2.4 Operation and Maintenance Plan

(1) Basic Policy

As the target area faces the following problems, there is concern about effective and sustained use of the water supply facilities constructed in the project.

- Inefficient and unfair distribution of Hand pump wells
- Insufficient conversion from use of unhygienic shallow wells to hand pump wells due to lack of residents' knowledge about hygiene
- Inadequate hand pump well repair system
- Low ability to bear repair costs
- Lack of support for O&M of village hand pump wells by PDRD and DOD

Solutions to the above problems and smooth implementation of O&M activities relating to the water supply facilities constructed in the project are expected through the following basic policies.

- Deciding on effective and fair well distribution using transparent methods
- Effective use of good quality wells through hygiene education
- Clear division and implementation of roles relating to repairs as follows:
  - Minor repairs are performed by the residents (Village Level Operation & Maintenance).
  - PDRD and DOD provide technical support to the villages.
  - Major repairs are performed by PDRD and DOD.
- A system for repair costs is set up as follows.
  - The total cost of minor repairs is borne by the users.
  - PDRD and DOD bear part of the cost of major repairs.
- To reinforce sustained use of hand pump wells, the soft component (support program for the enhancement of O&M skills), such as the formation of residents' organizations, reinforcement of the O&M system and hygiene education, is introduced.

(2) Operation and Maintenance System

A Water and Sanitation User's Group (WSUG) is established for each hand pump well. The group chooses a leader and caretakers and carries out daily inspections, cleaning, minor repairs and collection of repair costs.

A Village Water and Sanitation Committee (VWSC) is established in each village. The committee presides over the village WSUG and requests PDRD and DOD, the implementing agencies that support O&M, for repair of the facilities, delivery of spare parts, etc.

The overall structure of village well operation and maintenance is as shown in Figure 2-11, Figure 2-12 and Figure 2-13. The roles and structure of hand pump well O&M organizations are as follows:

1) Water and Sanitation User's Group (WSUG)

A) Role

- Operation and maintenance of the water supply facilities
- Minor repairs of the water supply facilities
- Collection of repair costs from users and payment to VWSC

B) Structure

- Group leader (1) : Acts as a coordinator for WSUG users. Decides the rules for using the hand pump wells. Implements the rules on use of the wells. Contacts VWSC when the well breaks down. Collects the repair costs.
- Caretakers (1 man, 1 woman) : Regularly inspect the Hand pump wells, perform repairs, clean around the wells, etc.

2) Village Water and Sanitation Committee (VWSC)

A) Role

- Planning of well distribution in the village
- Promotion of formation of WSUG and coordination of groups
- Contact point for village in negotiations with PDRD and DOD
- Safekeeping of repair reserve funds
- Technical support for WSUG in O&M of Hand pump wells

B) Structure

- Chairman (1): Acts as coordinator for WSUG, notifies DOD when a well breaks down, communicates with other administrative agencies, etc.
- Person in charge of management of the facilities (1) : Acts as coordinator in technical areas such as support for repair of the water supply facilities and procurement of spare parts
- Person in charge of hygiene education (1): Promotes hygiene education. Verifies the cleaning of each well
- Person in charge of accounts (1): Manages the water charges paid by WSUG. Reviews subsidies for major repairs, etc.

3) District Office of Development (DOD)

- Management of well inventory
- Regular visits to water supply facilities and repair, or arrangement for repair, of major breakdowns
- Provision of O&M education
- Technical support for WSUG regarding minor repairs

4) Provincial Department of Rural Development (PDRD)

- Supervision of DOD
- Technical support for DOD
- Support for procurement of spare parts
- Major repairs
- Guidance for setting up Village Water and Sanitation Committees and Water and Sanitation User's Groups
- Provision of hygiene education
- Fostering of private well repair firms

5) Private well contractor

A private well contractor shall carry out major repairs when necessary. The private well contractor shall carry out well repair on behalf of DOD and PDRD.

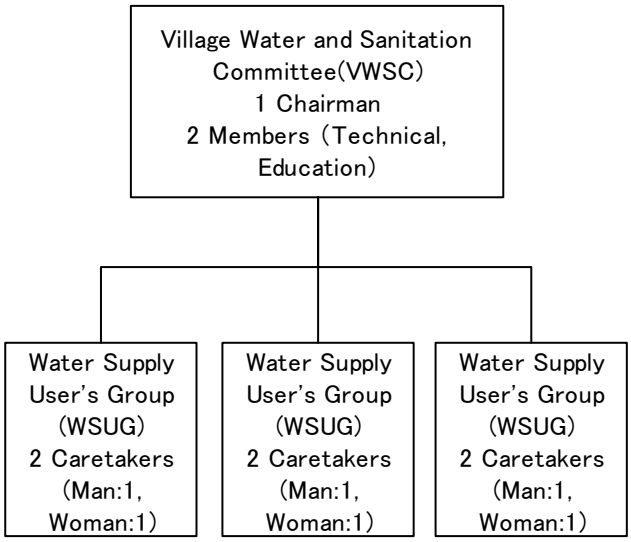


Figure 2-11: Structure of Village Well Operation and Maintenance

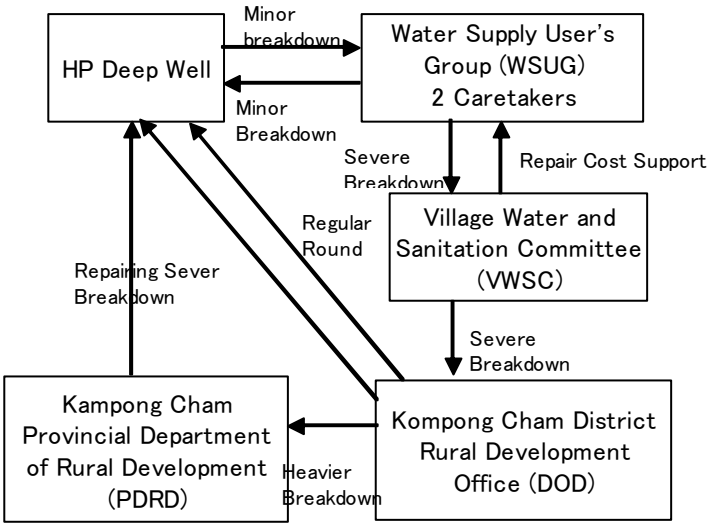


Figure 2-12: Overall Structure of Well Operation and Maintenance (without participation of private firms)

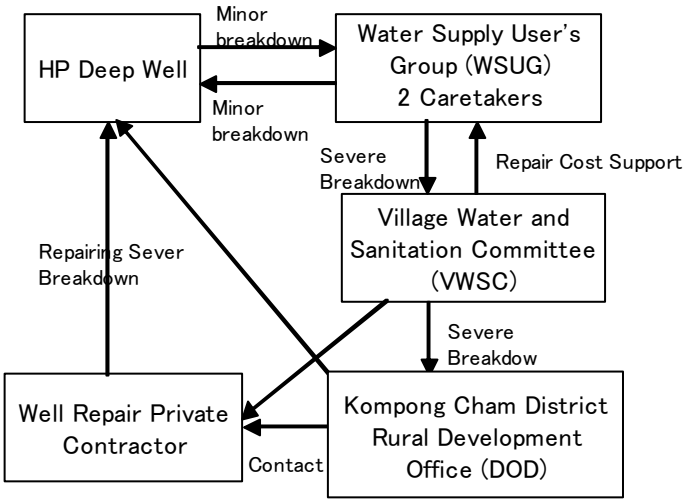


Figure 2-13: Overall Structure of Well Operation and Maintenance (with participation of private firms)

(3) Repair System of the Water Supply Facilities

1) Minor repairs

If the water supply facilities can be repaired easily, such as by changing the spare parts, the village purchases the necessary spare parts with its own funds and the caretaker changes the spare parts. DOD provides technical guidance to the village if necessary.

2) Major repairs

In the event of breakdown requiring special equipment and expert well technology, the village asks a competent private well constructor to carry out the repairs. However, in areas where there are no private well constructors, PDRD and DOD are asked to perform the repairs. Basically, the total cost of the repairs is borne by the village, but if necessary, PDRD and DOD bear part of the cost.

(4) Operation and Maintenance Costs

In other hand pump well projects in the target area, the practice of regularly contributing money for repair costs into a reserve fund often stopped after it had been started. The main reasons for this were the limited availability of a safe means of storing the money, the difficulty of assuring accountability for the stored funds, the possibility of using easy storage methods other than for the intended purpose, lack of understanding of the need for repair funds among residents and the infrequent need for repair costs due to infrequent breakdown. Accumulating reserve funds is particularly difficult in the target area because of the low amount of money in circulation.

Under these circumstances, the following methods are proposed to secure the necessary repair funds.

- Repair funds are collected when the amount residents are willing to pay in exchange for the benefit of having a hand pump well built is at its highest, in other words, before the well is built.
- VWSC deposits the repair funds collected before the well is constructed in a joint account at the Acelida Bank in the name of the VWSC. A joint account can be opened by three or more persons and the minimum deposit necessary to maintain the account is 200,000 riel. The Acelida Bank has branches in every region of Kampong Cham province.
- One of the conditions for building wells in a village is that VWSC deposits at least 200,000 riel as reserve funds for repairs. As it is difficult to impose contributions on the poor, cross subsidies are introduced by mutual aid in the village using this system to relieve the burden on the poor and secure repair funds.
- WSUG collects the cost of purchasing the necessary spare parts for minor repairs from users on a case-by-case basis.
- WSUG collects the costs necessary for major repairs from users on a case-by-case basis, but if there is a shortfall, the committee dips into the repair funds that were collected and deposited before construction of the well and grants a subsidy to WSUG.

(5) Spare Parts Supply System

The firm that supplies spare parts for hand pump wells has an office in Phnom Penh, but there is

no office or outlet store in Kampong Cham province. The main reason for this is that there are too few hand pump wells in Kampong Cham province at present. If the number of wells increases through implementation of this project, a store selling spare parts may be set up, but as this is not certain, plans are based on the current situation in which there are no private firms in Kampong Cham.

A standard set of spare parts required for about two years is sold by the distributor in Phnom Penh for 12 dollars. However, as the whereabouts of the store is unknown to most well users and virtually none of the villagers have business that would take them the long distance to Phnom Penh, it is hard to imagine the villagers in the target area actually going to the store to buy the spare parts.

As for the system whereby PDRD buys spare parts, stores them in the warehouse and supplies them to WSUG when necessary, there is concern because, in the past, Kampong Cham PDRD failed to adequately store and manage the spare parts supplied by Grant Aid.

A system is therefore proposed whereby DOD takes orders for spare parts as it goes round the villages and wells on its regular visits and when it has a certain number of orders, it contacts the dealer in Phnom Penh and obtains the spare parts by group purchase. There are a number of ways of purchasing and delivering the spare parts, such as the store delivering them directly to the village or WSUG that ordered them and receiving payment for them, or PDRD or DOD collecting money and buying the spare parts by group purchase, and the particular method used is chosen on a case-by-case basis.

To ensure reliable O&M for the first four years, it is planned to distribute one set of spare parts under the project, in addition to the set provided as accessories with the well equipment.

(6) Hygiene Education

As there are a large number of shallow wells in the target area, the question of water quality is more important than the question of quantity. In other words, even if good quality water resources are developed, unless there is a shift away from the unsanitary water that residents are used to drinking, an effective reduction in waterborne disease may not be seen. To avoid this, it is necessary for the residents to be fully aware of the importance of using good quality water by acquiring correct knowledge of hygiene, leading to a positive change in their attitude to water use. For this reason, hygiene education was carried out using exploratory wells as a pilot project during the Development Study, with the result that in the exploratory well survey carried out in the basic study three years later, it was found that residents had shifted from using shallow wells to hand pump wells, confirming that the hygiene education carried out in the Development Study was appropriate. The way of carrying out hygiene education used in the Development Study will therefore be used in the current project too.

More precisely, hygiene education is planned as follows:

- One-day training for hygiene education trainers will be held for PDRD and DOD

personnel.

- The hygiene education manual prepared in the Development Study will be used as teaching material, and the stock of teaching materials prepared in the past by UNICEF and WHO and supplied to DRWS will be used as support materials.
- The smallest organization responsible for administering water resources was called a Water Point Committee in the Development Study, but following recommendations in the development study report to emphasize hygiene, MRD changed the name to the Water and Sanitation User's Group. Consequently, hygiene education deals with three themes, "water", "sewage" and "garbage".

(7) Resident Participation

The objective of resident participation is to reinforce ownership through the participation of residents and heighten sustained use of the water supply facilities. Resident participation is limited to the following tasks, which do not affect the essential functions of the water supply facilities.

Table 2-24: Resident Participation Work

Resident Participation Work	% of Participation
Preparation of well construction sites. Carrying out of works such as removal of obstructions, cutting down of trees, ground leveling, etc., to prepare necessary sites for construction plots and temporary equipment storage space.	100%
Securing of road access for transporting well drilling equipment. Carrying out of works such as removal of obstacles, widening of roads, cutting down of trees, ground leveling, covering with gravel, etc., when necessary.	100%
Banking work during construction of platform. However, as the filling material affects the quality of construction, the contractor will supply good quality material.	Partial Participation as necessary
Planting on slope faces. Planting of plants available in the village area to prevent erosion of slopes and to maintain sanitary environment around the water supply facilities.	Partial Participation as necessary
Set up of iron removal devices when necessary, depending on water quality conditions and desire of residents. The iron removal devices will be provided by the contractor but the filter materials, i.e. aggregate, charcoal, etc. will be procured and set up by the residents.	Partial Participation as necessary
Stagnant water around the platform drainage ditch is not desirable in terms of sanitary conditions as it leads to accumulation of trash, penetration of dirty water into the well, breeding of mosquitoes, etc. Therefore, drainage channels will be constructed from the drainage ditch to the existing channels and fields to avoid stagnant water. This work will be done by residents.	100%

(8) Operation and Maintenance Plan for Procured Equipment

With the exception of the pickup trucks and motorbikes assigned to PDRD and DOD, all the O&M equipment procured in the project is assigned to DRWS.

The pickup trucks and motorbikes assigned to PDRD and DOD will be used for the soft component activities in this project. However, after completion of the project, they will be used for monitoring the operation and maintenance of facilities and to support hygiene education. DRWS has promised to secure budget for the fuel cost and O&M cost of the pickup trucks and motorbikes.

The Drilling Well Section and Water Analysis Section of the Drinking Water Division of DRWS, to which the survey and testing equipment is assigned, has some well drilling equipment, support vehicles, and survey and testing equipment donated in the Peri-Urban Project. The technical personnel gained experience in well logging, well development, pumping tests, and water analysis in the Peri-Urban Project and are judged to be proficient. After completion of the project, the equipment and vehicles will be used for quality control of well drilling works in future projects.

Of the equipment for operation and maintenance, the video set and projector set are assigned to the Survey and Design Section of the Design and Planning Division. This equipment will be used in the soft component activities in the project, in which instruction will be given on how to operate, maintain and use the equipment. However, after completion of the project, this equipment will be used in educational activities; work-shop, trainer training, etc. related to facility operation and maintenance and hygiene education in future projects.

As for the computer set, it will be assigned to the field office during implementation of the project for carrying out data input and database creation concerned with the well drilling works. After completion of the project, it will be assigned to the Planning and Statistics Section of the Design and Planning Division and will be used for creating databases in future projects.

