NO

Ministry of Rural Development
Department of Rural Water Supply
The Kingdom of Cambodia

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

March 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

KOKUSAI KOGYO CO., LTD.

GE
JR
09-038

Ministry of Rural Development
Department of Rural Water Supply
The Kingdom of Cambodia

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

March 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

KOKUSAI KOGYO CO., LTD.

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 Memot District of Kampong Cham Province and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Kingdom of Cambodia a study team from October 2, 2008 to November 10, 2008 .

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

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

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

March 2009

Masafumi KUROKI
Vice President
Japan International Cooperation Agency

March 2009

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Rural Drinking Water Supply in Memot District of Kampong Charm 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 2008 to March 2009. 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,

Satoshi ISHIDA
Project manager,
Basic design study team on
The Project for Rural Drinking Water Supply
in Memot District of Kampong Cham Province
Kokusai Kogyo Co., Ltd.

Summary

1. COUNTRY OVERVIEW

(1) Land and Nature

The Kingdom of Cambodia is located in the south-western part of the Indochina peninsula and has a total national land area of 181,000km². The target site of this Study, Memot District of Kampong Cham Province, is situated in the central eastern part of the country, bordering Viet Nam to the east and south.

The target site has a tropical monsoon climate, with the year being divided into two seasons, the dry season from November to April and the rainy season from May to October. The average yearly temperature is 27.5˚C and the temperature goes higher from March to August with its peak in April. It is relatively cool for the period from September to February and the lowest temperature is recorded in December. There can be a 1 or 2 month difference in the classification of seasons into the rainy season and the dry season. The annual rainfall has ranged between 1,100mm and 2,000mm from year to year since 1994, when meteorological observation started in the country and the average annual rainfall is around 1,500mm. Also, about 75% of the annual rainfall is recorded in the rainy season which continues for about half a year. But, the rainy season often does not start at around the same time every year and it stretches even for up to 7 or 8 months a year. When it continues for up to 7 or 8 months, the rainfall during the rainy season can account for 85-90% of the country's total annual precipitation.

Geologically, the target site of this Study can be divided largely into 2 physiographic regions: a low-lying region and a hilly region. In the low-lying region that closes around the hilly region, diluvial plains (at an altitude of 20-50m) have developed. The hilly region is gently sloped and has a rather low-altitude above sea level (at an altitude of 150-200m in the eastern part) and is characterized with its plateau-like shape with a flat top. The geological feature of the target site is a composition of sandstone, shale and limestone, which represents a marine formation of the Mesozoic age. The target site is mostly composed of sandstone with shale pinched in here and there. On the bedrock of this geological formation, there are three geological layers developed and distributed over a large area. The three layers are as follows from bottom to top: Continental sediment of the Tertiary Era (unconsolidated gravel, sand, silt and clay and the alternation of these); Diluvial formation of the Quaternary Era (unconsolidated gravel, sand, silt and clay and the alternation of these); and, Alluvial formation of the Quaternary Era (unconsolidated gravel, sand, silt and clay and the alternation of these). In addition to these sedimentary layers there is a distribution of basaltic lava layer in a vast area which was blown off from volcanic mountains during the Pliocene period of the Tertiary Era and the Pleistocene period (diluvial epoch) of the Quaternary Era. The lava bed generated by volcanic activity in earlier years generally forms the plateau-like hilly region in the Project site and lava of the Quaternary Era generally shapes the low-lying hilly region to the west of the Project site. Since volcanic activities during these two periods occurred

more than one time, the lava layer often interfingers with sedimentary layers of the same periods. In the western part, the lava layer ends are wedged between the diluvial and alluvial layers.

（2） Socioeconomic Status

According to the preliminary figures of the population census conducted in 2008, the total population of Cambodia is 13,388,910, with an annual average population growth rate since 1998 of 2.55% in urban areas, 1.30% in rural areas, and 1.54% as the national average. Meanwhile, the population of Kampong Cham Province totals 1,680,694 and the province's annual average population growth rate is 2.14% in urban areas and 0.32% in rural areas.

Although the country's GDP growth has somewhat slowed down since 2005, its people's individual earnings have steadily increased. In addition, approximately 80% of revenues in the national budget are appropriated to the ordinary budget and, therefore, Cambodia has no other choice but to rely on foreign assistance for approximately 80% of its development budget (special project budget).

The financial base of DRWS, the organization in charge of the implementation of this Project in Cambodia, is also fragile and the majority of previous local water supply-related programs could become a reality through assistance from international organizations such as World Bank, Asian Development Bank and UNICEF or through bilateral aid programs between foreign governments

2. Background of the Project

（1） Overall Programs related to this Project

The government of Cambodia aims to increase the supply rate of safe and stable water supply in rural areas from 27% in 2000 to 50% in 2015 in "Cambodian Millennium Development Goals" (CMDGs).

The government of Cambodia also aims to achieve "Every person in rural communities has sustained access to safe water supply and sanitation services and lives in a hygienic environment by 2025" in "National Water Supply and Sanitation Sector Policy."

This project will contribute to the improvement of the rural water supply included in "Sector Investment Plan 2005-2015 for Rural Water Supply and Sanitation Sector" as part of the above targets.

（2） Current Conditions and Issues of this Sector

In Memot District, Kampong Cham Province, which is the target site of this Project, Japan's grant aid program, the "Project for Rural Drinking Water Supply in Kampong Cham Province," was carried out in

FY 2005 and FY2006 and, as a result, the supply rate of safe water in the targeted 96 villages improved significantly from 9.5%[1] to 82%.

Meanwhile, of 52 target villages in the Project site, only 5 villages have a safe water supply system in place, in spite of all these villages being in the same Memot District. Also the safe water supply rate accounts for just 6.5% in the 52 villages, and the rate is significantly lower than the goal of the country's rural water supply rate of 50%, which is a goal to be achieved by 2015 under CMDGs.

Although residents of the target site get drinking water mainly from dug wells, most of these wells are contaminated by coli bacteria, etc., as surface water such as rainwater flows and penetrates into them. As the result, the area is suffered from pervasive diseases such as diarrhea caused by contaminated water.

In addition, because not a few such hand-cut wells dry up during the dry season, people living in the target site suffer great hardship caused by the short supply of safe water. Therefore, improvement in rural water supply is an urgent issue in the area.

（3） Project goal

This project aims to increase the supply rate of safe and stable water supply from 6.5% to 92.7% for 33,075 people in 2015 by providing a safe and sustainable drinking water supply facilities in 52 villages in Memot district where the situation of safe drinking water supply is very serious.

（4） Related investigation

Previously, Japan carried out both the Study on Ground Water Development in Southern Cambodia (1996-2001) and the Study on Ground Water Development in Central Cambodia (2000-2002) and, later, based on the results of these 2 studies, the grant aid project called the "Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh City" (2000-2003) was carried out as the primary program. In rural areas in Cambodia, however, the water supply rate still remained low and, therefore, the grant aid project entitled the "Project for Rural Drinking Water Supply in Kampong Cham Province, Phases I/II and II/II" (2005-2006) was carried out as the secondary program following the primary program, particularly with a focus on Kampong Cham Province where the lowest water supply was recorded of the 4 provinces in the central and southern parts of Cambodia.

[1] Since there is no clear definition of the safe water supply rate in Cambodia, the supply rate was calculated based on the specifications of the water supply program under this Project. The supply rate was obtained as follows: Based on the assumption that 1 hand-pump well can supply water to a population of 210 people, the number of hand-pump wells installed in the area was multiplied with 210 and then the figure obtained was divided by the total population of the area.

3. Result of the Study and Contents of the Project

(1) Summary of Result of the Basic Design Study

The based on the above background, Japan International Cooperation Agency (JICA) decide to send basic design study team to Cambodia form October 2, 2008 to November 10, 2008 and from February 12, 2009 to February 21, 2009. The team conducted natural condition survey (field survey, water quality analysis, geophysical prospecting) and social condition survey (hearing at target village).

The summary of result for the field survey and study in Japan are as below.

i) Hand pump well scheme

52 target villages were selected for implementation under the selection criteria based on field surveys, including those on the natural and social conditions in 72 villages, as shown in Appendix.

(2) Contents and Scale of the Project

A. Facility Construction

A detailed list of facilities which will be constructed in this project is given below.

Table 1: Facilities planned for this project

Description	Total	Contents
Target Village	52 villages	
Borehole Construction	136 locations	Including installation of casing and screen
Platform Construction	136 locations	Concrete platform, 3.0m of drainage
Installation of Hand pump	136 locations	Afridev type
Procurement and set up of iron removal device	11 locations	Stainless
Procurement and set up of hygiene education billboard	11 locations	Stainless

B. Soft Component

Procured facility is planned content based on capability of residents. However resident's capability for operation and maintenance is partially seems insufficient, therefore soft component activity shall be introduced to support for improvement of their capacity.

Output of the activities shall be confirmed by an operation & maintenance training implementation

report, hygiene education implementation report, soft component implementation status report, etc.,.

The soft component activities and output are summarized as follows.

Table 2: Project activities and output

Item	Activities	Output
Workshop for PDRD・DORD	A workshop will be held for PDRD and DORD staff in order to determine project contents, and implementation plan and method for soft component activities.	The support system of O&M of PDRD and DORD is strengthened.
Formation of resident organization	The objective and the contents of the project are explained. The residents' participation and cooperation intentions shall be confirmed. The necessity for WSUG is explained and shall be established. The necessity for O&M fund is explained and shall be collected. The bank account to deposit O&M fund shall be established.	WSUG is established as a sustainable O&M organization.
Residents' participation	Construction site for water supply facilities shall be determined through democratic discussion. Residents' responsibilities shall be explained and their intent to cooperate confirmed. Access roads to and the cleaning of well drilling sites shall be constructed by residents. Fore slope planting, construction of drainage canal, and livestock protection fence shall be constructed by residents.	Residents will conduct O&M with a sense of ownership.
Hygiene education	Participatory Hygiene and Sanitation Transformation program (PHAST) of MRDs DRHC, shall be implemented.	Resident's consciousness of health and healthy habits improved.

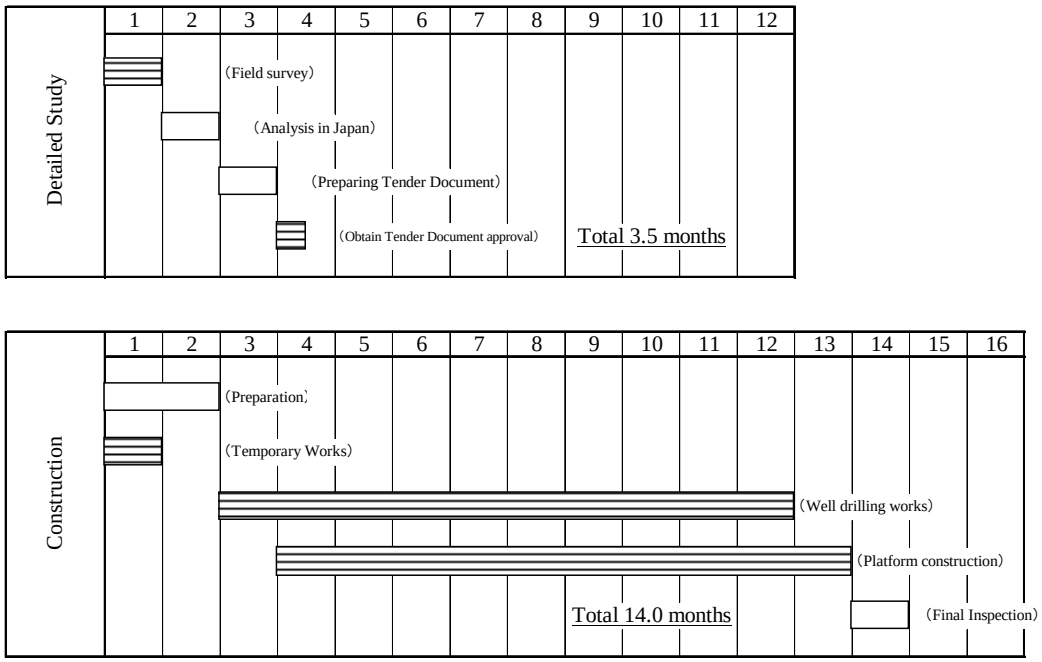
Item	Activities	Output
Instruction of O&M	The role which WSUG should perform shall be explained. Management method of the O&M fund deposited in a bank account shall be explained. Daily Management method shall be instructed. Maintenance of fore slope planting, construction of drainage canal, and livestock protection fence, shall be instructed. Replacement and procurement method of spare parts shall be instructed. Correspondence procedure for the request of maintenance support to DORD shall be instructed. Maintenance method for iron removal device shall be instructed.	WSUG will master the techniques for O&M.

4. Implementation Schedule and Project Cost Estimation

(1) Implementation schedule

The implementation schedule of this project is shown below:

Table 3: Implementation schedule



(2) Project Cost Estimation

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

- Obligation of Cambodia side

Cambodia's obligations are as shown in the table below.

Table 4: Cambodia's Obligation

Project Expenses	Total amount (US$)	Remarks
Bank Charge	1,839	Opening of B/A, Issuing of A/P

5. Project Evaluation

The implementation of this project under the Japanese Grant Aid system based on the results of this basic design study is judged to be appropriate from the following points.

① If this Project is implemented, the safe water supplied population in the target site will increase from 2,100 (2008) to 33,075 (2015) and this Project can contribute to an improvement in the access rate to safe water in Cambodia.

② Residents in the target site have been forced to use unsanitary water sources such as hand-drilled wells (dug wells) and surface water (river and ponds). If this Project is implemented, residents in the target site will be able to have access to safe drinking water in a stable manner and this Project can contribute significantly to the improvement of their living environment.

③ DRWS, which belongs to the Ministry of Rural Development and at the same time is the organization implementing this Project on the Cambodian side, and PDRD of Kampong Cham Province and DORD of Memot District, which are local organizations of the Ministry, have capabilities to support activities to repair target facilities and to procure spare parts and to establish residents' organizations as well as capabilities to implement components of this Project including those for sanitation education. In addition, facilities to be constructed in this Project are common in Cambodia, and particular techniques for operation and maintenance/management will be unnecessary.

④ In its National Policy on Water Supply and Sanitation, the government of Cambodia intends to make sustainable and safe drinking water available to each and every resident in rural areas by 2025. This

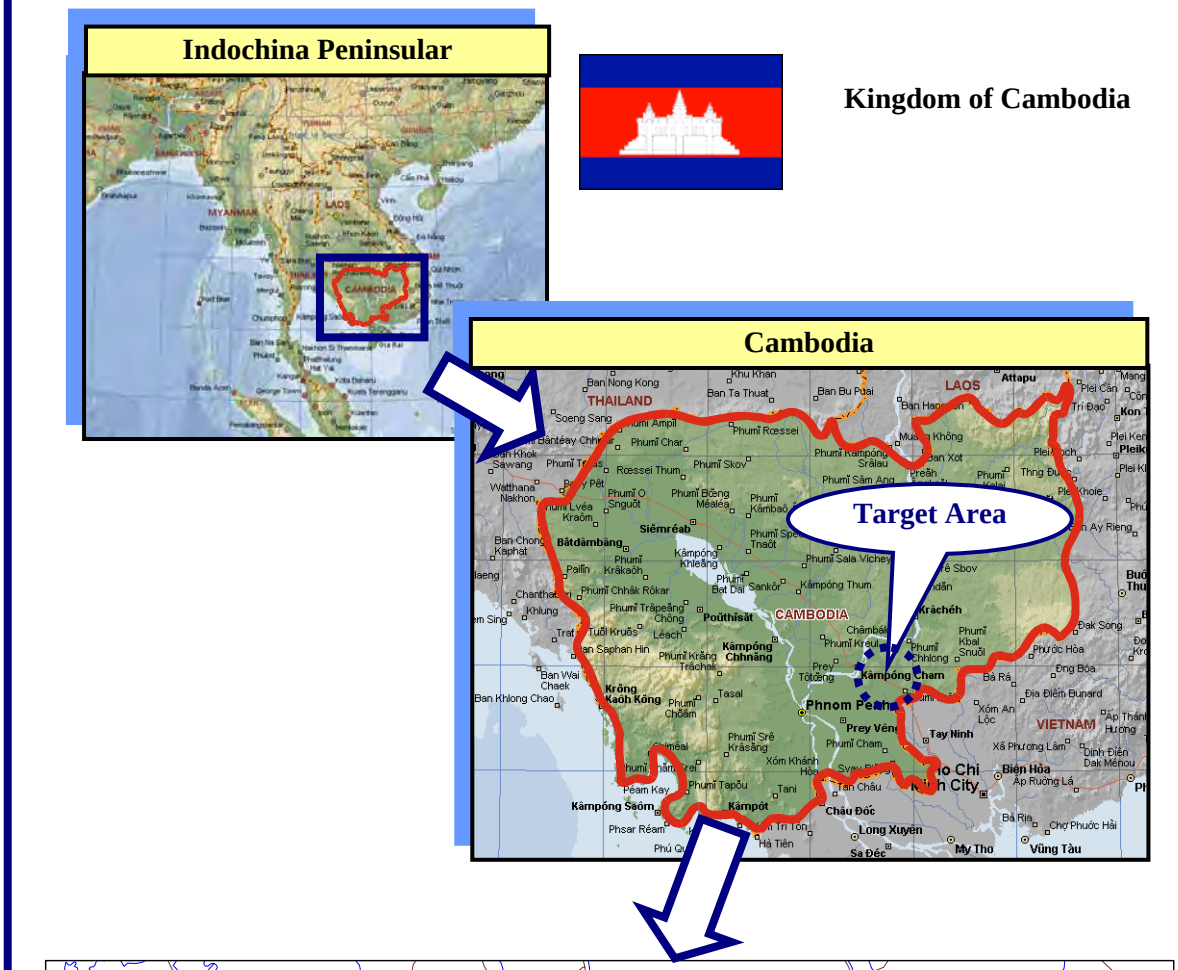
Project can help the government to achieve this goal of their national policy.