Table 2-25: Assignment of equipment procured

Equipment	Place of assignment	No. of staff	Plan of use after completion of the project
Borehole logging equipment	Drilling Section, Drinking Water Division, DRWS	54	Quality control of well drilling works
Low-pressure compressor for well development	Drilling Section, Drinking Water Division, DRWS	54	Quality control of well drilling works and O&M of existing wells
Pumping test equipment	Drilling Section, Drinking Water Division, DRWS	54	Quality control of well drilling works
Water analyzer	Water Analysis Section, Drinking Water Division, DRWS	4	Quality control of well drilling works
Cargo truck with crane	Drilling Section, Drinking Water Division, DRWS	54	Transport of equipment for quality control of well drilling works
Pickup truck	Drilling Section, Drinking Water Division, DRWS	54	Transport of equipment for quality control of well drilling works
Pickup truck	Rural Water Supply Section, PDRD, Kampong Cham Province	5	Support for O&M of water supply facilities and monitoring

Equipment	Place of assignment	No. of staff	Plan of use after completion of the project
Motorbike	DOD（4 districts）: Memot, Ponhea Kraek, Dambae, Tboung Khmum	4	Support for O&M of water supply facilities, transport of O&M equipment, and monitoring
Video Set	Survey and Design Section, Design and Planning Division, DRWS	5	Seminars, workshops, educational activities, etc. concerned with O&M hygiene education.
Projector Set	Survey and Design Section, Design and Planning Division, DRWS	5	Seminars, workshops, educational activities, etc. concerned with O&M hygiene education.
Computer Set	Planning and Statistics Section, Design and Planning Division, DRWS	5	Development of groundwater and well database

(9) Operation and Maintenance Cost

The annual operation and maintenance cost of a well with HP is estimated as shown in Table 2-25, inclusive of spare parts cost, well cleaning cost, and HP replacement cost. The annual O&M cost necessary for one facility (average number of users: 210 people) is 110.8 US$, or 2.6 US$ per one household (5 family members) per year.

Table 2-26 Annual O&M Cost for Hand-pump Wells

No.	Item	Cost per unit	Qty	Amount	Remarks
1	Spare parts replacement	20	0.50	10.00	Once 2 years
2	Regular checkup PDRD staff per diem	15	0.50	15.00	Once a year
3	ditto. Round car cost	25	0.50	25.00	ditto.
4	Well cleaning cost	160	0.15	24.00	Once 7 years
5	ditto. DRWS staff per diem	15	0.15	2.25	ditto.
6	ditto. Round car cost	25	0.15	3.75	ditto.
7	Hand pump replacement	400	0.07	28.00	Once 15 years
8	ditto. DRWS staff per diem	15	0.07	1.05	ditto.
9	ditto. Round car cost	25	0.07	1.75	ditto.
	Total			110.80	

2.5 Other Relevant Issues

2.5.1 Soft Component

(1) Background to Planning the Soft Component

DRWS's basic policy is for operation and maintenance (O&M) of hand pump wells to be carried out by VLOM (Village Level Operation & Maintenance). However, in many projects involving the construction of wells, failure to set up O&M organizations and provide O&M education meant that villagers did not know how to perform even minor repairs or they did not have the special tools (fishing

tool) required for repairs. As a result, many wells that had broken down were left without being repaired.

Sustained use of water supply facilities requires that the villagers themselves are aware of hygiene and recognize the importance of having access to safe water. Hygiene education in the target area is provided by public health centers, but at the present time emphasis is placed on family planning, etc., and not enough is taught about water and sanitation. PDRD has a department that conducts sanitation activities, but they lack vigor and dynamism.

Under such circumstances, the following issues should be considered for improving the sustainability of water supply facilities constructed in this project.

- Setting up of sustained O&M organizations at the village level
- Enhancement of O&M skills at the village level
- Improvement of residents' awareness of hygiene
- Reinforcement of PDRD and DOD support for O&M activities and hygiene education in villages

(2) Target of the Soft Component

Based on the issues mentioned above, a support program (soft component) for operation and maintenance is implemented in this project to achieve the following goals.

- Setting up of a sustainable O&M system for water supply facilities at the village level
- Improvement of villagers' awareness of health and hygiene, effective use of the developed water resources and establishment of correct hygiene habits and behavior
- Development of O&M support capabilities of PDRD and DOD for the villages

(3) Results of the Soft Component

The concrete activities and achievements of the soft component are shown in Table 2-27.

Table 2-27: Project Activities and Results

Item	Activities	Results
Activities relating to launching the project	Explaining to PDRD and DOD staff and heads of villages targeted in the plan the objectives and content of the project and enlightenment program and the implementation plan, and requesting their cooperation.	Building of cooperation on the project among PDRD, DOD and village leaders and improvement of leadership skills
Activities relating to enlightenment education and establishment of organizations at village level	Visits to launch activities Establishment of VWSC Enlightenment education for residents and establishment of WSUG Building of consensus on introduction of wells for domestic use Temporary works, such as improving road access necessary for building wells, and well facilities (fences, surrounding slopes, etc.) Enlightenment relating to participation of residents in construction work	Smooth organization of VWSC Smooth organization of WSUG Enhancement of residents' awareness of WSUG Improvement of residents' understanding of project Reinforcement of residents' ownership of project
Activities relating to reinforcement of organization at community level	Holding of workshops to reinforce WSUG organization Holding of workshops on hand pump O&M skills for VWSC technical workers and WSUG caretakers Provision of hygiene education for VWSC technical workers, WSUG caretakers and users	Enhancement of capabilities and knowledge of WSUG personnel Enhancement of skills of WSUG caretakers in O&M of hand pumps Improvement in attitude towards hygiene by enhancing knowledge of hygiene among all users
Reinforcement of PDRD/DOD organization	Provision of training in essential repair techniques Holding of workshops on O&M support services for villages	Enhancement of major repair skills of PDRD/DOD Enhancement of PDRD/DOD technical support for villages

(4) Verification of Performance

The performance of the soft component is verified using a checklist. The checklist (draft) is as shown below, but it may be added to or amended in line with the actual situation when conducting soft component activities.

Table 2-28: Activity Outcomes and Performance Measure

Result	Means of Verifying Performance
Building of cooperation on the project among PDRD, DOD and village leaders and improvement of leadership skills	Are the objectives and content of the project understood?
	Are the significance, goals and content of the soft component of the project understood?
	Is the role of each group in the soft component understood?
Smooth organization of VWSC and WSUG	Are VWSC and WSUG established according to the O&M manual?
	Are members selected by the village assembly in a democratic manner?

Result	Means of Verifying Performance
	Has a method been decided for setting and collecting O&M charges?
Enhancement of residents' awareness of VWSC and WSUG	Is the need for VWSC and WSUG understood?
	Is the role of each member understood?
Enhancement of residents' understanding of the project	Has the description of the water supply facilities to be constructed been understood?
	Is the importance of O&M understood?
	Is the need for an O&M fund understood?
Reinforcement of village ownership of the project	Is the work to be undertaken by the residents understood and have the residents expressed their intention to participate?
	Have the well installation sites been decided democratically by a consensus of the residents?
Enhancement of the capabilities and knowledge of WSUG personnel	Is the role of each member understood?
	Do they understand how to use the facilities on a daily basis?
	Is the way of managing the O&M fund understood?
Improvement of WSUG caretakers' skills in O&M of the hand pumps	Can they perform minor repairs?
	Do they know how to procure spare parts?
	Do they know how to contact and request major repairs?
Improvement of attitude towards hygiene by enhancement of knowledge of hygiene among all users	Do they understand how to use safe water?
	Is the mechanism of contamination of groundwater by human waste understood?
	Is the mechanism of contamination of groundwater by garbage understood?
	Is the importance of cleaning around the water supply facilities understood?
Enhancement of the ability of PDRD/DOD to deal with major breakdowns	Do PDRD and DOD understand how to perform major repairs and procure the necessary materials and equipment?
	Do they understand the repair items that require DRWS support?
	Has a system been set up for contacting DRWS?
Enhancement of PDRD/DOD technical support for villages	Has a PDRD – DOD – VWSC/WSUG contact system been set up?
	Has a spare parts supply system been set up?
	Has a system been set up for regular monitoring of operation and maintenance?

(5) Soft Component Activities (Input Plan)

The soft component activities and input plans are shown in the tables below (Table 2-29, Table 2-30, and Table 2-31).

Table 2-29: Soft Component Activities and Input Plan (Entire Period)

No. of Villages: 115 villages
No. of Installation Spots: 380 points

No.	Item	Demand in units	Days	Content of Activity	Actual Work Operation Days						Work Operation Days in Calendar					
					Community Development Specialist		Sanitation Education Specialist		O&M Specialist		Community Development Specialist		Sanitation Education Specialist		O&M Specialist	
					Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian
A.1	Workshops for Implementing Agency (DRWS/PDRD/DOD)	3 times	3	・Project Guidance ・Roles of Implementing Agency ・Explanation of Implementation ・Creation of Detailed Implementation Plan	3.0	3.0	0.0	0.0	0.0	0.0	3.5	3.5	0.0	0.0	0.0	0.0
B.1	Kick-off "Explanation to Leaders of Villages"	115 villages	58	・Explanation of Outline of the Project ・Confirmation of Participation and Cooperation ・Request of Establishment of Sanitation Board	4.3	57.5	0.0	0.0	0.0	0.0	5.0	67.1	0.0	0.0	0.0	0.0
B.2	Residents Organisation Strengthening Workshop1 "Establishment of Village Sanitation Board"	115 villages	115	・Establishment of Sanitation Board, Selection of the Board Members ・Explanation of Outline of the Project ・Possibility of Groundwater Development ・The Need of O&M ・Reparing Reserve Fund ・Request of Residents Cooperation (Labor Power) ・Discussion and Determination of Location of Wells	8.6	115.0	0.0	0.0	0.0	0.0	10.0	134.2	0.0	0.0	0.0	0.0
B.3	Residents Organisation Strengthening Workshop2 "Establishment of Water Resources Association"	380 Wells	190	・ The Need and Roles of Water Resource Sanitation Association ・ Selection of persons in charge ・ Creation of Water Maintenance Association's Regulations	13.8	190.0	0.0	0.0	0.0	0.0	16.1	221.7	0.0	0.0	0.0	0.0
B.4	Residents Organisation Strengthening Workshop3 "Final Confirmation of Well Construction"	380 Wells	190	・Verification of Collecting Reparing Reserve Fund ・Location of Wells to be determined by Residents ・Contract of Well Constructions signed by Water Resource Sanitation Associations	13.8	190.0	0.0	0.0	0.0	0.0	16.1	221.7	0.0	0.0	0.0	0.0
C.1	Sanitation Education	273 Wells	137	1."Water" ・What is Safer Water？ ・Utilization of Groundwater ・Waterborne Diseases 2."Human Waste" ・Water Pollution and Diseases caused by Human Waste ・Adequate Treatment of Human Waste/Drainage(Use of Toilet Facilitiy and Usage etc.) 3.Garbage ・ Water Pollution Cuased by Garbage/ Pollution of Living Environment ・ Adequate Treatment of Domestic Waste, etc.	0.0	0.0	11.2	136.5	0.0	0.0	0.0	0.0	13.0	159.3	0.0	0.0
A.2	Training for Repairing Wells	2 times	2	・Training of Repairing Skills for PDRD/DOD staff and Local Subcontractors ・Provision of Well Registry Book to DOD staff and Local Subcontractors ・Creation and Custody of Well Registry Book of Local Subcontractors	0.0	0.0	0.0	0.0	2.0	2.0	0.0	0.0	0.0	0.0	2.3	2.3
E.1	O&M Training	273 Wells	137	1.Roles of Water Resources Association 2.Management and O&M ・Daily Checkup of Pumps ・Cleaning ・Repair of Minor Trouble ・Handling of Severe Breakdown ・Usage Regulations of the Facility ・How to Procure Spair Parts	0.0	0.0	0.0	0.0	11.2	136.5	0.0	0.0	0.0	0.0	13.0	159.3
				Total (MD)							50.7	648.1	13.0	159.3	15.3	161.6
				Total (MM)							1.8	21.7	0.5	5.4	0.6	5.5
															Ground Total (MM)	2.9	32.6

Table 2-30: Soft Component Activities and Input Plan (Phase I)

No. of Villages: 56 villages
No. of Installation Spots: 173 points

No.	Item	Demand in units	Days	Content of Activity	Ratio		Actual Work Operation Days						Work Operation Days in Calendar					
							Community Development Specialist		Sanitation Education Specialist		O&M Specialist		Community Development Specialist		Sanitation Education Specialist		O&M Specialist	
					Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian
A.1	Workshops for Implementing Agency (DRWS/PDRD/DOD)	2 times	2	・Project Guidance ・Roles of Implementing Agency ・Explanation of Implementation ・Creation of Detailed Implementation Plan	100%	100%	2.0	2.0					2.3	2.3	0.0	0.0	0.0	0.0
B.1	Kick-off "Explanation to Leaders of Villages"	56 village	28	・Explanation of Outline of the Project ・Confirmation of Participation and Cooperation ・Request of Establishment of Sanitation Board	10%	100%	2.8	28.0					3.3	32.7	0.0	0.0	0.0	0.0
B.2	Residents Organisation Strengthening Workshop1 "Establishment of Village Sanitation Board"	56 village	56	・Establishment of Sanitation Board, Selection of the Board Members ・Explanation of Outline of the Project ・Possibility of Groundwater Development ・The Need of O&M ・Reparing Reserve Fund ・Request of Residents Cooperation (Labor Power) ・Discussion and Dete	10%	100%	5.6	56.0					6.5	65.3	0.0	0.0	0.0	0.0
B.3	Residents Organisation Strengthening Workshop2 "Establishment of Water Resources Association"	173 well	87	・ The Need and Roles of Water Resource Sanitation Association ・ Selection of persons in charge ・ Creation of Water Maintenance Association's Regulations	10%	100%	8.7	86.5					10.1	100.9	0.0	0.0	0.0	0.0
B.4	Residents Organisation Strengthening Workshop3 "Final Confirmation of Well Construction"	173 well	87	・Verification of Collecting Reparing Reserve Fund ・Location of Wells to be determined by Residents ・Contract o	10%	100%	8.7	86.5					10.1	100.9	0.0	0.0	0.0	0.0
C.1	Sanitation Education	173 well	87	1."Water" ・What is Safer Water？ ・Utilization of Groundwater ・Waterborne Diseases 2."Human Waste" ・Water Pollution and Diseases caused by Human Waste ・Adequate Treatment of Human Waste/Drainage(Use of Toilet Facilitiy and Usage etc.) 3.Garbage ・ Water Pol	10%	100%			8.7	86.5			0.0	0.0	10.1	100.9	0.0	0.0
A.2	Training for Repairing Wells	1 time	1	・Training of Repairing Skills for PDRD/DOD staff and Local Subcontractors ・Provision of Well Registry Book to DOD staff and Local Subcontractors ・Creation and Custody of Well Registry Book of Local Subcontractors	100%	100%					1.0	1.0	0.0	0.0	0.0	0.0	1.2	1.2
E.1	O&M Training	173 well	87	1.Roles of Water Resources Association 2.Management and O&M ・Daily Checkup of Pumps ・Cleaning ・Repair of Minor Trouble ・Handling of Severe Breakdown ・Usage Regulations of the Facility ・How to Procure Spair Parts	10%	100%					8.7	86.5	0.0	0.0	0.0	0.0	10.1	100.9
											Total (MD)		32.3	302.2	10.1	100.9	11.3	102.1
											Total (MM)		1.1	10.1	0.4	3.4	0.4	3.5
																Ground Total (MM)	1.9	17.0

Table 2-31: Soft Component Activities and Input Plan (Phase II)

No. of Villages: 59 villages
No. of Installation Spots: 207 points

No.	Item	Demand in units	Days	Content of Activity	Ratio		Actual Work Operation Days						Work Operation Days in Calendar					
							Community Development Specialist		Sanitation Education Specialist		O&M Specialist		Community Development Specialist		Sanitation Education Specialist		O&M Specialist	
					Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian	Japanese	Cambodian
A.1	Workshops for Implementing Agency (DRWS/PDRD/DOD)	1 time	1	・Project Guidance ・Roles of Implementing Agency ・Explanation of Implementation ・Creation of Detailed Implementation Plan	100%	100%	1.0	1.0					1.2	1.2	0.0	0.0	0.0	0.0
B.1	Kick-off "Explanation to Leaders of Villages"	59 village	30	・Explanation of Outline of the Project ・Confirmation of Participation and Cooperation ・Request of Establishment of Sanitation Board	5%	100%	1.5	29.5					1.7	34.4	0.0	0.0	0.0	0.0
B.2	Residents Organisation Strengthening Workshop1 "Establishment of Village Sanitation Board"	59 village	59	・Establishment of Sanitation Board, Selection of the Board Members ・Explanation of Outline of the Project ・Possibility of Groundwater Development ・The Need of O&M ・Reparing Reserve Fund ・Request of Residents Cooperation (Labor Power) ・Discussion and Determination of Location of Wells	5%	100%	3.0	59.0					3.4	68.8	0.0	0.0	0.0	0.0
B.3	Residents Organisation Strengthening Workshop2 "Establishment of Water Resources Association"	207 well	104	・ The Need and Roles of Water Resource Sanitation Association ・ Selection of persons in charge ・ Creation of Water Maintenance Association's Regulations	5%	100%	5.2	103.5					6.0	120.8	0.0	0.0	0.0	0.0
B.4	Residents Organisation Strengthening Workshop3 "Final Confirmation of Well Construction"	207 well	104	・Verification of Collecting Reparing Reserve Fund ・Location of Wells to be determined by Residents ・Contract of Well Constructions signed by Water Resource Sanitation Associations	5%	100%	5.2	103.5					6.0	120.8	0.0	0.0	0.0	0.0
C.1	Sanitation Education	100 well	50	1."Water" ・What is Safer Water? ・Utilization of Groundwater ・Waterborne Diseases 2."Human Waste" ・Water Pollution and Diseases caused by Human Waste ・Adequate Treatment of Human Waste/Drainage(Use of Toilet Facilitiy and Usage etc.) 3.Garbage ・ Water Pollution Cuased by Garbage/ Pollution of Living Environment ・ Adequate Treatment of Domestic Waste, etc.	5%	100%			2.5	50.0			0.0	0.0	2.9	58.3	0.0	0.0
A.2	Training for Repairing Wells	1 time	1	・Training of Repairing Skills for PDRD/DOD staff and Local Subcontractors ・Provision of Well Registry Book to DOD staff and Local Subcontractors ・Creation and Custody of Well Registry Book of Local Subcontractors	100%	100%					1.0	1.0	0.0	0.0	0.0	0.0	1.2	1.2
E.1	O&M Training	100 well	50	1.Roles of Water Resources Association 2.Management and O&M ・Daily Checkup of Pumps ・Cleaning ・Repair of Minor Trouble ・Handling of Severe Breakdown ・Usage Regulations of the Facility ・How to Procure Spair Parts	5%	100%					2.5	50.0	0.0	0.0	0.0	0.0	2.9	58.3
											Total (MD)		18.4	345.9	2.9	58.3	4.1	59.5
											Total (MM)		0.7	11.6	0.1	2.0	0.2	2.0
																	Ground Total (MM)	1.0	15.6

(6) Procurement of Resources for Implementing the Soft Component

The soft component is implemented by Japanese consultants and local consultants. Due to the long period of activities, costs such as company expenses when procuring from a local consultant firm or NGO will mount up. For this reason, when procuring a local consultant, the qualifications, record, etc. of the consultants should be examined separately by individual interviews and the Japanese consultant should employ the consultant considered most suitable.

(7) Soft Component Implementation Process

The flowchart of soft component activities and the implementation process are shown in Table 2-32.

Table 2-32: Flowchart of Soft Component Activities

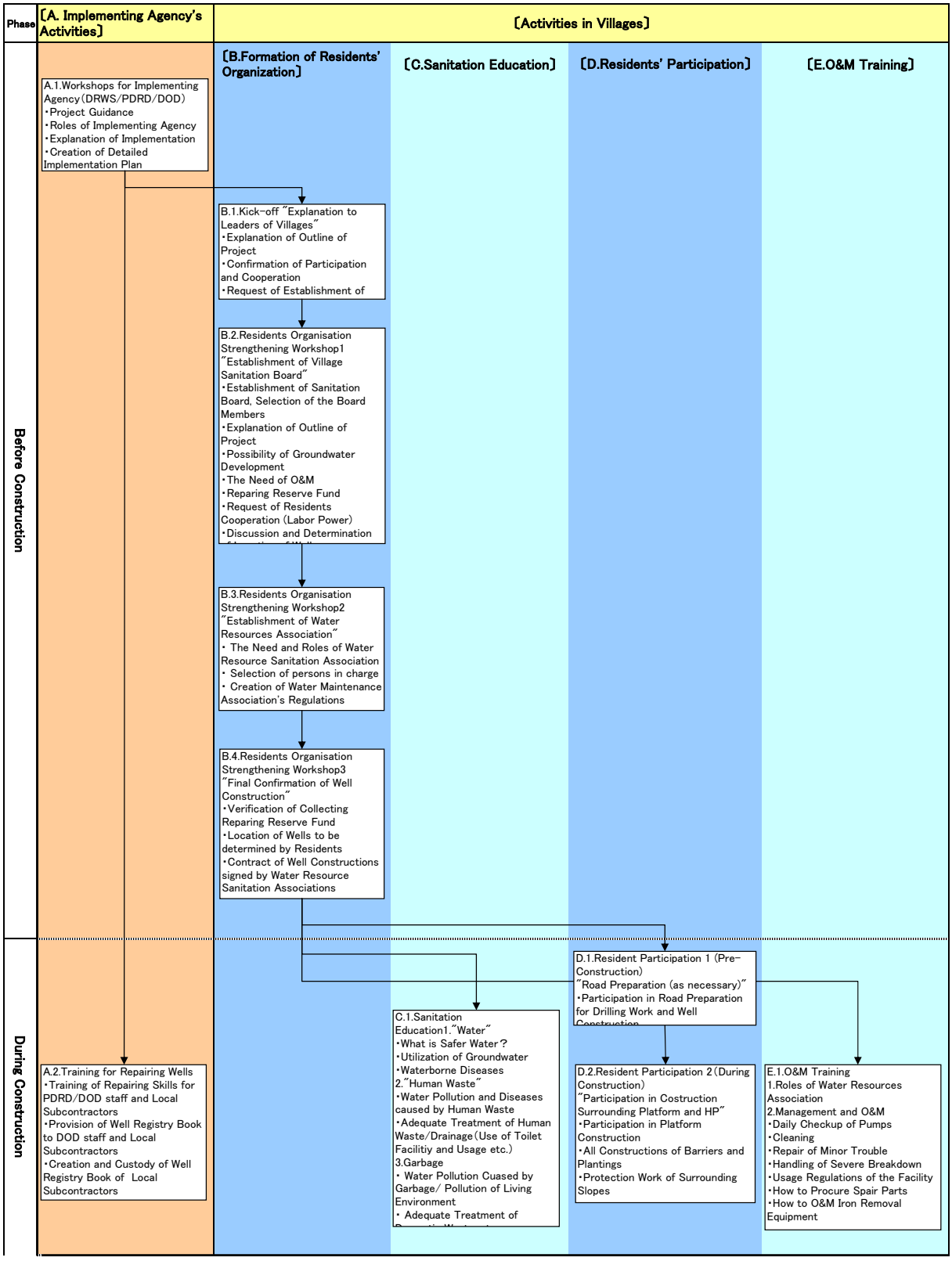
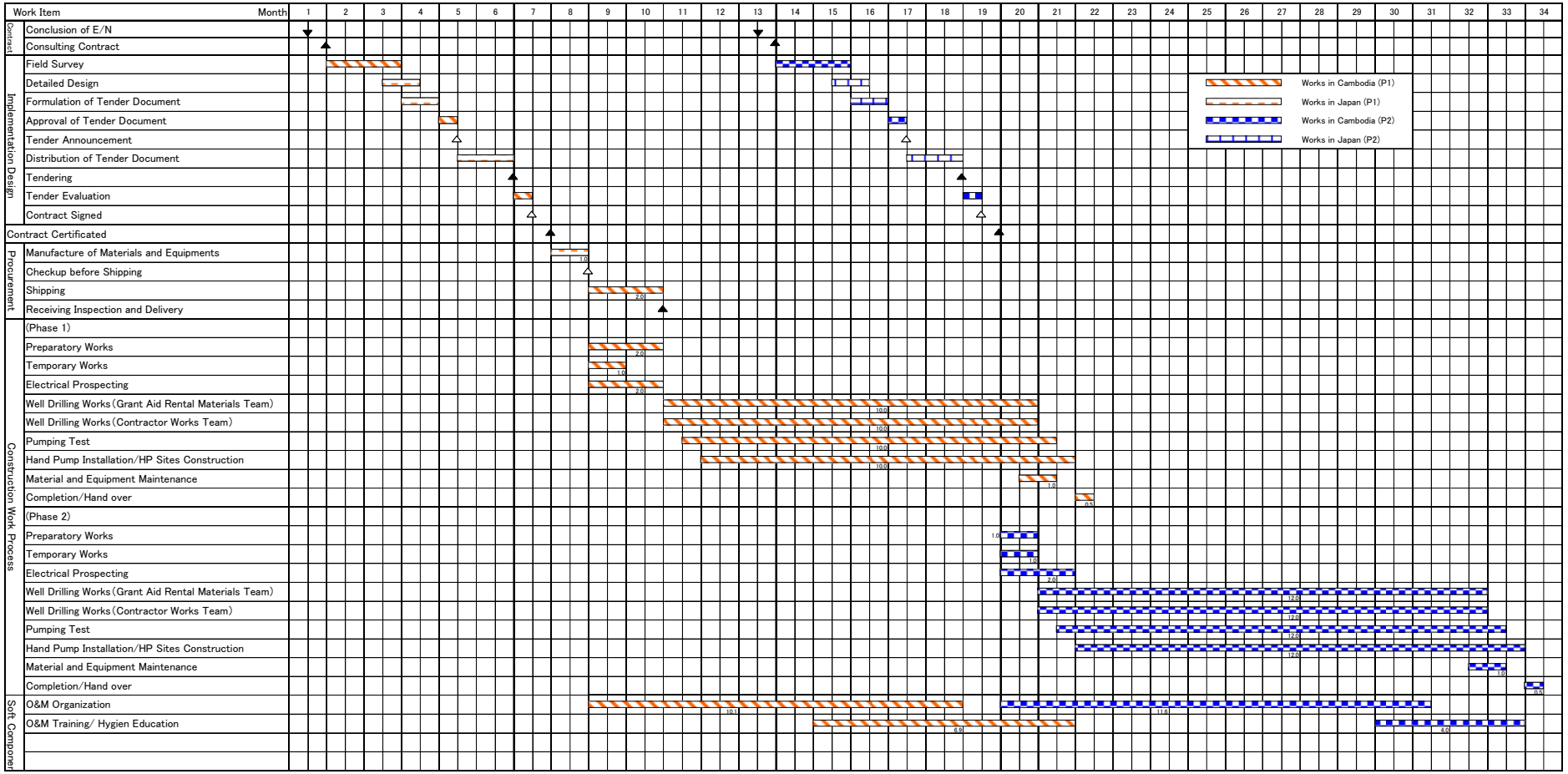


Table 2-33: Soft Component Implementation Process



(8) Products of the Soft Component

- Completion report (Government of recipient country, government of Japan)
- Soft component implementation status report (submitted upon return to Japan each time a Japanese consultant is dispatched)
- Operation and maintenance manual
- Rules for use of facilities
- O&M training implementation report
- Hygiene education manual
- Hygiene education implementation report

(9) Estimated Cost for Soft Component

Phase 1: 9.0 million Yen

Phase 2: 6.0 million Yen

Total : 15.0 million Yen

(10) Responsibilities of the Implementing Agency

The implementing agency bears the following responsibilities.

- Provision of counterparts for implementation of soft component activities
- Regular visits to all wells by PDRD and DOD personnel and implementation of O&M support activities

The roles of the parties concerned, including the implementing agency, are shown in Table 2-34 below.

Table 2-34: Role of Concerned Party

Concerned Party	Role
Japanese consultant	• Overall supervision of residents' enlightenment program and submission of reports to client and JICA • Control of construction work quality and processes and coordination with concerned parties • Preparation of execution plan for soft component program • Training of local consultants in soft component implementation methods • Holding of workshops for PDRD, DOD, villages and WSUG • Technical guidance relating to repair and O&M of hand pumps
Local consultant	• Holding of workshops for PDRD, DOD, villages and WSUG by hired consultant • Holding of mini-workshops to reinforce organization of WSUG • Training in inspection and repair of hand pumps for WSUG caretakers • Activities report to consultant and counterpart during absence of Japanese consultant

Concerned Party	Role
Implementing agency (DRWS)	• Overall management of program with cooperation of Japanese consultant and submission of report to headquarters • Request for cooperation to other ministries and agencies regarding implementation of program • Coordination of construction work processes and coordination with concerned parties • Holding of workshops for PDRD, DOD, villages and WSUG • Monitoring after construction of water supply facilities • Technical guidance relating to repair and O&M of hand pumps for WSUG
PDRD	• Holding of workshops for WSUG • Monitoring after construction of water supply facilities • Technical guidance relating to repair and O&M of hand pumps for WSUG
DOD	• Holding of workshops for WSUG • Monitoring after construction of water supply facilities • Technical guidance relating to repair and O&M of hand pumps for WSUG
VWSC	• Coordination of village water supply projects and contact point for PDRD, DOD and donors • Building of village-wide consensus on water supply plan and planning of water coverage • Management and safekeeping of repair funds • Subsidies for major repairs • Technical support for WSUG and storage of special repair tools for hand pump wells
WSUG	• Determination of installation sites for water supply facilities • O&M of water supply facilities • Storage of spare parts for hand pump wells

Chapter 3 Project Evaluation and Recommendations

Chapter 3 Project Evaluation and Recommendations

3.1 Project Effect

The effects of project implementation in regard to the project goal "to improve the coverage of safe and stable water supply" are summarized below.

A) Safe water will be supplied to village people.
B) The implementing agency's technical capacity for well drilling will be improved.
C) A system for sustainable operation and maintenance of water supply facilities will be established.

The improvement of the current situation to be realized through implementation of the project is shown in Table 3-1.