⑤ Costs to maintain and manage hand-pump wells to be constructed in this Project will be within the range that residents in the target site can cover with their revenues and they can maintain and manage the water supply facilities in a sustainable manner, too.

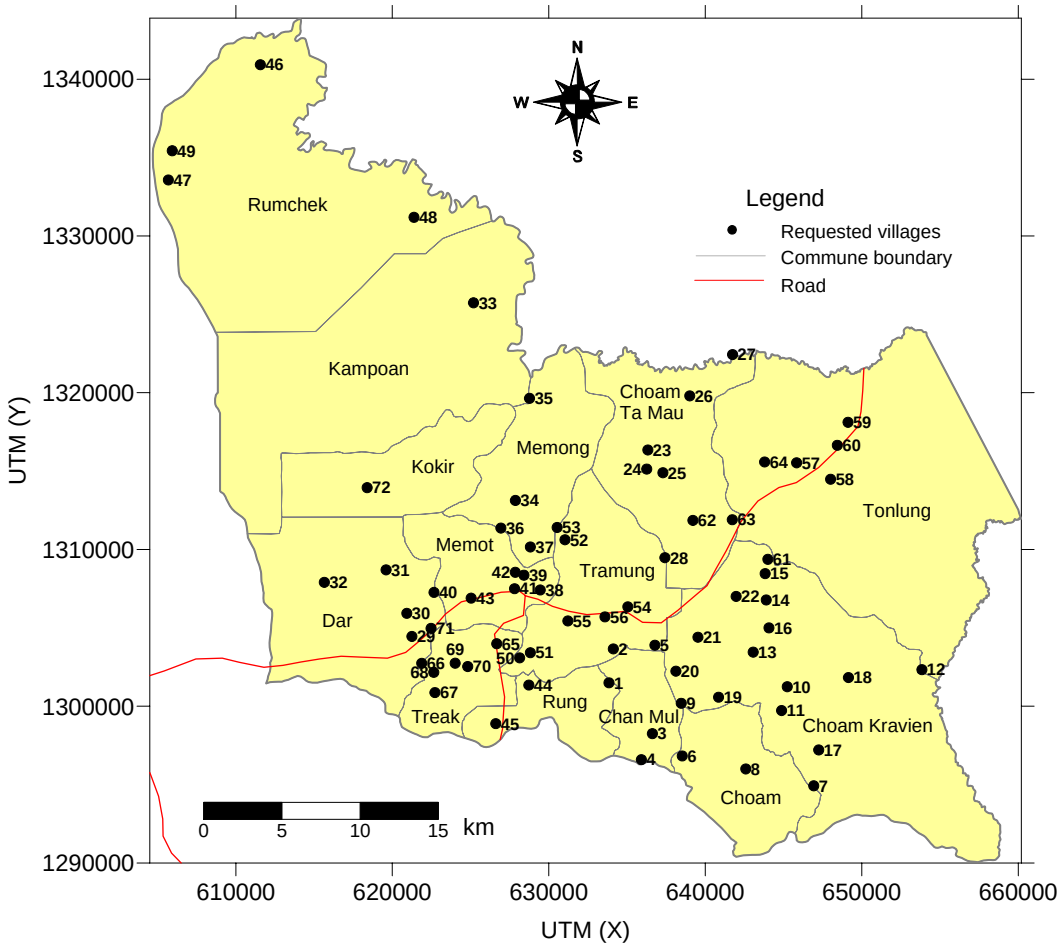
⑥ In the initial environmental evaluation (IEE) carried out during the development study, it was confirmed that there would be no adverse environmental effect in implementing this Project.

⑦ There are no particular impediments to the implementation of this project under the Japanese Grant Aid system.

Contents



LOCATION MAP OF THE STUDY AREA-1



Commune	ID	Village	Population 2008	Commune	ID	Village	Population 2008
Chan Mul	1	Ta Kaev	296	Memong	37	Sambour	179
Chan Mul	2	Peam	155	Memot	38	Masin Tuek	610
Chan Mul	3	Ta Lou	102	Memot	39	Tboung Voat	1,907
Chan Mul	4	Amphol		Memot	40	Chhngar Kaeut	345
Chan Mul	5	Khlong Tboung	134	Memot	41	Memot Thmei	271
Choam	6	Choam	245	Memot	42	Special Settlement (Trapaeng Raen	1,735
Choam	7	Mong	245	Memot	43	Sangkum Meanchey Thmei	1,005
Choam	8	Poploam	321	Rung	44	Andoung Ta Chou	692
Choam	9	Stueng Angkam	289	Rung	45	Doun Roadth Ti Muoy	854
Choam Kravien	10	Kravien Thum	1,244	Rumchek	46	Rumchek	2,199
Choam Kravien	11	Doung	1,211	Rumchek	47	Thma Dab	1,076
Choam Kravien	12	Thma Ta Daok	67	Rumchek	48	Srae Pongro	721
Choam Kravien	13	Kbal Slaeng	327	Rumchek	49	Khliech	556
Choam Kravien	14	Mkhaoh	447	Tramung	50	Ou Khlout	209
Choam Kravien	15	Mroan	504	Tramung	51	Tramaeng Kraom	168
Choam Kravien	16	Thma Da	315	Tramung	52	Ngeu Thmei	263
Choam Kravien	17	Danghet	377	Tramung	53	Trapeang Ngeu	164
Choam Kravien	18	Khmuor	535	Tramung	54	Doung Pir	365
Choam Kravien	19	Prei	768	Tramung	55	Sambour	565
Choam Kravien	20	Banghaeur Huos	364	Tramung	56	Krouch	280
Choam Kravien	21	Robang Chroh	420	Tonlung	57	Kdol Phsar	1,155
Choam Kravien	22	Chi Plok	310	Tonlung	58	Changkum Ti Muo	578
Choam Ta Mau	23	Ta Mau Cheung	171	Tonlung	59	Spean Changkum	383
Choam Ta Mau	24	Ta Mau Kaeut	790	Tonlung	60	Kaoh Thma	679
Choam Ta Mau	25	Tuol Kruos	344	Tonlung	61	Mkaor	385
Choam Ta Mau	26	Srae Ta Pich	605	Tonlung	62	Lvea Leu	397
Choam Ta Mau	27	Koun Krapeu	388	Tonlung	63	Sla	321
Choam Ta Mau	28	Lam Baor	235	Tonlung	64	Special Settlement (Pons Tuek)	2,004
Dar	29	Chamkar Kor	563	Treak	65	Dak Por	1,118
Dar	30	Salang Ti Mouy	1,126	Treak	66	Bangkov	1,102
Dar	31	Salang Ti Pir	2,024	Treak	67	Prei	493
Dar	32	Kang Keng	330	Treak	68	Khley	387
Kampoan	33	Srae Kandal	1,246	Treak	69	Romeas Choul	213
Memong	34	Peuk	406	Treak	70	Preah Ponlea	816
Memong	35	Kambas	1,078	Treak	71	Samraong	1,113
Memong	36	Cheach	358	Kokir	72	Chamkar Thmei	1,014