Table 3-1: Improvement to the current situation through implementation of the project

Current Situation and Issues	Measures (Japan's Grant Aid)	Effect / Degree of improvement
Residents in the study area rely on water sources such as shallow wells, which dry up easily in the dry season and are contaminated with fecal coliform, etc., for their drinking water. It is difficult to secure a safe and stable supply of water. Therefore, water-borne diseases are prevalent and water pumping work is a burden to residents.	・Construction of 380 water supply facilities in 115 villages	・Provision of safe drinking water to expected population of 108,400 persons ・ Improvement of water supply coverage from 9.5% to 82.3% ・Reduction in incidence of water borne diseases ・Lessening of water pumping work
DRWS and the private sector lack experience in survey and testing techniques for well drilling such as geophysical survey, borehole logging, pumping tests, water analysis, etc. and do not have adequate equipment.	・Procurement of testing and survey equipment for well drilling. ・ Transfer of testing and survey technologies by a Japanese engineer	・Placement of testing and survey equipment at DRWS ・Improvement of technical capacity of DRWS personnel ・ Improvement of well drilling capacity in Cambodia through the transfer of techniques from DRWS to the private sector
・In the study area, no system has been established for continuous operation and maintenance of water supply facilities. ・As the residents are not given instruction on how to maintain and repair hand pumps, existing water facilities that have broken down	・ Support activities for the establishment of resident organizations for O&M, training for O&M of water supply facilities and hygiene education. (Soft component)	・Establishment of WSUG in 380 water supply facilities. ・Collection of O&M fund. ・Ability to carry out water facility maintenance by village people themselves. ・ Establishment of system for sustainable O&M support by

Current Situation and Issues	Measures (Japan's Grant Aid)	Effect / Degree of improvement
have been neglected. ・Public awareness of hygiene issues such as safe water use is low; therefore, water contaminated with fecal coliform, etc. is often used directly for drinking water.		DRWS, PDRD, DOD. ・ Improvement of hygiene awareness by village people of the need for safe water. ・Ability for sustainable operation and maintenance of water supply facility.

Water supply ratio had calculated based on one deep well with hand pump for 210 personnel.

3.2 Recommendations

In order to ensure the sustainability of the effects of the overall project, DRWS shall address the following issues:

(1) Continuation of the support activities for maintenance of water supply facilities

For sustainable maintenance of water supply facilities, DOD, PDRD and DRWS shall continuously support the village level activities by WSUG and VDC.

The implementing agency, DRWS shall have a general understanding of village level O&M activities and support activities by DOD and PDRD, and provide advice and guidance when necessary. DRWS shall have a general understanding of the items below.

- Communication system between WSUG, VDC, DOD, PDRD and DRWS
- Monitoring system by DOD and PDRD
- Repair system and capacity of WSUG and PDRD
- Supply system of hand pump spare parts from local agent

(2) Dissemination of well drilling technologies to private sector

Testing and survey techniques, such as geophysical surveys, borehole logging, pumping tests and water analysis, are necessary items to improve the success rate of well drilling and to find better water sources. However, DRWS and private companies do not even have adequate equipment. Therefore, this project will provide testing and survey equipment and also carry out technology transfer for DRWS.

Based on the national water supply and sanitation policy, which specifies the encouragement of public sector participation in the water supply sector, private companies will play a greater role in well drilling works in the future. Therefore, it is important that the DRWS improve the well drilling capacity in Cambodia, by transferring the well drilling techniques it will acquire to the private sector using the survey and testing equipment provided in this project.

3.3 Relevance of the project

(1) Consistency with priority projects

The priority projects in Cambodia, include the CDMG s which set the goal to increase the water supply coverage of sustainable and safe drinking water in rural areas to 50% by the 2015. In the event that this project is implemented, the water coverage rate in the target villages will be improved from 9.5% in 2004 to 82.3% by the target year 2010. Therefore, the project is relevant.

(2) Consistency with policy

The revised national water supply and sanitation policy, approved by the Prime Minister on September 17, 2004, specifies that the DRWS will play the role as leader in the rural water supply and sanitation sector in Cambodia and will also be responsible for encouraging gradual participation by the private sector and building its capacity in this field. Through implementation of this project, the technical capacity of DRWS for well drilling will be improved, and they will disseminate the techniques they acquire to the private sector. Therefore, this project is relevant.

(3) Duplication with other donor projects

There are three ongoing projects in Kampong Cham, namely the MIME-WB Peri-Urban Water Supply Project, the SEILA program and the Social Fund; however, they do not overlap with the target villages of this project. In addition, as the Kampong Cham PDRD will coordinate the target villages between projects, it will be possible to avoid duplication with future projects. Therefore, the project is relevant.

(4) Necessity and urgency of safe water supply

In the target area, the main water sources include shallow hand-dug wells, rivers and ponds. However, despite the fact that they are contaminated with fecal coliform, etc. these water sources are utilized for drinking water. As a result, water-borne diseases such as diarrhea and typhus are widespread. Meanwhile, in 93 of the 115 villages to be targeted in this project , there is no safe water supply such as deep wells and the water supply coverage of safe water is low at 9.5%; thus, there is a great need for safe water. Therefore, the improvement of water supply conditions in the planned target villages is an urgent matter and the project is relevant.

(5) Sustainability of O&M

In the pilot project of the development study implemented in 2001, O&M training was conducted for the residents and tools and spare parts for repairs were provided. As a result, the residents themselves have been carrying out minor repairs and the operation rate of hand pump wells as of 2004 is high,

indicating that the VLOM are functioning well. Cases where caretakers who received O&M training in the pilot project carried out repair work on wells in other projects have also been confirmed. Therefore, if O&M training is provided to the residents, the VLOM will function well for carrying out minor repairs, and this is likely to contribute to enhancing sustainability of well use. Implementation of the project is, therefore, considered relevant.

(6) Potential for Groundwater Development

In the development study, the target area of this project was confirmed to be an area with high potential for groundwater development in terms of water volume and water quality. In this basic design study as well, the potential for groundwater development was reconfirmed by conducting studies on natural conditions such as geophysical surveys, water quality analysis, etc. As a result, the success rate of well drilling is expected to be high at 90%, which will lead to a reduction in the project cost. The project is, therefore, relevant.

Moreover, as water quality is directly linked to the residents' desire to use the water, to operate and maintain the water facilities, etc., the high potential for water quality makes implementation of the project relevant in terms of sustainability of O&M.

3.4 Conclusion

In the event that this project is implemented, numerous effects are expected such as a great increase in the water supply coverage of safe drinking water, a reduction in water-borne diseases, enhancement of DRWS's technical capacity for well drilling, establishment of an O&M system for water supply facilities, the raising of hygiene awareness of residents, and so on. In addition, from the viewpoint of consistency with priority projects, consistency with policy, duplication with projects by other donors, necessity and urgency of safe water, sustainability of O&M, and potential for groundwater development, implementation of the project is relevant.

However, in order to realize sustainability of the project effects, DRWS must take the initiative to solve the following issues:

Continuation of support activities for O&M of water supply facilities

Dissemination of survey and testing techniques for well drilling

[Appendices]

1. ***Member List of the Study Team***
2. ***Study Schedule***
3. ***List of the Parties Concerned in the Recipient Country***
4. ***Minutes of Discussions***
5. ***References and Documents***

1. Member List of the Study

(1) Basic Design Study (3rd Oct, 2004 - 31 Oct, 2004)

No	Member	Duty	Organization
1.	Mr. Juro CHIKARAISHI	Team Leader	JICA
2.	Mr. Shinsaku FUKAZAWA	Project Coordinator	JICA
3.	Mr. Satoshi ISHIDA	Chief Consultant/ Water Supply Planner	Kokusai Kogyo Co.,Ltd.
4.	Mr. Hisayuki UKISHIMA	Equipment Planner	Kokusai Kogyo Co.,Ltd.
5.	Mr. Kunio FUJIWARA	Groundwater Development Planner/Geophysical Survey	Kokusai Kogyo Co.,Ltd.
6.	Mr. Akira DOI	Social Survey/O&M Planner	Kokusai Kogyo Co.,Ltd.
7.	Mr. Shigeki KIHARA	Water Quality Survey/ Environment	Kokusai Kogyo Co.,Ltd.
8.	Mr. Yoshiharu NAKAMURA	Procurement/Cost Planner	Kokusai Kogyo Co.,Ltd.

(2) Discussion of Basic Design Study Draft Report (31 Jan, 2005 - 10 Feb, 2005)

No	Member	Duty	Organization
1.	Mr. Hiroto MITSUGI	Team Leader	JICA
2.	Mr. Jiro TAKEICHI	Project Coordinator	JICA
3.	Mr. Satoshi ISHIDA	Chief Consultant/ Water Supply Planner	Kokusai Kogyo Co.,Ltd.
4.	Mr. Hisayuki UKISHIMA	Equipment Planner	Kokusai Kogyo Co.,Ltd.
5.	Mr. Hiroshi FUJITA	Procurement/Cost Planner	Kokusai Kogyo Co.,Ltd.

2. Study Schedule

(1) Basic Design Study

No.	Date		Official Members(1 and 2)		Consultant Members (3,4 and 8)	Consultant Members (5,6 and 7)
1	10/3	Su			NRT→BKK BKK→PNH	
2	10/4	Mo			Meeting with JICA, DRWS	Preparation for field survey
3	10/5	Tu			Meeting with DRWS	Preparation for field survey
4	10/6	We		NRT→ BKK→PNH	Meeting with DRWS	
5	10/7	Th	Meeting with JICA/EOJ/DRWS			Site survey in Kampong Cham
6	10/8	Fr	Meeting with DRWS			Site survey in Kampong Cham
7	10/9	Sa	Signing of M/D with DRWS	Signing of M/D with DRWS PNH→BKK	Signing of M/D with DRWS	Site survey in Kampong Cham
8	10/10	Su		BKK→NRT	Site survey in Kampong Cham	Site survey in Kampong Cham
9	10/11	Mo			Site survey in Kampong Cham	Site survey in Kampong Cham
10	10/12	Tu			Site survey in Kampong Cham	Site survey in Kampong Cham
11	10/13	We			Site survey in Kampong Cham	Site survey in Kampong Cham
12	10/14	Th			Site survey in Kampong Cham	Site survey in Kampong Cham
13	10/15	Fr			Site survey in Kampong Cham	Site survey in Kampong Cham
14	10/16	Sa			Site survey in Kampong Cham	Site survey in Kampong Cham
15	10/17	Su			Site survey in Kampong Cham	Site survey in Kampong Cham
16	10/18	Mo			Kampong Cham→PNH, Condition Survey of equipment, procurement and other related matters in PNH	Site survey in Kampong Cham
17	10/19	Tu			Condition Survey of equipment, procurement and other related matters in PNH	Site survey in Kampong Cham
18	10/20	We			Condition Survey of equipment, procurement and other related matters in PNH	Site survey in Kampong Cham
19	10/21	Th			Condition Survey of equipment, procurement and other related matters in PNH	Site survey in Kampong Cham
20	10/22	Fr			Condition Survey of equipment, procurement and other related matters in PNH	Site survey in Kampong Cham
21	10/23	Sa			Condition Survey of equipment, procurement and other related matters in PNH	Site survey in Kampong Cham
22	10/24	Su			Condition Survey of equipment, procurement and other related matters in PNH	Site survey in Kampong Cham
23	10/25	Mo			Condition Survey of equipment, procurement and other related matters in PNH	Site survey in Kampong Cham
24	10/26	Tu			Condition Survey of equipment, procurement and other related matters in PNH	Site survey in Kampong Cham

No.	Date		Official Members(1 and 2)	Consultant Members (3,4 and 8)	Consultant Members (5,6 and 7)
25	10/27	We		Condition Survey of equipment, procurement and other related matters in PNH	Site survey in Kampong Cham
26	10/28	Th		Discussion with MRD and DRWS	Kampong Cham→PNH, Condition Survey in PNH
27	10/29	Fr		Meeting with JICA/EOJ/DRWS	
28	10/30	Sa		Internal meeting, arrangement of survey result	
29	10/31	Su		Internal meeting, PNH →BKK	
30	11/1	Mo		BKK →NRT	

(2) Discussion of Basic Design Study Draft Report

No.	Date		Official Members(1 and 2)	Consultant Members(3,4 and 5)
1	1/31	Mo		NRT→BKK
2	2/1	Tu	Discussion with DRWS for Basic Design Study Draft Report	
3	2/2	We		Site survey in Kampong Cham
4	2/3	Th		Site survey in Kampong Cham
5	2/4	Fr		Site survey in Kampong Cham
6	2/5	Sa		Preparation for M/D, arrangement of survey result
7	2/6	Su		Preparation for M/D, arrangement of survey result
8	2/7	Mo	Discussion with DRWS for M/D, visiting Embassy of Japan	
9	2/8	Tu	Signing of M/D with DRWS	
10	2/9	We		Internal meeting, arrangement of survey result
11	2/10	Th		Meeting with PDRD Kampong Cham, PNH →BKK
12	2/11	Fr		BKK →NRT

3. List of Parties Concerned in the Recipient Country

(1) Basic Design Study

＜Cambodian Parties＞

Ministry of Rural Development(MRD)

Mr. Lu Lay Sreng	Deputy Prime Minister / Minister of MRD
Mr. Chan Darong	Deputy Director General of Technical Affairs

Department of Rural Water Supply(DRWS)

Dr. Mao Saray	Director
Mr. Sok Sophally	Deputy Director of Rural Water Supply Department
Mr.. Touch Seng	Deputy Director of Rural Water Supply Department

Department of Rural Health Care(DRHC)

Dr. Chea Samnang	Director

Provincial Department of Rural Development(PDRD)

Mr. Chea Poly	Director
Mr. Phoung Min	Deputy Director
Mr. Lay Chenda	Chief of Water Section
Mr. Chhem Lang	Deputy Chief Water Supply

District of Rural Development of Memot

Mr. Sam Kim Srea	Director

Ministry of Industry, Mines and Energy(MIME)

Mr. Peng Navuth	Director, Department of Potable Water Supply

Ministry of Industry, Mines and Energy(MIME)

Mr. Tieng Vany	Vice President
Mr. Ly Cham Thy	Chief of Resource of Mine
Mr. Penh Chheng Horn	Deputy of Administration
Mr. Kheng Kim In	Chief of Administration
Mr. In Vannchan	Deputy of Industry of Fish
Mr. Sim kiy Chheng	Chief of Accounting

＜Japanese Parties＞

Japanese Embassy in Cambodia

Kazumi JIGAMI	Counselor
Tomoaki Korezumi	Second Secretary

JICA Cambodia office

Juro CHIKARAISHI	Resident Representative
Jiro TAKEICHI	Project Formulation Adviser
Chikahiro MASUDA	Assistant Resident Representative

＜Other Parties＞

UNICEF
Mr. Richard Schroeder

Asian Development Bank
Mr. Sophea Mar　　Social Sector Officer, Cambodia Resident Mission

Water and Sanitation Program administrated by World Bank
Mr. Jan-Willem Rosenboom　　Country Team Leader

Social Fund
Mr. Sao Phalla　　Supervision Director

Resource Development International
Mr. Mickey Sampson　　Country Director

International Development Enterprise
Mr. Michel Roberts　　Country Director

GRET-Kosan
Mr. Naulet Frederic

SINCAM Water Technology Co., Ltd.
Mr. Tith Voeurn　　Managing Director
Mr. Sun Sokhe　　Technical Director

(2) Discussion of Basic Design Study Draft Report

＜Cambodian Parties＞

Ministry of Rural Development (MRD)

Mr. Lu Lay Sreng	Deputy Prime Minister / Minister of MRD
Mr. Don Sammuon	Secretary of State
Mr. Chan Darong	Deputy Director General Technical Affairs

Department of Rural Water Supply (DWRS)

Dr. Mao Saray	Director
Mr. Seng Eam Hor	

Provincial Department of Rural Development (PDRD)

Mr. Lai Chenda	Chief of Water Supply Office

＜Japanese Parties＞

Japanese Embassy in Cambodia

Ryutaro TAKAKU	Second Secretary

JICA Cambodia office

Juro CHIKARAISHI	Resident Representative
Hiroto MITSUGI	Deputy Resident Representative
Jiro TAKEICHI	Project Formulation Adviser
Shigetada KAYUMI	Senior Adviser for Implementation of Grant Aid

4. Minutes of Discussions

MINUTES OF DISCUSSIONS
ON THE BASIC DESIGN STUDY
ON THE GROUND WATER DEVELOPMENT PROJECT IN
CENTRAL AND SOUTHERN CAMBODIA
IN THE KINGDOM OF CAMBODIA

Based on the results of the Preliminary Study, the Government of Japan decided to conduct a Basic Design Study (hereinafter referred to as "the Study") on THE GROUND WATER DEVELOPMENT PROJECT IN CENTRAL AND SOUTHERN CAMBODIA (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to The Kingdom of Cambodia (hereinafter referred to as "Cambodia") the Basic Design Study Team (hereinafter referred to as "the Team"), which is headed by Juro Chikaraishi, Resident Representative of JICA Cambodia Office, and is scheduled to stay in the country from October 3 to October 31, 2004.