Location Map of the Study Area-2

Figure List

Table List

Abbreviations

ADB	Asian Development Bank
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
CPI	Consumer Price Index
D/D	Detailed Design
DORD	District Office of Rural Development
DRHC	Department of Rural Health Care
DRWS	Department of Rural Water Supply
DTH	Down-the-hole hammer
EIA	Environmental Impact Assessment
E/N	Exchange of Notes
EU	European Union
GDP	Gross Domestic Product
GNI	Gross National Income
IEE	Initial Environmental Examination
IMF	International Monetary Fund
IRD	Iron Removal Device
JICA	Japan International Cooperation Agency
M/D	Minutes of Discussions
MDG	Millennium Development Goals
MDRI	Multilateral Debt Relief Initiative
MIME	Ministry of Industry, Mining and Energy
MLMUPC	Ministry of Land Management, Urban Planning and Construction
MOH	Ministry of Health
MRD	Ministry of Rural Development
NPRS	National Poverty Reduction Strategy
NSDP	National Strategic Development Plan
O/M	Operation and Maintenance
PDM	Project Design Matrix
PDRD	Provincial Department of Rural Development
PHAST	Participatory Hygiene and Sanitation Transformation
PIC	Plan International Cambodia
PRDC	Provincial Rural Development Committee
PVC	Polyvinyl Chloride
RWSS	Rural Water Supply and Sanitation
SEDP	Socio-Economic Development Plan
SEILA	Name of Cambodian Government's Program
SIP	Sector Investment Plan
SNV	Stichting Nederlandse Vrijwilligers
UNICEF	United Nations Children's Fund
USD	United States Dollar
VDC	Village Development Committee

WSUG	Water and Sanitation User's Group
WB	World Bank
WHO	World Health Organization

Chapter 1 Background of the Project

Chapter 1. Background of the Project

1-1 Background of the Project

Cambodia has included as an objective in its Millennium Development Goals (CMDGs, established in 2003) an increase in the water supply rate in rural areas from 24% in 1998 to 50% in 2015. The Department of Rural Water Supply under the Ministry of Rural Development in charge of rural water supply projects has implemented a large number of such projects in cooperation with Japan, other countries and NGOs and international organizations, such as UNICEF. As a result, the rural water supply rate had risen to 41.6% by 2005 according to the National Strategic Development Plan (NSDP), and aims to achieve 45% by 2010.

Previously, Japan carried out both the Study on Ground Water Development in Southern Cambodia (1996-2001) and the Study on Ground Water Development in Central Cambodia (2000-2002) and, later, based on the results of these 2 studies, the grant aid project called the "Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh City" (2000-2003) was carried out as the primary program. In rural areas in Cambodia, however, the water supply rate still remained low and, therefore, the grant aid project entitled the "Project for Rural Drinking Water Supply in Kampong Cham Province, Phases I/II and II/II" (2005-2006) was carried out as the secondary program following the primary program, particularly with a focus on Kampong Cham Province where the lowest water supply was recorded of the 4 provinces in the central and southern parts of Cambodia. As the result, in this Project's target site, a water supply infrastructure was developed and accessibility to safe water was significantly improved. In the "Project for Rural Drinking Water Supply in Kampong Cham Province," conducted as the secondary program, a total of 355 wells were constructed in 115 villages in 4 districts in the eastern part of Kampong Cham Province. The villages targeted in the project were concentrated in Memot District where the water supply rate was lower than the other 3 districts. A total of 289 wells were constructed in 95 villages in Memot District. Nevertheless, the water supply rate in Memot District remains lower than other districts in Kampong Cham Province and the rate in villages not targeted in the previous project is particularly low at less than 5%. Considering the situation, the government of Cambodia requested Japan in August 2007 to offer a grant aid so that wells will be constructed in 72 villages in Memot District where residents are experiencing a worse water supply condition.

1-2 Natural Condition

The Kingdom of Cambodia is located in the south-western part of the Indochina peninsula and has a total national land area of 181,000km². The target site of this Study, Memot District of Kampong Cham

Province, is situated in the central eastern part of the country, bordering Viet Nam to the east and south.

The target site has a tropical monsoon climate, with the year being divided into two seasons, the dry season from November to April and the rainy season from May to October. The average yearly temperature is 27.5˚C and the temperature goes higher from March to August with its peak in April. It is relatively cool for the period from September to February and the lowest temperature is recorded in December. There can be a 1 or 2 month difference in the classification of seasons into the rainy season and the dry season. The annual rainfall has ranged between 1,100mm and 2,000mm from year to year since 1994, when meteorological observation started in the country and the average annual rainfall is around 1,500mm. Also, about 75% of the annual rainfall is recorded in the rainy season which continues for about half a year. But, the rainy season often does not start at around the same time every year and it stretches even for up to 7 or 8 months a year. When it continues for up to 7 or 8 months, the rainfall during the rainy season can account for 85-90% of the country's total annual precipitation.

Geologically, the target site of this Study can be divided largely into 2 physiographic regions: a low-lying region and a hilly region. In the low-lying region that closes around the hilly region, diluvial plains (at an altitude of 20-50m) have developed. The hilly region is gently sloped and has a rather low-altitude above sea level (at an altitude of 150-200m in the eastern part) and is characterized with its plateau-like shape with a flat top. The geological feature of the target site is a composition of sandstone, shale and limestone, which represents a marine formation of the Mesozoic age. The target site is mostly composed of sandstone with shale pinched in here and there. On the bedrock of this geological formation, there are three geological layers developed and distributed over a large area. The three layers are as follows from bottom to top: Continental sediment of the Tertiary Era (unconsolidated gravel, sand, silt and clay and the alternation of these); Diluvial formation of the Quaternary Era (unconsolidated gravel, sand, silt and clay and the alternation of these); and, Alluvial formation of the Quaternary Era (unconsolidated gravel, sand, silt and clay and the alternation of these). In addition to these sedimentary layers there is a distribution of basaltic lava layer in a vast area which was blown off from volcanic mountains during the Pliocene period of the Tertiary Era and the Pleistocene period (diluvial epoch) of the Quaternary Era. The lava bed generated by volcanic activity in earlier years generally forms the plateau-like hilly region in the Project site and lava of the Quaternary Era generally shapes the low-lying hilly region to the west of the Project site. Since volcanic activities during these two periods occurred more than one time, the lava layer often interfingers with sedimentary layers of the same periods. In the western part, the lava layer ends are wedged between the diluvial and alluvial layers.

1-3 Environmental and Social Consideration

(1) Result of Initial Environmental Evaluation (IEE) for the Study on Ground Development in Central

Cambodia

Initial Environmental Evaluation (IEE) was conducted in the development study on groundwater development in central Cambodia (JICA, 2000) which is the basis of this project, Based on the "Environmental Consideration Guideline for Development Studies (VIII Groundwater Development)" established by JICA(1994). The following results were obtained.

1) Social Environment

a. Not included in IEE: Residents move, economic activity, traffic/life institution, local division, and ruins/cultural properties

b. Evaluation D: Water rights, common right, waste

C. Evaluation B: Health and Hygiene

It is expected in general that the use of borehole well with hand pump can provide more safe groundwater with less contamination by coliform/bacteria, polluted surface water, domestic waste, agriculture chemicals, etc. often found in dug well. However, it is revealed by the water quality analysis done in the study at the newly constructed test wells that the groundwater from some test wells is not suitable for drinking directly, because the water has some chemicals more than the WHO guideline values. Particular from the view of health impact, arsenic (As), fluoride (F), manganese (Mn), and nitrate (NO_3) should be taken into account for the evaluation.

By the comparison of existing well water and newly constructed test well water, the latter can provide better groundwater with less contamination of arsenic, manganese and nitrate. However, the comparison shows that the fluoride concentrations of the test wells are worse in some area than of existing well.

Although the problematic areas in the study area were removed from the proposed groundwater development plan, there is a possibility that chemical substance that poses a health problem may appear locally. It is, therefore, evaluated that the health and hygiene item as "B": Some impact is expected "is this study.

In the case of project implementation, it is necessary to perform further quality analysis with higher accuracy at each water source well. When a problem is found in water quality, it is necessary to take necessary measures for the removal of problematic chemical substance or the sufficient reservation of safe water.

2) Natural Environment

a. Not included in IEE: Topography/ geology, soil erosion, sea shore/ ocean, climate, and scene

b. Evaluation D: Groundwater, lake, river conditions, and animals and plants

3) Public Nuisance

a. Evaluation D: Water pollution, soil pollution, noise and vibration, and land subsidence

(2) Measures of this project

Since there is a concern that there is localized contamination of chemical substances harmful to human health in the groundwater, the project established water quality standards and implemented water quality testing of all the wells. The wells that fail to meet the water quality standards will be filled in. For this reason, drinking the groundwater from this project's wells will not adversely impact human health.

(3) Procedure by Cambodia Side

Under the sub-decree of the Environmental Impact Assessment, water supply project serving over 10,000 people will require Initial Environmental Impact Assessment (IEIA) or Environmental Impact Assessment (EIA). In this project, since the population served by each hand-pump well is set as 210 persons, it does not require an IEIA or EIA.

The letter mentioned that EIA would not be required by implementation agency is shown in Annex.