The Team held discussions with the officials concerned of the Government of Cambodia and conducted a field survey at the study area.

In the course of discussions and field survey, both parties confirmed the main items described on the attached sheets. The Team will proceed to further works and prepare the Basic Design Study Report.

Phnom Penh, October 8, 2004

Mr. Juro Chikaraishi
Leader
Basic Design Study Team
Japan International Cooperation Agency (JICA)

Dr. Mao Saray
Director
Department of Rural Water Supply
Ministry of Rural Development
The Kingdom of Cambodia

ATTACHMENT

1. Objective of the Project

The objective of the Project is supplying enough quantity and good quality of drinking water for villages in Kampong Cham Province in the Kingdom of Cambodia.

2. Study Area

The sites of the Study are villages in Kampong Cham Province as shown in Annex- I .

3. Responsible and Implementing Agency

The Responsible Agency is Ministry of Rural Development (MRD) Annex- II

The Implementing Agency is Department of Rural Water Supply (DRWS) Annex-III

4. Items requested by the Government of Cambodia

After discussions with the Team, the items described in Annex-IV were finally requested by the Cambodian side. JICA will assess the appropriateness of the request and will recommend to the Government of Japan for approval.

5. Japan's Grant Aid Scheme

The Cambodian side understood the Japan's Grant Aid Scheme and the necessary measures to be taken by the Government of Cambodia as explained by the Team and described in Annex-2 and Annex-3 of the Minutes of Discussions signed by both parties on October 15, 2003

6. Schedule of the Study

6-1. The consultants will proceed to further studies in Cambodia until October 31, 2004.

6-2. JICA will prepare the draft report in English and dispatch a mission in order to explain its contents in January 2005.

6-3. In case that the contents of the report is accepted in principle by the Government of Cambodia, JICA will complete the final report and send it to the Government of Cambodia by March 2005.

7. Other relevant issues

7-1. Principle for the drilling machines and operation teams

The Japanese side explained that the Japanese side would not procure new drilling equipments (refered Annex-IV 2.A) under the Project, because the Japanese side decided to give priority to construct water supply facilities as much as possible. The Cambodian side requested for further consideration to procure new drilling equipments.

Both sides agreed that the Study would be taken based on the following principle,

1) The operative existing drilling machines and drilling teams belong to the Cambodian side would be allocated for the Project as much as possible. In that case the Japanese side would repair the machines before the drilling works and restore to the previous condition after the works.

2) If the equipments would be insufficient number to finish the Project in time, local drilling companies would be consider as subcontractor for shortage.

3) In case that the local drilling companies estimated to be not enough capacity or skill for the Project, third

country drilling companies also would be considered as subcontractor.

7-2. Project components

Both sides agreed that the Project would be focused on construction of water supply facilities, equipment for operation and maintenance (O/M) and on the job training (OJT).

7-3. Allocation the staffs for OJT

The Cambodian side confirmed that the Cambodian side would allocate proper staffs for OJT according to the result of the basic design study.

7-4. Criteria for site examination

Both sides agreed that the target villages would be examined during further studies on the conditions as listed in Annex-V. The Cambodian side agreed that through the Study the Japanese side may revise these criteria.

7-5. Implementation system and O/M system

The Cambodian side explained the implementation and O/M system as shown in Annex-VI.

7-6. Alternative sites

The Cambodian side agreed that the Japanese side would not construct the third well at the same well point after two unsuccessful wells in terms of water quality, quantity, water table, etc. Both sides agreed that the alternative sites would be selected in the same commune from the alternative sites list that would be submitted from the Cambodian side.

7-7. Title of the Project

Both sides agreed to change the title of the Project to "THE PROJECT FOR RURAL DRINKING WATER SUPPLY IN KAMPONG CHAM PROVINCE", because the Project area was focused on Kampong Cham Province.

ANNEX-I

List of 142 Villages (1/2)

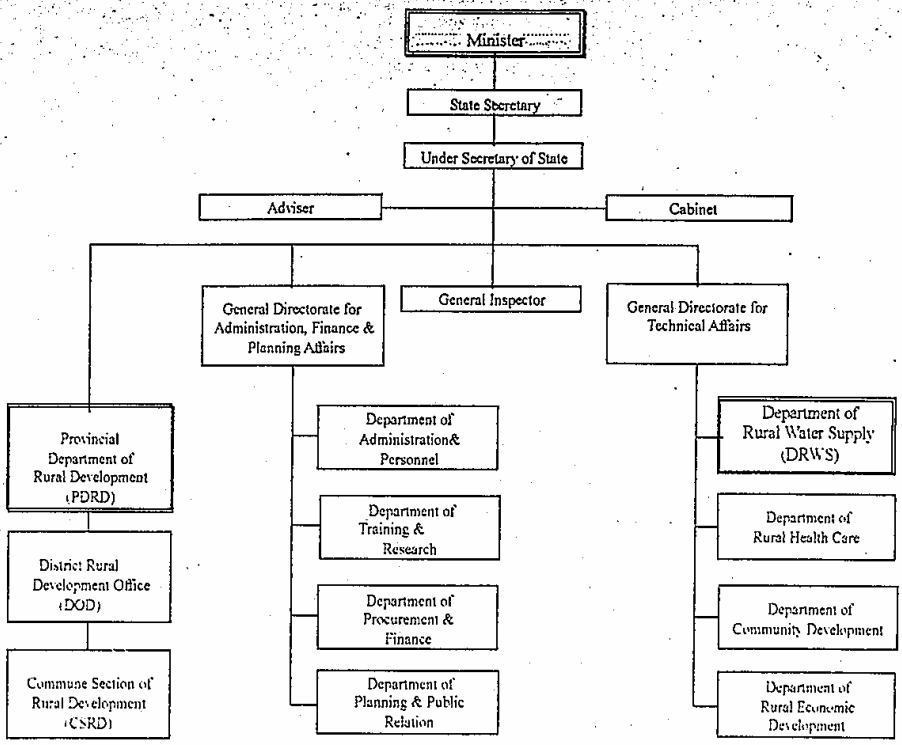
District	Commune	Village No.	Village Name	Population in 2001	Population in 2005	Rank	Reqired New Borehole Well	Lat	Long
Memot	Dar	7	Dar Cheung	764	834	A	4	11.79062	106.09586
Memot	Dar	8	Dar Lech	997	1,089	D	5	11.79293	106.09346
Memot	Dar	9	Dar Phsar	1,225	1,338	D	4	11.78777	106.08925
Memot	Dar	10	Dar Kandaol	1,868	2,040	D	6	11.78735	106.09197
Memot	Dar	11	Prampir Meakkakra	1,066	1,164	B	6	11.78372	106.03284
Memot	Dar	12	Dar Tboung	961	1,050	D	4	11.78715	106.09422
Memot	Dar	13	Triek	410	448	H	3	11.80237	106.09096
Memot	Dar	14	Spean	1,966	2,147	D	4	11.82283	106.05061
Memot	Dar	15	Meaek Puk	450	492	D	2	11.95466	106.06133
Memot	Dar	16	Srae Chroam	930	1,016	A	5	11.82933	106.01633
Memot	Dar	17	Chhngar Cheung	780	852	A	5	11.83433	106.11850
Memot	Dar	18	Chhngar Kandal	400	437	B	3	11.84729	106.11611
Memot	Dar	19	Samraong	537	587	D	2	11.80684	106.12279
Memot	Dar	21	Seng	388	424	B	3	11.78775	106.06877
Memot	Rung	22	Chambak	953	1,041	B	5	11.76776	106.16616
Memot	Rung	24	Doun Roadth Ti Pir	671	733	B	4	11.75064	106.16194
Memot	Rung	25	Bos	536	585	B	3	11.75350	106.18151
Memot	Rung	26	Choam Tuk	507	554	D	1	11.78060	106.20411
Memot	Rung	27	Rung	584	638	B	4	11.75439	106.19346
Memot	Rung	28	Taonh	378	413	C	1	11.76942	106.19092
Memot	Rung	29	Doung	504	550	B	3	11.75011	106.18195
Memot	Rung	30	Beng	461	504	B	3	11.79257	106.10040
Memot	Rung	31	Masin	647	707	B	4	11.76707	106.18163
Memot	Rung	33	Soutey	1,089	1,189	A	6	11.75916	106.16533
Memot	Rung	34	Trapeang Ruessei	1,080	1,180	B	6	11.73878	106.20763
Memot	Chan Mul	35	Thlok	545	595	B	3	11.73625	106.21781
Memot	Chan Mul	36	Chan Mul	1,107	1,209	D	5	11.73726	106.23950
Memot	Chan Mul	37	S'am	830	907	B	5	11.74147	106.22792
Memot	Chan Mul	38	Srae Ta Nong Kaeut	460	502	D	2	11.73650	106.21730
Memot	Chan Mul	39	Srae Ta Nong Lech	340	371	B	2	11.73290	106.21006
Memot	Chan Mul	44	Kor	561	613	B	3	11.75092	106.24872
Memot	Ton Lung	47	Kdol Leu	406	443	B	3	11.88556	106.33589
Memot	Ton Lung	48	Changkum Kandal	610	666	H	4	11.88034	106.35248
Memot	Ton Lung	50	Beng Kaong	409	447	B	3	11.89799	106.28913
Memot	Ton Lung	54	Kdol Kraom	760	830	B	4	11.89922	106.34500
Memot	Ton Lung	55	Sla Phnum	597	652	D	3	11.85985	106.31098
Memot	Ton Lung	56	Pong Tuek	412	450	B	3	11.88968	106.31635
Memot	Rumchek	59	Pnov	390	426	B	3	12.03695	106.04219
Memot	Rumchek	60	Kantuot	377	412	B	2	12.04592	106.03269
Memot	Rumchek	62	Chheu Khloem	685	748	G	4	12.02429	106.10927
Memot	Rumchek	63	Kampey	887	969	G	5	12.04694	106.09464
Memot	Rumchek	64	Khpob	692	756	G	4	12.04638	106.05245
Memot	Memot	68	Memot Phsar	3,155	3,446	B	17	11.82616	106.18966
Memot	Memot	73	Choam M'aor	417	455	A	3	11.81511	106.17952
Memot	Memot	74	Trabaek	734	802	A	4	11.83410	106.19150
Memot	Memot	75	Nang Krapeu	357	390	B	2	11.81946	106.17895
Memot	Memot	76	Trapeang Reang	1,707	1,864	A	9	11.83582	106.16949
Memot	Memot	78	Sangkom Mean Chey Chas	845	923	D	4	11.82238	106.15749
Memot	Memot	79	Chi Peh	987	1,078	B	6	11.81358	106.13892
Memot	Memot	80	Chhngar Sala	359	392	B	2	11.84720	106.11621
Memot	Memot	81	Mukh Kras	585	639	B	4	11.83213	106.14146
Memot	Tramung	82	Tramaeng Leu	351	394	B	2	11.78350	106.18266
Memot	Tramung	85	Tramung	949	1,037	D	3	11.79942	106.18504
Memot	Tramung	86	Choam Triek	1,040	1,136	D	5	12.04592	106.03269
Memot	Tramung	87	Roung Chak Skar	301	329	B	2	11.81387	106.20994
Memot	Tramung	88	Andoung Thma Leu	405	442	B	3	11.81980	106.20482
Memot	Tramung	89	Andoung Thma Kraom	339	370	B	2	11.82262	106.20521
Memot	Tramung	90	Doung	340	371	D	1	11.82139	106.23272
Memot	Tramung	91	Choam Trav	417	455	B	3	11.82773	106.22998
Memot	Tramung	92	Chhuk	656	717	D	3	11.83604	106.21094
Memot	Tramung	93	Ngeu Thum	663	724	D	3	11.84676	106.20433
Memot	Tramung	96	Roung Chakr Lech	2,560	2,796	B	14	11.81483	106.18566
Memot	Tramung	100	Chrey	477	521	B	3	11.86664	106.23373
Memot	Kampoan	101	Lour	1,334	1,457	C	5	11.95550	106.05900
Memot	Kampoan	102	Kampoan	1,623	1,773	C	7	11.92654	106.10357
Memot	Kampoan	104	Srae Saom Thmei	793	866	A	5	11.96031	106.15187
Memot	Kampoan	105	Srae Saom Chas	487	532	A	3	11.94441	106.16304
Memot	Kampoan	106	Tuek Tum	486	531	A	3	11.97951	106.10993
Memot	Kampoan	107	Chhloung Muoy	1,526			2	11.91118	106.08244
Memot	Kampoan	108	Chhloung Pir	1,201			2	11.92841	106.05037
Memot	Kampoan	109	Chhloung Bei	626			2	11.90578	106.05032
Memot	Kokir	110	Srae Poul	674	736	B	4	11.89936	106.12554
Memot	Kokir	111	Kokir Cheung	1,485	1,622	D	7	11.89378	106.12347
Memot	Kokir	112	Kokir Tboung	1,069	1,168	A	6	11.89183	106.12274

ANNEX-I

List of 142 Villages (2/2)