Chapter 2 Contents of the Project

Chapter 2. Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Overall Goal and Project Goal

The government of Cambodia aims to increase the supply rate of safe and stable water supply in rural areas from 27% in 2000 to 50% in 2015 in "Cambodian Millennium Development Goals" (CMDGs).

The government of Cambodia also aims to achieve "Every person in rural communities has sustained access to safe water supply and sanitation services and lives in a hygienic environment by 2025" in "National Water Supply and Sanitation Sector Policy."

This project will contribute to the improvement of the rural water supply included in "Sector Investment Plan 2005-2015 for Rural Water Supply and Sanitation Sector" as part of the above targets.

This project aims to increase the supply rate of safe and stable water supply from 6.5% to 92.7% for 33,075 people in 2015 by providing a safe and sustainable drinking water supply facilities in 52 villages in Memot district where the situation of safe drinking water supply is very serious.

2-1-2 Basic Concept of the Project

This project is to contribute to achieving the project goal and primary objective through the construction of 136 deep wells with hand pumps and the soft component for operation and maintenance, which will enable operation and maintenance of the facilities by the residents at the village level, and can provide a safe and sustainable water supply.

The table below gives a list of the requested items and is followed by a summary of project descriptions in the Project Design Matrix (PDM).

Table 2-1: Contents of Request by Cambodian Side

Item	Request	
Facility construction	Target villages	72 villages
	Construction of hand pump well facilities	179 sites
Soft component	Setting up and guidance of O&M organization	
	Hygiene campaign	

Table 2-2: Project Design Matrix (PDM)

Title of the project: Rural Drinking Water Supply in Memot District of Kampong Cham province

Period: July 2009 – March 2011 Target Area: 72 villages of Memot District Target Group: Villagers Date: January 8, 2009

Summary of Project	Indicator	Method of Measurement	Outside Conditions
Primary Objective To improve living and hygienic environment of the residents in target villages	Amount of medical expenses	Questionnaire survey	
Project Goal To supply safe and stable drinking water in target villages	-Breakdown rate of water supply facilities -Remaining balance of maintenance fund -Number of established WSUG	-Site visit -Bank account book -Site visit	No drastic changes in Cambodia's water and sanitation policy
Results 1. Water supply coverage rate will be increased in target villages. 2. Time to fetch water will be decreased. 3. Resident's health awareness of will be improved by hygiene education.	1-1.Water supply coverage rate 1-2.Number of wells constructed 2.Time to fetch water 3-1.Number of facility users 3-2.Frequency facility surroundings cleaned	1-1.Site visit 1-2.Construction record 2.Questionnaire survey 3-1.Interview 3-2.Interview	No rapid increase or migration of the population
Activities (numbers correspond to those of results) **Japanese Side** 1-1.Well drilling and facility construction 2-1.Support of residents' activities to organize WSUG 2-2. Training WSUG in how to maintain facilities 2-3. Capacity development of implementation agency to support maintenance of facilities 2-4.Establishing maintenance system 2-5.Establishing system to supply spare parts 3-1. Hygiene education **Cambodian Side** 1-1. The residents prepare access road to drilling sites 1-2. The implementing agency will explain the project to residents 1-3. Implementing agency will conduct tax exemption 2-1.Implementing agency will give instruction to residents to set up WSUG. 3-1. Implementing agency will provide hygiene education for the residents 3-2. Implementing agency will conduct monitoring for facility maintenance and continue to support WSUG	**Input** **(Japanese Side)** -Water supply facility construction -Soft component -Consulting services	**(Cambodian Side)** -Arrangement of necessary personnel and budget -Land acquisition -Preparation of access road	No unforeseeable drought or decline in groundwater level **Preconditions**

Supervising Agency: Department of Rural Water Supply (DRWS), Ministry of Rural Development (MRD);
Implementing Agency: Provincial Department of Rural development (PDRD);

WSUG: Water and Sanitation User's Group

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy

1) Selection of project sites

52 target villages were selected for implementation under the selection criteria based on field surveys, including those on the natural and social conditions in 72 villages, as shown in Appendix.

(2) Policy Relating to Natural Conditions

- Although the water quality in the project area is generally satisfactory, the water in some areas is thought to have high iron content. Therefore, this project shall pay attention when setting water quality standards regarding iron, and the installation of iron removal devices shall be examined.

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

(3) Policy Relating to Social Conditions

Since many existing water resources are surface water such as dug wells, waterborne disease is widespread. For this reason, an effective health education implementation method shall be examined.

(4) Policy Relating to Construction Conditions

1) Related Laws

In Cambodia, the Labour Code was enacted in 1997, which established many working standards, such as: statutory working hours, minimum wage, overtime pay, and paid leave of absence.

Therefore, allowances for local workers shall be set based on the estimated labour cost (standard unit price) in the locality, while accounting for 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. After clearing customs at the Port of Sihanoukville, the equipment will be transported by land via Phnom Penh to the project site in Kampong Cham province. As all of these roads are paved there should

be no problem in using them for land transport.

3) Construction Materials

Materials and equipment required for construction work shall be procured locally as much as possible. However, materials and equipment that cannot be procured locally, or can only be procured with difficulty within a given time period 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 procured locally, the cost 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 procured locally. While no cement or PVC pipes are produced in Cambodia, Thai-made products are in wide circulation and shall be procured locally.

4) Hand Pumps

Afridev hand pumps are the standard model used in Cambodia. There are two types of Afridev hand pump: 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 area, these shall be procured.

(5) Policy Relating to Utilization of Equipment Owned by Implementing Agency

1) Equipment to be borrowed from Cambodian side

Of the equipment owned by the implementing agency, the Department of Rural Water Supply, Ministry of Rural Development, the drilling shall be implemented by utilizing the following equipment supplied by Japan under the Grant Aid Project shown in Table 2-1, based on the minutes of discussion (M/D) between the study team and the implementing agency. One drilling team and two quality control teams for well drilling are organized with this equipment. In addition, the Field Survey Report has confirmed that this equipment is in a utilizable condition.

Table 2-1: Equipment List to be borrowed from Cambodia Side

	Items	Q'ty	Specification	Remark
A. 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	Discharge air capacity 21.2m^3/min, Load 6t	Airman/ Nissan Diesel

4	Cargo truck with crane*	1	Load 6t , Lifting capacity 3t	Isuzu/ UNIC
5	Water tank truck*	1	6,000 litter	Isuzu
6	Fuel tank truck*	1	4,000 litter	Isuzu
B. 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
	Ditto**	1	Measurable depth 150m	Oyo
3	Low pressure air compressor*	1	Discharge air capacity 8.5m^3/min	Airman
	Ditto**	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	Okamoto/ Airman
	Ditto**	1	Pumping volume 80 L/min and head 80m, Generator 6.5 KVA	Okamoto/ Airman
5	Water analysis instruments*	1	Portable spectrophotometer	HACH
	Ditto**	1	Portable spectrophotometer	HACH
6	Truck with Crane**	2	Load 4 ton, lifting capacity 3 ton	Hino/ UNIC
7	Pick-up truck*	1	4WD, 5 persons, Load 0.5t	Isuzu

* Equipment procured by the Japan's Grant Aid "The Project for Rural Drinking Water Supply in Peri-Urban of Phnom Penh City" in 2003.

** Equipment procured by the Japan's Grant Aid "The Project for Rural Drinking Water Supply in Kampong Cham Province" in 2006

2) Expense Distribution

Based on the minutes of discussion (M/D), the only burden to be borne by the Cambodia side is to lend equipment owned by the implementing agency for the Japanese side's use. All other expenses such as the cost of fuel, labor, consumables, repairs, overhauling; shall be borne by Japanese side.

(6) Policy Relating to Utilization of Local Companies

Since there are a few local contractors capable of drilling works of the scale and specification of this project, local contractors worked collaboratively with the Japanese contractor in the last Japanese Grant Aid Project. Also in this plan, two locally contracted drilling teams are organized. However, the local contractors have poor well drilling quality control capability, such as geophysical prospecting, borehole logging, well cleaning, pumping test, and water quality analysis. Furthermore, they do not even possess the equipment required for such quality control. For this reason, the Japanese contractor shall carry out quality control for well drilling works. Two quality control teams are organized utilizing the equipment shown in Table 2-1.

Therefore, three drilling teams and two quality control teams will undertake construction of all the wells in this plan.

(7) Policy Relating to Capability for Operation and Maintenance by Implementing Agency

In the last project the technology transfer to PDRD and DORD, local administrative organs of MRD, was carried out by DRWS, the implementing agency as facilitator, during the soft component

comprising operation and management, and hygiene education. In this plan, a soft component for operation and management and hygiene education is to be mainly conducted by PDRD, trained during the last project.

(8) Policy Relating to Grading of Facilities and Equipment

The water supply facilities will be a level-1 system consisting of a tube well, hand pump, and incidental facilities which can be easily maintained and operated by residents at a low cost.

The hand pump will be Afridev type, which is used at DRWS and throughout Cambodia, can be easily operated and maintained by residents, and spare parts are available from local agents.

The area surrounding the well will be covered with concrete and an appropriate length of drainage constructed so that dirty water on the ground does not enter the well. Banking will be constructed around the well to make a slope for draining muddy water, and reinforcing bars will be used in the concrete floor and drainage in order to prevent cracks due to any uneven settling in the future.

The well water quality will satisfy the quality level for drinking water. Iron removing devices will be installed, where necessary, as requested by local residents, in areas where iron content exceeds Cambodian standards.

Further, a notice board to enhance residents' awareness of the importance of daily maintenance and sanitary use of the well facilities will be installed near each well.

(9) Policies Relating to Construction and Procurement Methods and Work Period

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 methods that require special technology will be adopted.

2) Procurement Method

The construction materials required for this Project will be procured from the suppliers as shown in Table 2-2. Selection of a construction company shall be made by general competitive bidding, including pre-qualification to Japanese drilling companies.

Table 2-2: List of Construction Materials and Procurement

Name of equipment	Japan	Cambodia	Other countries	Remarks
Aggregate		○		
Cement		○		
Reinforcement		○		
Wood and plywood for mold form		○		
Bentonite		○		
Effervescent agent		○		
Centeriser		○		
Screen Casing Pipe		○		
Hand pump		○		

3) Work Period

The construction period of 13.5 months, starting from February 2010 to March 2011, was decided after considering: local natural conditions including rainfall and road access, the number of facilities to be constructed, and the organization of well drilling groups.

2-2-2 Basic Plan

(1) Overview of Assistance Project

- On the basis of the results of surveys of natural and social conditions conducted in 72 villages, water supply facilities will be constructed in villages where: there is a serious need for water supply, there is potential for groundwater development (in water quality and quantity), there is no possibility of participation by private constructors, and residents have the clear intention of forming organizations by themselves to participate voluntarily in the Project and sustainably maintain 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.
- Consulting service will be provided for design and supervision of the Project.
- Soft component support will be provided for the activities of the Cambodian side including maintenance and operation activities, and hygiene education.

(2) Facilities Plan

1) Water Supply Plan

A water supply plan was formulated based on design criteria approved in the minutes of discussion with DRWS as shown in Table 2-3.

Table 2-3: Design Criteria for Water Supply Plan

Items	Criteria
Target year	2015
Water demand (litres/ capita/ day)	40
Population served per deep well with hand pump	210

2) Number of Water Supply Facilities to be installed

The number of water supply facilities for 52 target villages selected under the criteria was estimated according to the following conditions and is shown in Table2-4.

- The number of installations (rounded off) is calculated by dividing estimated population in 2015 to be supplied water, by the population covered per hand pump deep well (210 people). Population growth rate used is 0.32%, which is the population growth rate in rural areas of Kampong Cham Province in the Ministry of Planning's advance report of census in 2008.
- The number of hand-pump water supply facilities per village will be limited to 5 sites based on the M/D with DRWS.

Table 2-4: Number of Water Supply Facilities to be constructed

No.	Commune	ID	Village	Population*		Number of handpump wells**		
				2008	2015	Operating	Required	Plan for the project
						2008	2015	
1	Chan Mul	1	Ta Kaev	296	303	0	1	1
2	Choam	6	Choam	245	251	0	1	1
3	Choam	7	Mong	245	251	0	1	1
4	Choam	8	Poploam	321	328	0	2	2
5	Choam	9	Stueng Angkam	289	296	0	1	1
6	Choam Kravien	10	Kravien Thum	1,244	1,272	0	6	5
7	Choam Kravien	11	Doung	1,211	1,238	0	6	5
8	Choam Kravien	14	Mkhaoh	447	457	0	2	2
9	Choam Kravien	15	Mroan	504	515	0	2	2
10	Choam Kravien	17	Danghet	377	386	0	2	2
11	Choam Kravien	18	Khmuor	535	547	0	3	3
12	Choam Kravien	19	Prei	768	785	0	4	4
13	Choam Kravien	20	Banghaeur Huos	364	372	0	2	2
14	Choam Kravien	22	Chi Plok	310	317	0	2	2
15	Choam Ta Mau	23	Ta Mau Cheung	171	175	0	1	1
16	Choam Ta Mau	24	Ta Mau Kaeut	790	808	0	4	4
17	Choam Ta Mau	25	Tuol Kruos	344	352	0	2	2
18	Choam Ta Mau	28	Lam Baor	235	240	0	1	1
19	Dar	29	Chamkar Kor	563	576	0	3	3
20	Dar	30	Salang Ti Mouy	1,126	1,151	0	5	5
21	Dar	31	Salang Ti Pir	2,024	2,070	0	10	5
22	Dar	32	Kang Keng	330	337	0	2	2
23	Kampoan	33	Srae Kandal	1,246	1,274	1	6	5
24	Memong	34	Peuk	406	415	0	2	2
25	Memong	35	Kambas	1,078	1,102	0	5	5
26	Memong	36	Cheach	358	366	0	2	2
27	Memong	37	Sambour	179	183	0	1	1
28	Memot	39	Tboung Voat	1,907	1,950	0	9	5
29	Memot	40	Chhngar Kaeut	345	353	0	2	2
30	Memot	41	Memot Thmei	271	277	0	1	1
31	Rung	44	Andoung Ta Chou	692	708	2	3	1
32	Rung	45	Doun Roadth Ti Muoy	854	873	0	4	4
33	Rumchek	47	Thma Dab	1,076	1,100	0	5	5
34	Rumchek	49	Khliech	556	569	0	3	3
35	Tramung	50	Ou Khlout	209	214	0	1	1
36	Tramung	51	Tramaeng Kraom	168	172	0	1	1
37	Tramung	52	Ngeu Thmei	263	269	0	1	1
38	Tramung	53	Trapeang Ngeu	164	168	0	1	1
39	Tonlung	57	Kdol Phsar	1,155	1,181	2	6	4
40	Tonlung	58	Changkum Ti Muo	578	591	0	3	3
41	Tonlung	59	Spean Changkum	383	392	0	2	2
42	Tonlung	60	Kaoh Thma	679	694	0	3	3
43	Tonlung	61	Mkaor	385	394	0	2	2
44	Tonlung	62	Lvea Leu	397	406	0	2	2
45	Treak	65	Dak Por	1,118	1,143	1	5	4
46	Treak	66	Bangkov	1,102	1,127	4	5	1
47	Treak	67	Prei	493	504	0	2	2
48	Treak	68	Khley	387	396	0	2	2
49	Treak	69	Romeas Choul	213	218	0	1	1
50	Treak	70	Preah Ponlea	816	834	0	4	4
51	Treak	71	Samraong	1,113	1,138	0	5	5
52	Kokir	72	Chamkar Thmei	1,014	1,037	0	5	5
	Total			32,344	33,075	10		136

* Annual population growth rate: 0.32% (Source: General Population Census of Cambodia 2008, National Institute of Statistics, Ministry of Planning, August 2008)

** Serving population per handpump well: 210person (round off)

3) Configuration of Water Supply Facilities

The water supply facilities to be constructed in this Project are described in Table 2-5 below.

Table 2-5: Components of Water Supply Facilities

Type of Work	Specification	Sites	Description of Work	Responsible Organization
Well	4"PVC Screen casing Depth：30～65m	136	Preparation work (geophysical survey, ground levelling, drilling rig setup), drilling work, well logging, insert casing/ screen, aggregate fillings, cleaning of wells, pumping test, water quality test, backfilling, stopping water, after construction work （clean-up, removal）	Japanese Contractor
Filling soil	30cm above ground level	136	Filling soil and compaction	Japanese Contractor
Platform/drainage	Reinforced concrete	136	Ground levelling, moulding work, reinforcing work, concrete laying/ curing	Japanese Contractor
Hand Pump	Afridev type	136	Procurement and installation	Japanese Contractor
Fore slope planting	Grasses surrounding the sites	136	Protection of fore slope by planting	Residents
Iron removal device	Stainless portable equipment	11	Procurement and setup	Japanese Contractor
Hygiene Education Billboard	Stainless	136	Procurement and setup	Japanese Contractor
Fence		136	Installed with residents' own creativity for prevention of invasion of livestock	Residents

4) Design Conditions

a. Well construction sites

Good aquifers were found in the field surveys of the project area. Therefore, no further surveys of natural conditions to select construction sites will be made in the implementation stage. The construction sites will be determined by forming resident organizations in the implementation stage, taking into account the social conditions including the village make-up and the requests of village residents.

b. Required yield capacity of well: 900 litres/hour or more

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

c. Water height

According to the brochure from Afridev, the hand-pump manufacturer adopted in this plan, applicable

water level is set to less than 45m. However, when water level exceeds 35m, handle operation of the hand-pump becomes heavy, making it difficult for women and children to get water. For this reason, in this plan, static water level will be set as less than 35m. So the well shall be classed unsuccessful if the static water level exceeds 35m.

d. Water quality conditions

Cambodian drinking water quality standards consist of general standard and small-scale water supply standards. As the volume of water supplied per day from the water supply facilities is planned to be $8.4m^3$ in this Project, it is equivalent to small-scale water supply standards in the Cambodian drinking water quality standard. Thus, basically, small-scale water supply standards of Cambodian drinking water quality standards shall be applied for the water quality standard for this project. Water quality standards in this Project shall be set as shown in Table 2-9, based on the examination of the results of the water quality surveys and the effect on health.