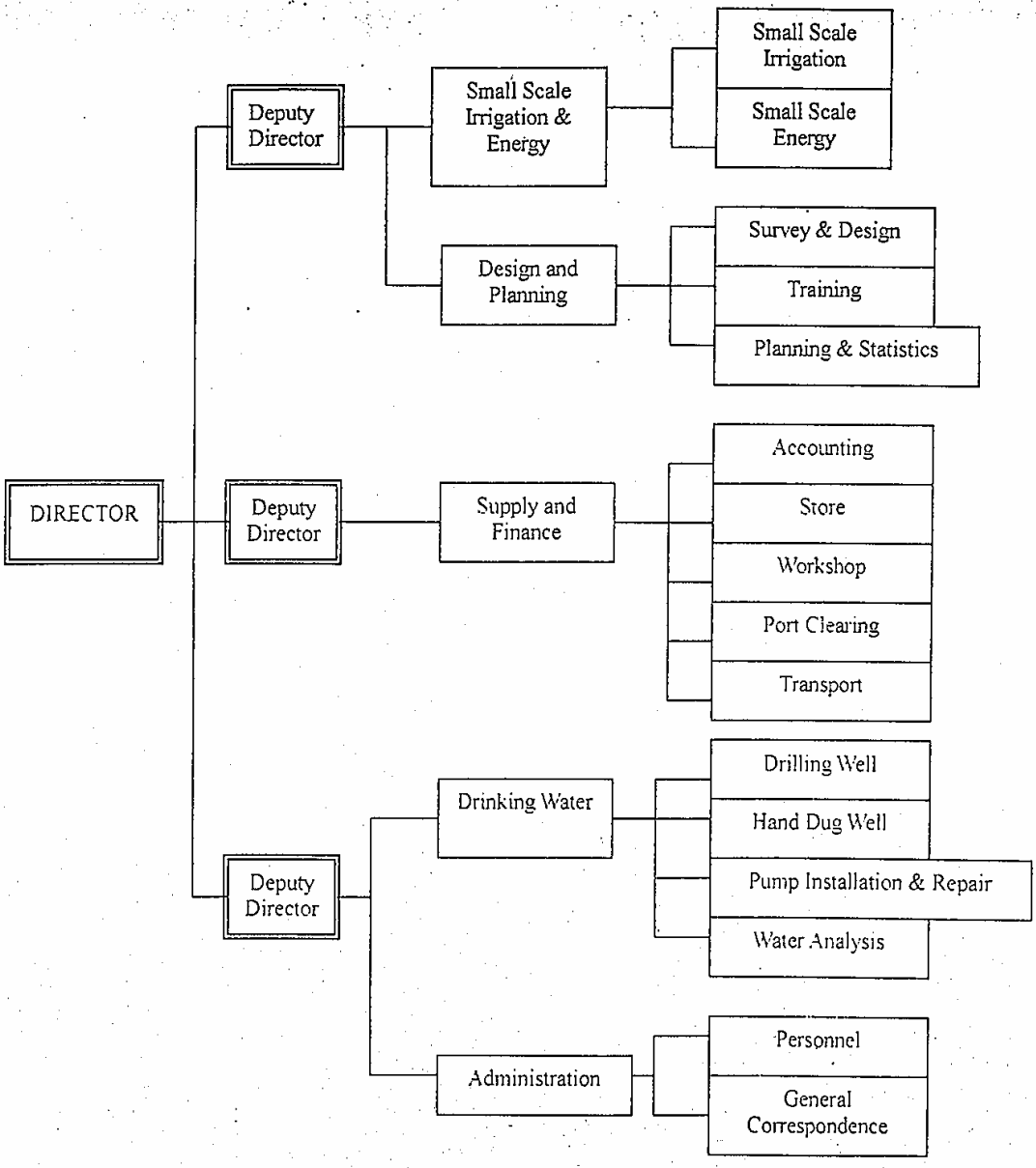
District	Commune	Village No.	Village Name	Population in 2001	Population in 2005	Rank	Reqired New Borehole Well	Lat	Long
Memot	Kokir	113	Tuol Thma	635	694	B	4	11.88977	106.13351
Memot	Kokir	115	Kngaok	575	628	D	2	11.90119	106.07937
Memot	Kokir	116	Preaek Puoy	1,117	1,220	B	6	11.90626	106.07992
Memot	Kokir	120	Thanl Kaeng	384	419	B	2	11.89129	106.24780
Memot	Kokir	121	Thma Totueng Tboung	503	549	D	1	11.89015	106.24138
Memot	Kokir	124	Sampov Lun	1,079	1,179	G	6	11.92010	106.22830
Memot	Kokir	125	Chumnum Pol	629	687	B	4	11.94116	106.21216
Memot	Kokir	126	Kantuot	743	812	C	3	11.86163	106.24639
Memot	Kokir	127	Angkam	409	447	D	2	11.89425	106.21830
Memot	Kokir	130	Bos Ta Oem	1,154	1,260	B	6	11.90758	106.23350
Memot	Memong	132	Memong	1,333	1,456	B	7	11.85702	106.17602
Memot	Memong	136	Triek	361	394	A	2	11.89601	106.18438
Memot	Memong	137	Choam Khyang	332	363	A	2	11.89909	106.17757
Memot	Memong	138	Sangkae Thmei	406	443	A	3	11.87217	106.15668
Memot	Memong	139	Sangkae Chas	1,021	1,115	A	6	11.88267	106.15632
Memot	Choam Kravien	141	Khcheay	659	720	B	2	11.82495	106.28043
Memot	Choam Kravien	143	Satum	1,115	1,218	B	6	11.70666	106.38133
Memot	Choam Kravien	144	Kravien Cheung	520	568	B	3	11.77283	106.33750
Memot	Choam Kravien	147	Chrey Laeung	326	356	C	1	11.83305	106.32540
Memot	Choam	159	Boeng Chroung	504	550	B	3	11.70728	106.27653
Memot	Choam	160	Choam Ampil	383	418	B	2	11.73804	106.29035
Memot	Choam	162	Cheung	455	497	B	3	11.71905	106.27105
Memot	Choam	163	Leach Leu	562	614	B	3	11.72175	106.28665
Memot	Choam	167	Ngiev	616	673	B	4	11.75066	106.30550
Memot	Choam	168	Leach Kraom	937	1,023	B	5	11.71451	106.28296
Ponhea Kraek	Popel	169	Tuol Kandal	687	750	B	4	11.83183	105.86566
Ponhea Kraek	Popel	170	Srah	707	772	C	1	11.80842	105.86079
Ponhea Kraek	Popel	171	khsak	1,364	1,490	D	5	11.83024	105.84393
Ponhea Kraek	Popel	172	Popel	1,337	1,460	B	7	11.84266	105.86900
Ponhea Kraek	Kandaol Chrum	179	Tuol Chamkar	1,057	1,154	C	3	11.84104	105.81385
Ponhea Kraek	Kandaol Chrum	180	Sbaek Kueu	868	948	C	2	11.82455	105.79686
Dambae	Chong Cheach	227	Cheach Cheung	1,231	1,345	A	7	11.91524	105.86182
Tboung Khmum	Kor	264	Veal Khmum	2,222	2,427	C	11	11.99144	105.70697
Tboung Khmum	Mong Rieng	267	Thnong	1,176	1,284	B	7	11.89488	105.62509
Tboung Khmum	Mong Rieng	268	Mong Ti Prammuoy	672	734	A	4	11.90084	105.62738
Tboung Khmum	Mong Rieng	269	Mong Ti Prampir	772	843	C	3	11.90440	105.62516
Tboung Khmum	Mong Rieng	271	Trapeang Sangkae	664	725	B	4	11.86467	105.78631
Tboung Khmum	Anhchaeum	272	Trapeang Chak	446	487	A	3	11.86362	105.72547
Tboung Khmum	Anhchaeum	273	Chheu Teal Chrum	403	440	C	2	11.85447	105.72636
Tboung Khmum	Lngieng	264	Lvea Thum	749	818	C	2	11.94868	105.74858
Tboung Khmum	Lngieng	265	Lngieng	795	868	A	5	11.92596	105.73311
Tboung Khmum	Vihear Luong	287	Pnov	646	706	A	4	11.91876	105.68609
Tboung Khmum	Vihear Luong	289	Prasrae Leu	537	587	A	3	11.93245	105.68983
Tboung Khmum	Suong	290	Prey Totueng	630	688	A	4	11.92722	105.63187
Tboung Khmum	Suong	291	Chrak Poun	746	815	C	2	11.92347	105.63119
Tboung Khmum	Suong	292	Ponnareay	1,976	2,158	C	4	11.88622	105.69356
Tboung Khmum	Thma Pechr	294	Chambak	1,162	1,269	D	5	12.03883	105.65333
Tboung Khmum	Thma Pechr	295	Chies Ti Muoy	1,117	1,220	C	3	12.04432	105.63067
Tboung Khmum	Roka Po Pram	297	Trapeang Khla	2,217	2,421	D	10	12.07433	105.69083
Tboung Khmum	Roka Po Pram	298	Ta Pav Bampenh Tes	2,269	2,478	B	12	12.06183	105.68933
Tboung Khmum	Roka Po Pram	299	Pong Tuek	1,530	1,671	A	8	12.09683	105.69666
Tboung Khmum	Chirou Pir	304	Srae Siem	1,830	1,999	C	2	11.94492	105.54443
Tboung Khmum	Chirou Pir	305	Tuol Vihear	2,299	2,511	C	9	11.95436	105.52933
Ou Reang Ov	Damrel	307	Tuol	364	398	A	2	11.81916	105.58366
Ou Reang Ov	Mlen	310	Pray Sambour Loch	728	795	A	4	11.78879	105.46294
Ou Reang Ov	Kong Chey	315	Soeng	689	753	A	4	11.76350	105.53383
Ou Reang Ov	Kong Chey	317	Changva	365	399	C	1	11.76606	105.54455
Ou Reang Ov	Kong Chey	320	Prum Khet	310	339	A	2	11.81833	105.45600
Ou Reang Ov	Kong Chey	324	Stueng Chey	638	697	G	3	11.76816	105.50833
Ou Reang Ov	Chak	325	Chamlak	705	770	C	3	11.78900	105.60450
Ou Reang Ov	Chak	327	Pring	795	868	D	3	11.78320	105.59962
Ou Reang Ov	Tuol Sophy	332	Poung	803	877	D	4	11.79466	105.56466
Ou Reang Ov	Tuol Sophy	337	Thma Da Lech	629	687	D	3	11.81891	105.53824
Ou Reang Ov	Tuol Sophy	338	Thma Da Kaeut	566	618	B	3	11.81950	105.54850
Ou Reang Ov	Preah Theat	340	Tuol Khleang	1,027	1,122	G	1	11.98783	105.45800
Ou Reang Ov	Preah Theat	341	Preah Theat Kandal	460	502	D	1	11.84137	105.47657
Ou Reang Ov	Ampil Ta Pok	346	Svay Roluos	775	846	C	4	11.79216	105.46833
Ou Reang Ov	Ampil Ta Pok	351	Meas Snae	814	889	A	5	11.80550	105.49066
		142	Total	117,713	124,905		562		

ANNEX-II



Structure of Ministry of Rural Development (MRD)

ANNEX-III



Structure of Department of Rural Water Supply (DRWS)

ANNEX-IV

<Contents of the request>

1. **Facility Construction**

Region	Province	Number of Villages	Target Year 2005	
			Population	Required Number of Tube Wells
Central Cambodia	Kampong Cham	142	124,905	562
	Total	142	124,905	562

2. **Procurement of Equipment**

A. Drilling Equipment

1. Drilling rig: 2 sets
2. High pressure air compressor: 2 sets
3. Drilling tools: 2 sets
4. Cargo truck with crane: 2 sets
5. Water tank truck: 2 sets
6. Fuel tank truck: 2 sets
7. Pick-up truck for well drilling: 2 sets

B. Testing and Survey Equipment

1. Pumping test equipment: 2 sets
2. Cargo truck with crane for pumping test: 2 sets
3. Borehole logging equipment: 2 sets
4. Pick-up truck for well logging: 2 sets
5. Resistivity survey equipment: 2 sets
6. Station-wagon for resisitivity survey: 2 sets
7. Water analysis kit: 2 sets

C. Equipment for Operation & Maintenance

1. Pick-up truck for WSUG training: 2 sets
2. Video set with screen for training: 1 sets
3. Notebook computer with projector for health and hygiene education: 2 sets
4. Computer set for data base 1 sets
5. Low pressure air compressor for well rehabilitation: 2 sets