A comparison with WHO drinking water quality guidelines and Cambodian drinking water quality standards is shown in the Appendix.

Reasons for setting water quality standards are as follows;

i) Arsenic (As)

An arsenic concentration of 0.05mg/l of water is the water quality standard for this project in accordance with Cambodian general standards and small-scale water supply standards because it concerns health.

ii) Chloride (Cl)

A chloride concentration of 250mg/l of water is the water quality standard for this project in accordance with Cambodian general standards because people do not use for drinking water when the saline concentration is high.

iii) Fluoride (F)

A fluoride concentration of 1.5mg/l of water is the water quality standard for this project in accordance with Cambodian general standards because it concerns health.

iv) Manganese (Mn)

A manganese concentration of 0.4mg/l of water is the water quality standard for this project in accordance with WHO guidelines because it concerns health.

v) pH

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 has an effect on the water

supply facilities, such as corrosion, but has no impact on human health, so it is not specified in WHO drinking water quality guidelines. Therefore, the pH standard value is not specified in this Project.

vi) Total dissolved solid (TDS)

A total dissolved solid concentration of 800mg/l of water is the water quality standard for this project in accordance with Cambodian small-scale water supply standards.

vii) Iron (Fe)

According to the water quality survey results, iron content is over the value of Cambodian drinking Water Quality Standards in about 23% of the existing wells (deep groundwater) at target villages. Since iron content is not an item impacting health, and this plan aims to supply water for drinking, an iron concentration acceptable as residents' drinking water will be set as a success standard.

WHO sets 0.3mg/l of iron concentration as acceptable aspect due to taste, odour, colour etc. But villagers' allowable limit of iron concentration is not fixed. It can also depend on the existence of alternative water source, taste of alternative water source, distance to the alternative water source, etc.

In the monitoring results of the Study on Groundwater Development, maximum allowable level for iron concentration is 2.0mg/l as raw water for drinking (Table 2.6). And in the results of the last project, 1.8mg/l was allowable for direct drinking water at some sites; however, 0.8mg/l was not allowable at some sites so iron removal devices (IRD) were installed (Table 2.7). Therefore it is appropriate to consider the maximum limit of iron concentration for villagers' drinking water is 2.0mg/l.

In case an iron concentration is much higher, it is possible to reduce the iron concentration by IRD, up to certain level of concentration. It is considered that no iron standard value is necessary to be specified in the project, and success of well construction is determined by the villagers who have intention to use IRD. But, in this case, the following problems may be encountered in the future.

- In case iron concentration is much higher, the water will not be used for washing because the colour of clothes will be changed into red colour by iron. In this case, the water for washing shall be supplied by IRD. However, the volume of water output through IRD is much less than the volume of water directly from hand pumps, so IRD can not cover enough volume of water for both drinking and washing. Even now, some villagers who use IRD sometimes complain that it takes much time to fetch water by IRD because the flow rate of IRD is less (Table 2.8). In case iron concentration is very high, it is easy for iron sludge to become clogged among the

filtering materials of IRD, reducing its flow rate. In this case, villagers shall maintain IRD frequently such as washing filtering materials, etc., and this is a disincentive to use IRD. Iron concentration, which maximum value was 10mg/l, in the pilot wells of the Study on Groundwater Development, was much higher than the iron concentration, which maximum value was 1.8 mg/l, of wells constructed by the last Japan's Grant Aid project. Thus the Study on Groundwater Development monitoring of IRD found that they have not always been used by local residents despite there ability to remove iron content. In case iron concentration is much higher, sustainability of IRD use is not secured.

- In the experience of past projects, villagers generally request to complete construction of water supply facilities even when water quality is not good enough for drinking purposes because they can use water for washing, bathing, livestock, gardening, etc., so that the time and energy for water fetching can be saved. Therefore if villagers accept to use IRD and use the water for drinking even if iron concentration is very high, they may not use for drinking purpose in the future.

- The well construction works will be conducted by a Japanese contractor selected by tender so that the standard value of iron concentration to determine the success of the wells shall be clearly mentioned in the specifications in the tender documents and contract documents. Otherwise it is impossible to judge if unsuccessful, and to order the contractor to re-drill even if iron concentration is very high.

Thus, an iron concentration of 2.0mg/l of water is the water quality standard for this project.

Table 2-6 Villager's Evaluation of Iron Concentration during the Development Study

Province	Village	Concentration (mg/ℓ)	Drinking use	Taste
Svay Rieng	Koy Tra Bek	10	×	Iron
Svay Rieng	Trapaing Thmor	10	×	Iron, Salty
Svay Rieng	Dok Por	10	×	Iron
Svay Rieng	Cham Kar Leive	10	×	Iron
Svay Rieng	Toul Khpos	10	×	Iron
Takeo	Ta Pen	0.05	○	Iron, Salty
Prey Veng	Ka Kou	2	○	Good
Prey Veng	Russei Tvear	2	○	Good
Prey Veng	Prey Phdau	5	×	Iron
Prey Veng	Prek Ta Sa	10	×	Iron
Prey Veng	Sre Kak	0.05	○	Good

Source: Final Report, The Study on Groundwater Development in Southern Cambodia (January 2002)

Table 2-7 Villager's Evaluation of Iron Concentration for Wells constructed by the last project

Commune	Village	Concentration (mg/ℓ)	Drinking use	Taste
Tonlung	Beng Kaong (50-1)	0.9	×	Iron
Tonlung	Pong Tuek (56-2)	0.8	×	Iron
Rumchek	Chheu Khloem (62-3)	1.5	×	Iron
Rumchek	Chheu Khloem-(62-4)	1.5	×	Iron
Rumchek	Chheu Khloem-(62-5)	0.8	○	Iron
Rumchek	Kampey (63-1)	1.2	○	Good
Rumchek	Kampey (63-2)	1.5	○	Iron
Rumchek	Kampey (63-4)	1	×	Iron
Rumchek	Kampey (63-5)	0.8	○	Good
Memot	Trapeang Rean (76-2)	0.2	○	Good
Memot	Sangkom Mean Chey Chas	0.1	○	Good
Choam Kravieng	Satum (143-1)	1.5	×	Iron
Choam Kravieng	Satum (143-2)	1.5	○	Good
Choam Kravieng	Satum (143-3)	0.6	○	Iron
Choam Kravieng	Satum (143-5)	1.8	○	Good

Source: Survey results (October 2008)

Table 2-8 Comparison of Flow Rate between Hand Pump and Iron Removal Device

	Hand pump	Iron Removal Device	Reduction rate
Flow Rate (l / min)	16～23	11～13	19～52%

Source：Survey results during implementation of the last project (2006-2008)

Remark）Flow rate of hand pump depends on physical power (such as difference between male and female, and between adults and children, etc.), groundwater table, etc.

viii) Nitrate (NO_3)

A nitrate concentration of 50mg/l of water is the water quality standard for this project in accordance with Cambodian general standards and WHO guidelines because it concerns health.

ix) Turbidity

A turbidity concentration of 5 NTU of water is the water quality standard for this project, in accordance with Cambodian small-scale water supply standards.

Table 2-9: Water Quality Standard for Successful Wells

Item	Standard value
Arsenic (As)	0.05 mg/l
Chloride (Cl)	250 mg/l
Fluoride (F)	1.5 mg/l
Manganese (Mn)	0.4 mg/l
Total dissolved solid (TDS)	800 mg/l
Iron (Fe)	2.0 mg/l
Nitrate (NO_3)	50 mg/l
Turbidity	5 NTU

5) Standard Well

a. Faces of stratum for drilling

The strata that appear at the well drilling depth in the 52 target villages are mainly categorized into 4 types: unconsolidated layer, soft rock, medium hard rock, and hard rock. The estimated stratum structure of each category is shown in Appendix 5. Ground water level at target sites based on a distribution map of ground water which was estimated from drilling results of existing wells, is also shown in Appendix 5. However, the groundwater level considered this time is only a rough indication because ①in the last project wells were drilled in various aquifers, and ②target sites with good accessibility were selected in the last project, so data is limited at sites with poor accessibility such as in valleys as there was little well drilling conducted there.

b. Well drilling methods

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 mostly used because there will be a lot of drilling of soft sediment.