3. **Soft Component**

a) Socio-Economic Analysis

b) Setting up and guidance of O & M organization

c) Hygiene campaign

d) Monitoring of water point committee's O & M

4. **On the job training on construction work**

a) Resistivity survey technique skill

b) Drilling machine (Especially DTH) operation & Maintenance

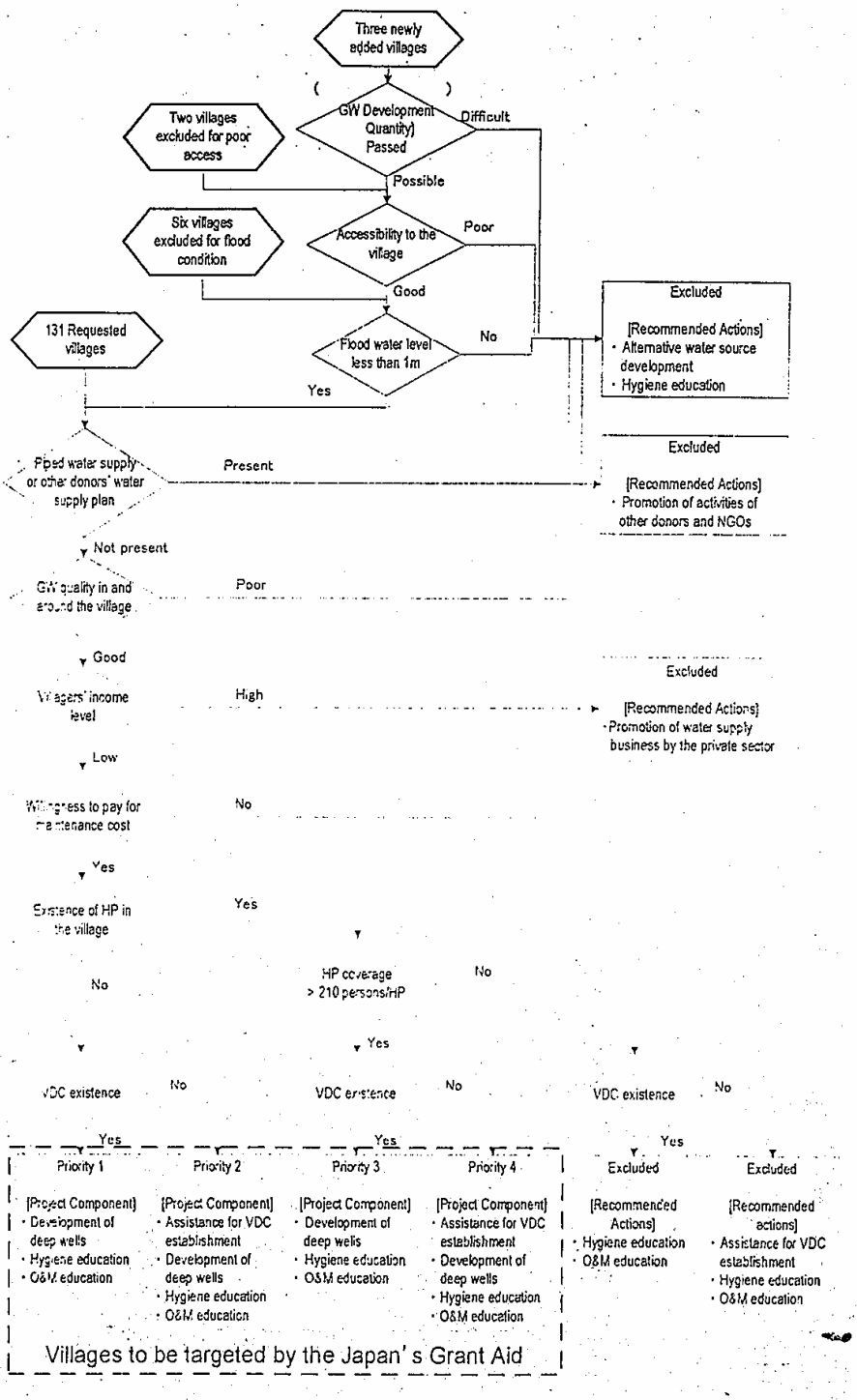
c) Borehole logging technique

d) Skill for water quantity measurement

e) Water quality

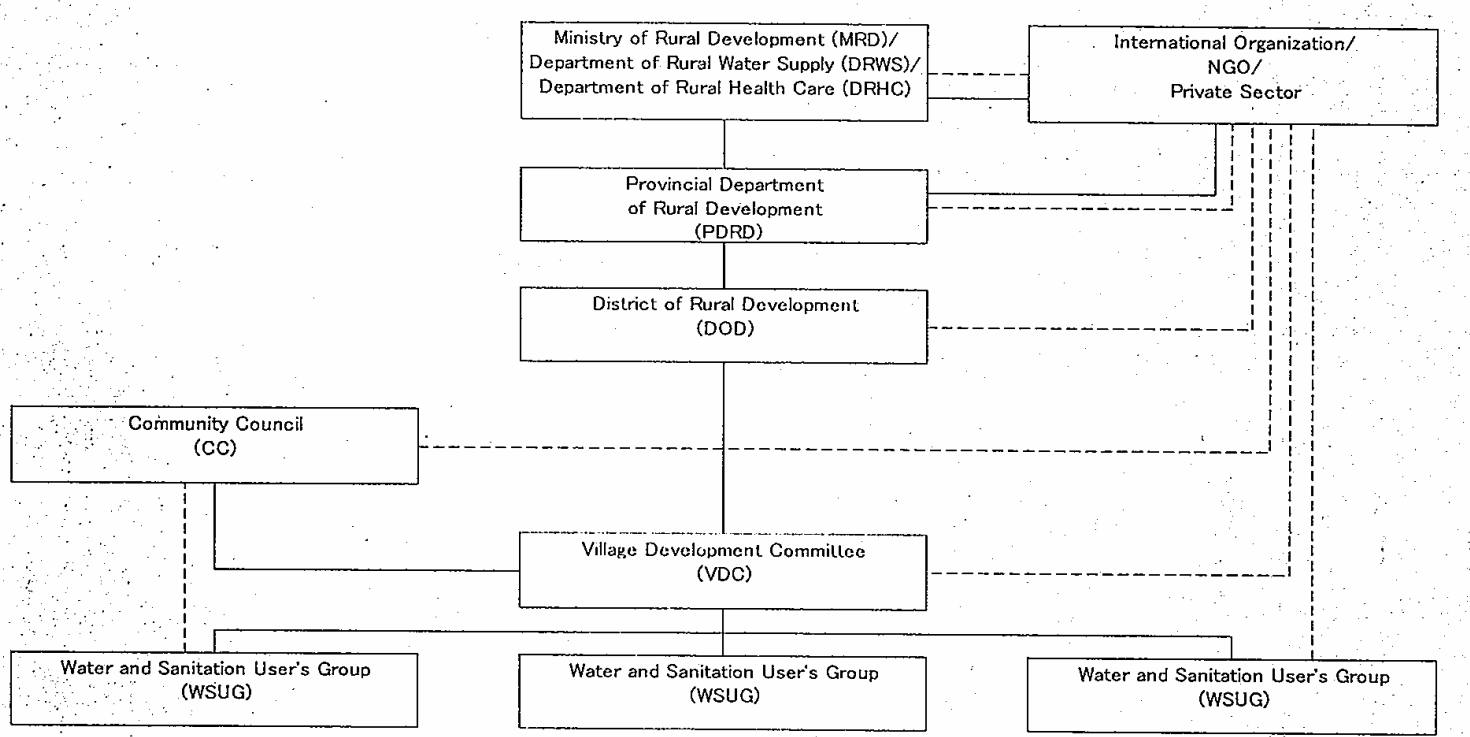
f) Well database management skill

ANNEX-V Flow Chart of Village Selection Criteria



ANNEX-VI

Organization Chart for Ipmplementation and O&M



Note:

——— : Direct Contact
- - - - - - : Coodination and Support

TECHNICAL NOTES
ON THE BASIC DESIGN STUDY
ON THE PROJECT FOR RURAL DRINKING WATER SUPPLY
IN KAMPONG CHAM PROVINCE
IN THE KINGDOM OF CAMBODIA

Based on the Minutes of Discussions signed on October 8, 2004 between the Basic Design Study Team (hereinafter referred to as "the Team") of Japan International Cooperation Agency (hereinafter referred to as "JICA") and Department of Rural Water Supply, Ministry of Rural Development of the Kingdom of Cambodia on THE GROUND WATER DEVELOPMENT PROJECT IN CENTRAL AND SOUTHERN CAMBODIA (hereinafter referred to as "the Project"), the consultant members of the Team had a series of discussions and conducted field surveys from October 4 to October 27, 2004.

As a result of the discussions and the surveys, both sides confirmed the technical conditions described on attached sheets.

Phnom Penh, October 29, 2004

Mr. Satoshi Ishida
Chief Consultant,
Basic Design Study Team
Japan International Cooperation Agency (JICA)

Dr. Mao Saray
Director
Department of Rural Water Supply
Ministry of Rural Development
The Kingdom of Cambodia

ATTACHMENT

The both parties agreed upon and confirmed the following items.

1. Existing drilling machines and drilling teams

1) Japanese side informed the Cambodian side of the survey result that the three sets of drilling machines owned by DRWS shown in ANNEX-1 are capable to drill boreholes for the Project.

2) Cambodian side replied as follows

a) DRWS is not able to commit the allocation of both Ingersoll Rand drilling machines because of high possibility of allocation of both equipment for the UNICEF project which will start from 2005. DRWS has to give UNICEF the priority to use the equipment because these equipments donated by UNICEF have been utilized for the UNICEF projects with its continuous assistance.

b) DRWS is also not able to fully allocate a set of YBM drilling machines to the Project because DRWS has already allocated it for the ADB project, which will probably start from the middle of 2005, in accordance with the future YBM utilization plan prepared in response to the request by the Japanese side during the Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh City. However, DRWS agreed to allocate a set of YBM drilling machines for the Project partly, although its available period is not able to be determined at present.

2. Burden sharing of the cost for existing drilling machines and drilling teams

1) Cambodian side requested Japanese side to shoulder all of the cost required for implementing drilling works including overhaul cost before and after use, fuel and lubricant cost, repair and spare parts cost and maintenance cost except depreciation cost of drilling machines and salary of staffs on the job training (OJT).

2) Cambodian side requested Japanese side to bear perdium and transportation for the OJT staffs, because the OJT staffs have to stay in Kampong Cham province apart from Phnom Penh.

3. Water supply plan

1) Cambodian side agreed that the target year of the Project is 2010 in accordance with the "Cambodia Millennium Development Goals (MDG)".

2) Cambodian side agreed that the basic water demand to apply for the Project is 40 litter / person / day in accordance with the result of the Study on Ground Water Development in Central Cambodia (hereinafter referred to as "Development Study").

3) Cambodian side agreed that the standard population per borehole well to apply for the Project is 210 persons / well in accordance with the result of the Development Study.

4. Budget for operation and maintenance of equipment procured in the Project

Cambodian side committed to allocate the budget for operation and maintenance of the equipment which will be procured in the Project.

5. Water quality standard to determine the successful borehole well

Japanese side explained that the water quality standard to determine the successful borehole well as shown in

ANNEX-II will be finalized after the careful examination based on the result of the survey.

3

Annex-I

Team	Item	Description
"YBM"	YBM Rig	YBM-YTD45B, Nissan Diesel
	Compressor	Airman PDSJ750S
	Compressor-Truck	Nissan Diesel
	Cargo truck with crane	Isuzu
	Water tank truck	Isuzu
	Fuel tank truck	Isuzu
	Pick-up	Isuzu
"F" (TH10)	Ingersoll-Rand Rig	Ingersoll-Rand, Iveco-Turbo
	Compressor	Ingersoll-Rand VHP-700
	Compressor-Truck	Iveco-Turbo
	Water-tank trailer	$1.5m^3$
	Pick-up	Toyota Landcruiser
"G" (TH10)	Ingersoll-Rand Rig	Ingersoll-Rand, Iveco-Turbo
	Compressor	Ingersoll-Rand VHP-700
	Compressor-Truck	Iveco-Turbo
	Water tank truck with crane	Iveco-Magirus
	Pick-up	Toyota Landcruiser
Additional Vehicle for Transportation		
	Transportation Truck	Nissan-UD 8 ton
	Transportation Truck	Nissan-Ben 6 ton

ANNEX-II

	WHO Guidelines for Drinking-water Quality(3rd Edition)		Drinking Water Quality Standards, January 2004 (Ministry of Industry Mines and Energy)		Proposed Water Quality Standard for Succeessful Wells for the Project
	Value (mg/l)	Acceptability Aspect (mg/l) [a]	Standard Value (mg/l)	Small water supply (less than 100 persons or $100m^3$/day) (mg/l)	Value (mg/l)
1. Microbial aspects					
Total coliform Thermotolerant coliform E.Coli. Faecal streptcoques	0 in 100ml sample	-	0 in 100ml sample	0 in 100ml sample	-
2. Naturally occurring chemicals					
Arsenic (As)	0.01	-	0.05	0.05	0.05
Barium (Ba)	0.7	-	0.7	-	-
Boron (B)	0.5	-	-	-	-
Chloride (Cl)	-	250	250	-	250
Chromium (Cr_6^+)	0.05	-	0.05	-	-
Fluoride (F)	1.5	-	1.5	-	1.5
Hardness	-	-	300	-	-
Hydrogen sulfide (H_2S)	-	0.05	0.05	-	-
Manganese (Mn)	0.4	0.1	0.1	-	0.4
Molybdenum (Mo)	0.07	-	-	-	-
pH	-	-	6.5 - 8.5	6.5 - 8.5	-
Selenium (Se)	0.01	-	0.01	-	-
Sodium (Na)	-	200	200	-	-
Sulfate (SO_4)	-	250	250	-	-
Total dissolved solid (TDS)	-	1000	800	800	800
Uranium (U)	0.015	-	-	-	-
Silver (Ag)	-	-	-	-	-
Aluminium (Al)	-	0.2	0.2	-	-
Iron (Fe)	-	0.3	0.3	0.3	2.0
Zinc (Zn)	-	3	3	-	-
Antimony (Sb)	0.02	-	-	-	-
Copper (Cu)	2	1	1	-	-
Lead (Pb)	0.01	-	0.01	-	-
Nickel (Ni)	0.02	-	0.02	-	-
3. Chemicals from agricultural activities					
Ammonium (NH_4)	-	1.5	1.5	-	-
Nitrate (NO_3)	50	-	50	-	50
Nitrite (NO_2) (long/short term)	3/0.2	-	3	-	-
4. Others					-
Taste	-	-	Acceptable	-	-
Color	-	15 TCU[b]	5 TCU	-	-
Odor	-	-	Acceptable	-	-
Turbidity	-	5 NTU[c]	5 NTU	5 NTU	5 NTU
Magnesium (Mg)	-	-	-	-	-
Calcium (Ca)	-	-	-	-	-
Anionic detergent	-	-	-	-	-
Potassium (K)	-	-	-	-	-
Bicarbonate (HCO_3)	-	-	-	-	-
Carbonate (CO_3^-)	-	-	-	-	-
Free carbon dioxide (CO_2)	-	-	-	-	-
Electric Conductivity	-	-	-	-	-

a) Value is not confirmed. It is valuable depend on the situation.
b) TCU: true colour unit
c) NTU: nephelometric turbidity unit

MINUTES OF DISCUSSIONS
ON THE BASIC DESIGN STUDY
ON THE PROJECT FOR RURAL DRINKING WATER SUPPLY IN KAMPONG CHAM PROVINCE
IN THE KINGDOM OF CAMBODIA
(EXPLANATION OF THE DRAFT REPORT)

In October 2004, Japan Internal Cooperation Agency (hereinafter referred to as "JICA") dispatched the Basic Design Study Team on THE PROJECT FOR RURAL DRINKING WATER SUPPLY IN KAMPONG CHAM PROVINCE (hereinafter referred to as "the Project") to The Kingdom of Cambodia (hereinafter referred to as "Cambodia"), and through discussions, field survey in Cambodia and technical examination of the results in Japan, JICA prepared a draft report of the study.

In order to explain and to consult with Cambodia on the components of the draft report, JICA sent to Cambodia the Draft Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Hiroto MITSUGI, Deputy Resident Representative of JICA in Cambodia, and is scheduled to stay in the country from January 31 to February 10, 2005.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Phnom Penh, February 8, 2005

Mr. Hiroto MITSUGI
Leader
Basic Design Study Team
Japan International Cooperation Agency (JICA)

Dr. Mao Saray
Director
Department of Rural Water Supply
Ministry of Rural Development
The Kingdom of Cambodia

ATTACHMENT

(1) Components of the Draft Report

The Government of Cambodia agreed and accepted in principle the components of the draft report explained by the Team.

(2) Content of the Grant Aid project

In the event that the Government of Japan decides to implement the project, the Cambodian side and the Japanese side agree that the content will be as follows:

1) Construction of hand pump wells: 380 locations (Shown in Annex-I)
2) Procurement of survey and testing equipment and O&M equipment (Shown in Annex-II)
3) Technology transfer for well drilling techniques
4) Soft component to support O&M activities for water supply facilities and hygiene education activities

(3) Minutes of Discussions (October 8, 2004)

Both sides confirmed again all the contents of the previous Minutes of Discussions, on the basic design study of October 8, 2004.

(4) Japan's Grant Aid System

The Cambodian side has understood Japan's Grant Aid System and the necessary measures to be taken by the Government of Cambodia as recorded in attachment of the Minutes of Discussions signed by both parties on October 8, 2004.

(5) Schedule of the Study

JICA will complete the final report in accordance with the items confirmed and send it to Cambodia around May 2005.

(6) Other relevant issues

The following issues were discussed and agreed by both parties.

1) Lending of equipment owned by the Cambodian side

In the event that the Government of Japan decides to implement the project, the Cambodian side has promised to lend the equipment and materials provided by the Japanese side in "The Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh City" to the Japanese side free of charge (Shown in Annex-III). Both sides agreed that the Japanese side shall bear all of the cost required for operating the equipment including fuel and lubricant cost, repair and spare parts cost and maintenance cost except depreciation cost.

2) Allowance for personals of the Cambodian side

Both sides agreed that the Japanese side shall not bear the cost of allowance for the OJT staff as requested by the Cambodian side in the Technical Notes of October 29, 2004. The Cambodian side agreed that the Cambodian side shall bear the cost of allowance for the personals who were appointed by the government of Cambodia.

Annex-I

List of the Project Sites and the Planning of the Number of Wells

District	Commune	ID	Village	Population	Estimated Population	No. of Wells to be constructed		
				2004	2010	Maximum 5 wells	1 well for poor group	Total
Memot	Dar	7	Dar Cheung	798	875	0	1	1
Memot	Dar	10	Dar Kandaol	2,301	2,523	0	1	1
Memot	Dar	11	Prampir Meakkakra	1,100	1,206	5	0	5
Memot	Dar	12	Dar Tboung	997	1,093	0	1	1
Memot	Dar	13	Triek	448	491	2	0	2
Memot	Dar	14	Spean	2,230	2,446	5	0	5
Memot	Dar	15	Meaek Puk	590	647	2	0	2
Memot	Dar	16	Srae Chroam	945	1,036	5	0	5
Memot	Dar	17	Chhngar Cheung	880	965	5	0	5
Memot	Dar	18	Chhngar Kandal	420	461	2	0	2
Memot	Dar	19	Samraong Cheung	550	603	2	0	2
Memot	Dar	21	Beng	410	450	0	1	1
Memot	Rung	22	Chambak	1,013	1,111	5	0	5
Memot	Rung	24	Doun Roadth Ti Pir	527	578	3	0	3
Memot	Rung	25	Bos	590	647	3	0	3
Memot	Rung	26	Choam Tuk	660	724	3	0	3
Memot	Rung	27	Rung	577	633	3	0	3
Memot	Rung	28	Taonh	380	417	1	0	1
Memot	Rung	29	Doung	482	529	3	0	3
Memot	Rung	30	Beng	579	635	3	0	3
Memot	Rung	31	Masin	710	779	4	0	4
Memot	Rung	33	Soutey	1,107	1,214	5	0	5
Memot	Rung	34	Trapeang Ruessei	1,153	1,264	5	0	5
Memot	Chan Mul	35	Thlok	780	855	4	0	4
Memot	Chan Mul	36	Chan Mul	1,167	1,280	5	0	5
Memot	Chan Mul	37	S'am	868	952	5	0	5
Memot	Chan Mul	38	Srae Ta Nong Kaeut	362	397	1	0	1
Memot	Chan Mul	39	Srae Ta Nong Lech	350	384	2	0	2
Memot	Chan Mul	44	Kor	531	582	3	0	3
Memot	Tonlung	47	Kdol Leu	426	467	2	0	2
Memot	Tonlung	48	Changkum Kandal	956	1,048	5	0	5
Memot	Tonlung	50	Beng Kaong	520	570	3	0	3
Memot	Tonlung	54	Kdol Kraom	845	927	4	0	4
Memot	Tonlung	55	Sla Phnum	789	865	3	0	3
Memot	Tonlung	56	Pong Tuek	1,865	2,045	5	0	5
Memot	Rumchek	59	Pnov	550	603	3	0	3
Memot	Rumchek	60	Kantuot	568	623	3	0	3
Memot	Rumchek	62	Chheu Khloem	878	963	5	0	5
Memot	Rumchek	63	Kampey	943	1,034	5	0	5
Memot	Rumchek	64	Khpob	1,363	1,495	5	0	5
Memot	Memot	73	Choam M'aor	386	423	1	0	1
Memot	Memot	74	Trabaek	975	1,069	5	0	5
Memot	Memot	75	Nang Krapeu	362	397	2	0	2
Memot	Memot	76	Trapeang Reang	1,774	1,946	5	0	5
Memot	Memot	78	Sangkom Mean Chey Chas	849	931	3	0	3
Memot	Memot	79	Chi Peh	997	1,093	5	0	5
Memot	Memot	80	Chhngar Sala	370	406	2	0	2
Memot	Memot	81	Mukh Kras	610	669	3	0	3
Memot	Tramung	82	Tramaeng Leu	378	415	2	0	2
Memot	Tramung	85	Tramung	944	1,035	3	0	3
Memot	Tramung	87	Roung Chakr Skar	307	337	2	0	2
Memot	Tramung	88	Andoung Thma Leu	422	463	2	0	2
Memot	Tramung	89	Andoung Thma Kraom	294	322	2	0	2
Memot	Tramung	90	Doung	359	394	1	0	1
Memot	Tramung	91	Choam Trav	490	537	3	0	3
Memot	Tramung	92	Chhuk	661	725	2	0	2
Memot	Tramung	93	Ngeu Thum	645	707	3	0	3
Memot	Tramung	96A	Khnong Krapeu Kaeut	1,952	2,141	0	1	1
Memot	Tramung	96B	Khnong Krapeu Lech	2,400	2,632	0	1	1
Memot	Tramung	100	Chrey	527	578	3	0	3

District	Commune	ID	Village	Population	Estimated Population	No. of Wells to be constructed		
				2004	2010	Maximum 5 wells	1 well for poor group	Total
Memot	Kampoan	101	Lour	1,802	1,976	5	0	5
Memot	Kampoan	102	Kampoan	1,600	1,755	5	0	5
Memot	Kampoan	104	Srae Saom Thmei	1,053	1,155	4	0	4
Memot	Kampoan	105	Srae Saom Chas	602	660	1	0	1
Memot	Kampoan	106	Tuek Tum	1,000	1,097	4	0	4
Memot	Kampoan	107	Chhloung Muoy	1,278	1,402	2	0	2
Memot	Kampoan	108	Chhloung Pir	797	874	1	0	1
Memot	Kampoan	109	Chhloung Bei	560	614	3	0	3
Memot	Kokir	110	Srae Poul	799	876	4	0	4
Memot	Kokir	111	Kokir Cheung	1,498	1,643	5	0	5
Memot	Kokir	112	Kokir Tboung	1,021	1,120	4	0	4
Memot	Kokir	113	Tuol Thma	671	736	4	0	4
Memot	Kokir	115	Kngaok	770	844	3	0	3
Memot	Kokir	116	Preaek Puoy	1,127	1,236	5	0	5
Memot	Choam Ta Mau	120	Thnal Kaeng	350	384	2	0	2
Memot	Choam Ta Mau	121	Thma Totueng Tboung	380	417	2	0	2
Memot	Choam Ta Mau	124	Sampov Lun	819	898	4	0	4
Memot	Choam Ta Mau	125	Chumnum Pol	665	729	3	0	3
Memot	Choam Ta Mau	126	Kantuot	787	863	3	0	3
Memot	Choam Ta Mau	127	Angkam	437	479	1	0	1
Memot	Choam Ta Mau	130	Bos Ta Oem	1,072	1,176	5	0	5
Memot	Memong	132	Memong	1,456	1,597	5	0	5
Memot	Memong	136	Triek	401	440	2	0	2
Memot	Memong	137	Choam Khyang	405	444	2	0	2
Memot	Memong	138	Sangkae Thmei	915	1,003	5	0	5
Memot	Memong	139	Sangkae Chas	1,052	1,154	5	0	5
Memot	Choam Kravien	141	Khcheay	600	658	3	0	3
Memot	Choam Kravien	143	Satum	1,195	1,311	5	0	5
Memot	Choam Kravien	144	Kravien Cheung	540	592	3	0	3
Memot	Choam Kravien	147	Chrey Laeung	350	384	2	0	2
Memot	Choam	159	Boeng Chroung	562	616	3	0	3
Memot	Choam	160	Choam Ampil	489	536	3	0	3
Memot	Choam	162	Cheung	490	537	3	0	3
Memot	Choam	163	Leach Leu	602	660	3	0	3
Memot	Choam	167	Ngiev	668	733	3	0	3
Memot	Choam	168	Leach Kraom	1,092	1,198	5	0	5
Ponhea Kraek	Popel	169	Tuol Kandal	700	768	4	0	4
Ponhea Kraek	Popel	171	khsak	1,453	1,593	5	0	5
Ponhea Kraek	Kandaol Chrum	179	Tuol Chamkar	821	900	4	0	4
Dambae	Chong Cheach	227	Cheach Cheung	1,368	1,500	5	0	5
Tboung Khmum	Moung Rieng	267	Thnong	1,130	1,239	5	0	5
Tboung Khmum	Moung Rieng	268	Mong Ti Prammuoy	660	724	3	0	3
Tboung Khmum	Moung Rieng	269	Mong Ti Prampir	797	874	3	0	3
Tboung Khmum	Sralab	271	Trapeang Sangkae	588	645	3	0	3
Tboung Khmum	Anhchaeum	272	Trapeang Chak	549	602	3	0	3
Tboung Khmum	Anhchaeum	273	Chheu Teal Chrum	589	646	2	0	2
Tboung Khmum	Lngieng	285	Lngieng	868	952	5	0	5
Tboung Khmum	Vihear Luong	287B	Kien Rung	407	446	2	0	2
Tboung Khmum	Vihear Luong	289	Prasrae Leu	547	600	2	0	2
Tboung Khmum	Suong	291	Chrak Poun	719	789	4	0	4
Tboung Khmum	Thma Pechr	294	Chambak	1,216	1,334	5	0	5
Tboung Khmum	Thma Pechr	295	Chies Ti Muoy	1,013	1,111	4	0	4
Tboung Khmum	Roka Po Pram	297	Trapeang Khla	2,220	2,435	5	0	5
Tboung Khmum	Roka Po Pram	298	Ta Pav Bampenh Tes	2,700	2,961	5	0	5
Tboung Khmum	Roka Po Pram	299	Pong Tuek	1,712	1,878	5	0	5
Total				98,872	108,431	374	6	380
Number of Villages						109	6	115

Annex-II

List of Equipment to be procured under the Japan's Grant Aid Project

Equipment No.	Name of Equipment	Specification/Ability	Qty	Purpose of use
A	**Survey and Testing Equipment**			
A.1	Well logging equipment			
A.1.1	Well logger	Logging depth 150m or more, specific resistance, Self-Potential (SP), SP-γ logging equipment	1	Development of casing program, and data collection of the geological figure
A.1.2	Note PC for the site use	Anti-shock, dust and drip proof	1	Analysis of well logging results on-site, and development of casing program
A.2	Well cleaning equipment and material			
A.2.1	Low pressure compressor	Skid Type, Out put Pressure 7.0kg/cm^2(100psi), Out put air volume 8.5m^3/min (300psi)	1	Cleaning of the well for pumping test
A.2.2	Well cleaning parts	Raiser pipes, flange etc.	1	Cleaning of the well for pumping test
A.3	Test pumping equipment			
A.3.1	Underwater motor pump	Suit for 4 inch. Casing type Pump displacement 80 L/min or more Pump head 80m or more	1	Pumping test
A.3.2	Diesel generator	Output rating 10KVA or more, Frequency 50Hz,380V, Three-phase	1	Pumping test
A.3.3	Triangular weir	Measurable water volume 200L/min or more	1	Mesurement of Water volume in pumping test
A.3.4	Water level gauge	Measurable depth 100m or more	1	Mesurement of Ground water level in pumping test
A.4	Water quality analyzing equipment			
A.4.1	Water quality analyzer	Portable spectroscope type	1	Water quality analysis at site office
A.4.2	Turbidity meter	Measurable Range from 0 to 1000NTU or more	1	On-site water quality analysis (Turbidity meter)
A.4.3	Conductivity meter/TDS mete	Conductivity : Measurable Range from 0 to 19.9mS/cm and 3 range or more TDS : mesurable range 0~1999 mg/L	1	On-site water quality analysis (Conductivity meter/TDS meter)
A.4.4	pH meter	Measurable range 0-14	1	On-site water quality analysis (pH meter)
A.4.5	ORP meter	Measurable range ±2000mv	1	On-site water quality analysis (oxidation reduction potential)
A.4.6	Incubator	Mini desktop type, preset temperature 30-40℃	1	Germ culture for water quality analysis
A.5	Truck with cane	4WD Left hand Draive, crane lifting capacity 3t or more, GVW 10t or more	2	Transport of testing equipment and material
A.6	Pickup	4WD Left hand Drive, Seat 5 persons or more, Double cabin	2	Transport of testing staff/materials to testing site
B	**Equipment for Operation and Maintenance**			
B.1	Pickup	4WD Left hand Drive, Seat 5 persons or more, Double cabin	1	Transport of personnel for O&M, Strengthening activity and material for Hand Pump repairing
B.2	Motor bike	Engine 125cc or more, family type	4	Sanitary education and strengthening activities of O&M staff
B.3	Video set			
B.3.1	Video camera	Degital Video, PAL system, AC 220V / Battery	1	Sanitary education/strengthening activities/workshops
B.3.2	Video player	VHS,PAL system, AC 220V	1	Sanitary education/strengthening activities/workshops
B.3.3	Television	20 inch., color, stereo sound, AC 220V	1	Sanitary education/strengthening activities/workshops
B.4	Projector set			
B.4.1	Desktop computer	Pentium M 1.5GHz or more, HDD 40G or more, CDRW-DVD Compatible, 14.1 inch TFT or more, MS office XP Professional, AC220V	1	Sanitary education/strengthening activities/workshops
B.4.2	Projector	SVGA 800x600, Multi system, AC 100V~220V	1	Sanitary education/strengthening activities/workshops
B.4.3	Screen	60 inch x 60 inch or more, Tripod stand	1	Sanitary education/strengthening activities/workshops
B.4.4	Portable generator	0.9kVA, Gasoline type	1	For projector in village use
B.5	Computer set			
B.5.1	Desktop computer	Pentium IV 2.4GHz or more, HDD 40G or more, CDRW-DVD Compatible, 14.1 inch TFT or more, MS office XP Professional, AC220V	1	Database development of well drilling
B.5.2	UPS	Max. capacity 1200VA or more	1	Stabilizing of the Alternating current
B.5.3	Printer	Color laser printer, A3 size printable AC 220V	1	Database development of well drilling

Annex-III

List of Equipment to be allocated by DRWS for the Japan's Grant Aid Project

	Items	Q'ty	Specification	Remark
Drilling equipment and supporting vehicles				
1	Drilling rig	1	Truck mounted drilling rig YTD-45B	YBM
2	Drilling tools	1	drilling bits, rod etc.	YBM
3	High pressure air compressor with Cargo Track	1 1	Discharge air capacity 21.2m^3/min Load 6t	Airman Nissan Diesel
4	Cargo truck with crane	1	Load 6t , Lifting capacity 3t	Isuzu
5	Water tank truck	1	6,000 litter	Isuzu
6	Fuel tank truck	1	4,000 litter	Isuzu
7	Pick-up truck for well drilling	1	4WD, 5 persons, Load 0.5t	Isuzu
Survey and test equipment				
1	Resistivity survey equipment	1	Measurable depth not less than 150m	IRIS
2	Borehole logging equipment	1	Measurable depth 150m	RG LOG
3	Low pressure air compressor	1	Discharge air capacity 8.5m^3/min	Airman
4	Pumping test equipment	1	Pumping Volume 100 L/min and Head 80m, Generator 6.5 KVA	
5	Water analysis kit	1	Portable type, 11 items including arsenic	
6	Pick-up truck for Resistivity Survey	1	4WD, 5 persons, Load 0.5t	Isuzu

* The above equipments were procured by the Japan's Grant Aid Project "The Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh City".

5. References and Documents

List of References and documents

No	Name	Forms Print・Video Map・Photo etc	Original/ Copy	Published Organization	Year
1	CAMBODIA MILLENNIUM DEVELOPMENT GOLES REPORT 2003	Print	Copy	Ministry of Planning	2003.11
2	NATIONAL POVERTY REDUCTION STRATEGY 2003-2005	Print	Original	Council for Social Development CDS	2002.12
3	SECOND FIVE YEAR SOCIOECONOMIC DEVELOPMENT PLAN 2001-1005	Print	Copy	ROYAL GOVERNMENT, KINGDOM OF CAMBODIA	2002.7
4	SECTOR INVESTMENT PLAN 2003-2012 RURAL WATER SUPPLY AND SANITATION SECTOR(RWSS)	Print	Copy	Ministry of Rural Development	2002.9
5	ASIAN DEVELOPMENT BANK, RURAL WATER SUPPLY & SANITATION PROJECT FINAL REPORT Volume 2, Core Subprojects Appraisal Reports	Print	Copy	BECON in association with SAWAC	2002.8
6	NATIONAL POLICY ON WATER SUPPLY AND SANITATION	Print	Copy	Coordinating Committee for Development of Water Supply and Sanitation Sector	2004.9
7	Summary Situation Analysis, Arsenic Contamination of Groundwater in Cambodia	Print	Copy	The 3rd Meeting of Arsenic Inspection Sub Committee	2004.10
8	DRINKING WATER QUALITY STANDARDS	Print	Copy	Ministry of Industry Mines and Energy	2004.1
9	National Census of the victims & survives of landmines & unexploded ordnance in Cambodia 2002	Print	Original	Handicap International Cambodian Red Cross	2003.7
10	Annual Report 2003	Print	Original	Cambodia Mine Action Centre	2004