The strata in the project area are mainly categorized into 3 types: unconsolidated sediment stratum, basalt lava, and foundation rock (sandstone). However, the strata that appear at the planned drilling depth as described above in (1) are predominantly soft sediment (soft sediment: 78%, bedrock containing soft rock, medium hard rock or hard rock: 22%).

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 while 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.

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, than to change the drilling method halfway. Therefore, mud drilling and DTH hammering will be adopted depending on the stratum structure as described below.

The drilling length ratio is approx. 71% for mud drilling and 29% for DTH hammer drilling.

i) 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
- Where the soft sediment is drilled to a depth of 30m or more and lava/ foundation rock with a thickness of 10m or less appears

ii) 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
- Where the soft sediment is drilled to a depth of 30m or more and lava/ foundation rock with a thickness of 10m or more appears

The total drilling depths of both drilling methods for the stratum structures presumed from the results of existing hydro geological surveys and the specific resistance distribution obtained from the electrical logging results are summarized in Table 2-10 and Appendix 6.

Table 2-10: 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	18	43	1,785m	(29.3%)	716m	505m	448m	116m
Mud Water Drilling	34	93	4,315m	(70.7%)	3,999m	169m	138m	9m
Total	52	136	6,100m		4,715m	674m	586m	125m

c. Well drilling depth and screen casing

The depth of each of the 136 wells to be drilled in the 52 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 (8m section) in general and 3 screen casings (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, according to the depth of the aquifer, 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 35m to 65m, and the planned total well length is 6,100m. The planned drilling length by well depth and length of screen and casing is shown in Table 2-11. Also the number of screens and casings at each target village is shown in Appendix 7.

Table 2-11: Planned Drilling Length by Depth and Number of Screens and Casings

Planned Depth of wells（m）	Number of wells	Drilling length （m）	Total No. of Planned Screens	Total No. of Planned Casings
30	24	720	53	139
35	20	700	40	140
40	18	720	37	161
45	22	1,035	55	221
50	11	500	21	109
55	19	1,045	43	223
60	10	600	26	134
65	12	780	27	177
Total	136	6,100	302	1,304

In addition, each screen and casing mentioned above is assumed to be 4m in length. However, 3m long casing and screen will be used when necessary for the depth of the well as shown in the Appendix.

Screens are made of PVC pipes with 1mm-wide horizontal slits, and the aperture rate shall be 2% or more.

d. Well structure and drilling aperture

In the project area, there are a few dozen 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 centre 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.

Typical drawing of well structure is shown in Figure 2-1.

e. Established success standard for well drilling and well drilling success rate

Success standard for well drilling is shown in Table 2-12. Target villages in this project are in the same area as the previous Japanese Grant Aid Project. Also, the success standards for well drilling are the same as last project as shown in Table 2-13. Based on the drilling result of last project, well drilling success rate in this basic design is set up as shown in Table 2-14.

Table 2-12: Success standard for well drilling

Item	Standard
Water volume	Q≥15l/min
Water quality	Shown in Table 2-9
Water height	Statistics Water level≤35m

Table 2-13: Drilling results of previous Japanese Grant Aid Project

	Phase 1		Phase 2		total	
	No.	rate (%)	No.	rate (%)	No.	rate (%)
Successful well	161	95.27	194	95.10	355	95.18
Unsuccessful well (due to water volume)	8	4.73	4	1.96	12	3.22
Unsuccessful well (due to water quality)	0	0.00	5	2.45	5	1.34
Unsuccessful well (due to water height)	0	0.00	1	0.49	1	0.26
Total	169	100.00	204	100.00	373	100.00

Table 2-14: Well drilling success rate in this basic design

Item	Well drilling success rate
Water volume	96%
Water quality	98%
Water height	99%

f. Considerations regarding unsuccessful wells

The unsuccessful wells are viewed as follows:

i) Unsuccessful wells in respect of water volume and water height

When drilling by the DTH hammering method, it is possible to judge whether a well will be successful or not during drilling. Therefore, the drilling costs for unsuccessful work are included in the estimation.

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

ii) Unsuccessful wells in respect of water quality

In the case of wells judged unsuccessful due to water quality, success or failure can only be determined through procedures 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 cost of these procedures including the cost of materials for unsuccessful wells.

iii) Dealing with 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 thoroughly compacted with water to prevent subsidence in the future.

iv) 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 that village will be abandoned and another well will be drilled in an alternative village.

v) Alternative villages

Alternative villages are shown in Table 2-15.

Since these villages were included in the proposed area of a pipe water supply project planned by MIME at the time of the last project, only one water supply facility was constructed in each village during that Japanese Grant Aid Project. This field survey found that MIME no longer has a plan for these areas. Water supply hardship is very high in these villages, and as there is no foreseeable improvement, they have been designated as alternative villages in this plan.

The drilling order for alternative villages is as follows.

- One well will be drilled at each village in order from largest population down, with the aim of securing an alternative water source in the case of the loss of the existing well.
- From the 6th well on drilling will take place at the village with the lowest water supply rate, to be calculated by dividing the village population by (210 people multiplied by the number of existing wells). However, there is a maximum of five wells to a village.

Table 2-15: List of alternative villages

Commune	Village	Estimated population in 2015	Number of water supply facilities to be constructed		
			Existing wells	Required wells	Planned wells
Dar	Dar Kandaoul	2,564	1	12	4
Tramung	Khnong Krapeu Kaeut	2,175	1	10	4
Dar	Dar Tboung	1,110	1	5	4
Dar	Dar Cheung	889	1	4	3
Dar	Beng	457	1	2	1

g. Well drilling plan

Of the 52 target villages, 15 villages have poor access. Although well drilling period is estimated at 11.5 months in the included implementation schedule for this project, 6 months of this is rainy season. Therefore, the implementing schedule is formulated so that construction in villages with poor access is undertaken during the dry season, and during the rainy season, for villages with good access.

6) Hand Pumps

a. Hand pump specifications and materials

All the hand pumps to be installed in the wells in this Project are designed for boreholes, because a dynamic water level of between 2m and 5m cannot always be maintained for a long time in wells located at a very shallow depth.

All the pump parts to be submerged in water, including the pumping pipes, pump rods, and pump cylinders, need to be rustproof, because the groundwater in the most of the project area is acidic. The pumping pipes will be made of PVC, and the rods and cylinders will be stainless steel.

b. 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 centimetres, 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 much as 8m to 10m. The sites that are expected to have a large drop in water level will be almost entirely comprised of the 30 sites with fine grain aquifers (silty sand). 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 strengthened 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 planting work will be carried out with the participation of local residents.

8) Iron Removal Device

In the results of the last project, 1.8mg/l was allowable for direct drinking water at some sites;

however, 0.8mg/l was not allowable at some sites so iron removal devices were installed. It is planned to install iron removal devices so wells can be used as a supplementary water source, where the well, is not used as a direct drinking water source due to the taste and smell of iron.

Moreover, it is the policy of Japanese Grant Aid Projects to install iron removal devices in response to residents requests based on the actual taste of the water upon completion of every well, regardless of the actual iron concentration. For these reasons, before the residents decide on installation, we intend hold seminars to inspect an in-use iron removal device to ensure they understand there negative aspects.

In consideration of user-friendliness, a diverter will be installed on the hand pump so that water can either be drawn directly for everyday use, or pumped through an iron removal device for drinking water.

In the previous Japanese Grant Aid Project, iron removal devices were installed at the 27 of the 335 constructed wells (about 8%). As the field survey found that the water was being used for drinking at both, the wells with iron removal devices installed, and those which had none installed, the number of iron removal devices installed under the previous basic design plan is deemed to be appropriate. This basic design plan will keep the same level of iron removal device installation (about 8%) as the last project, because the target villages are in the same area, and the natural and social conditions are the same as the last Grant Aid Project.

In case there is a lack of iron removal devices in the implementation stage, wells with the highest iron content will be given priority for installation. Also to make up for this lack, the health education part of the soft component will undertake an educational campaign for safe water use, to improve the hygiene consciousness so that the well water is still used over an unsanitary alternative water source, even if there is a slight iron smell remaining.

2-2-3 Basic Design Drawing

Basic Design Drawings for this project are as shown below.

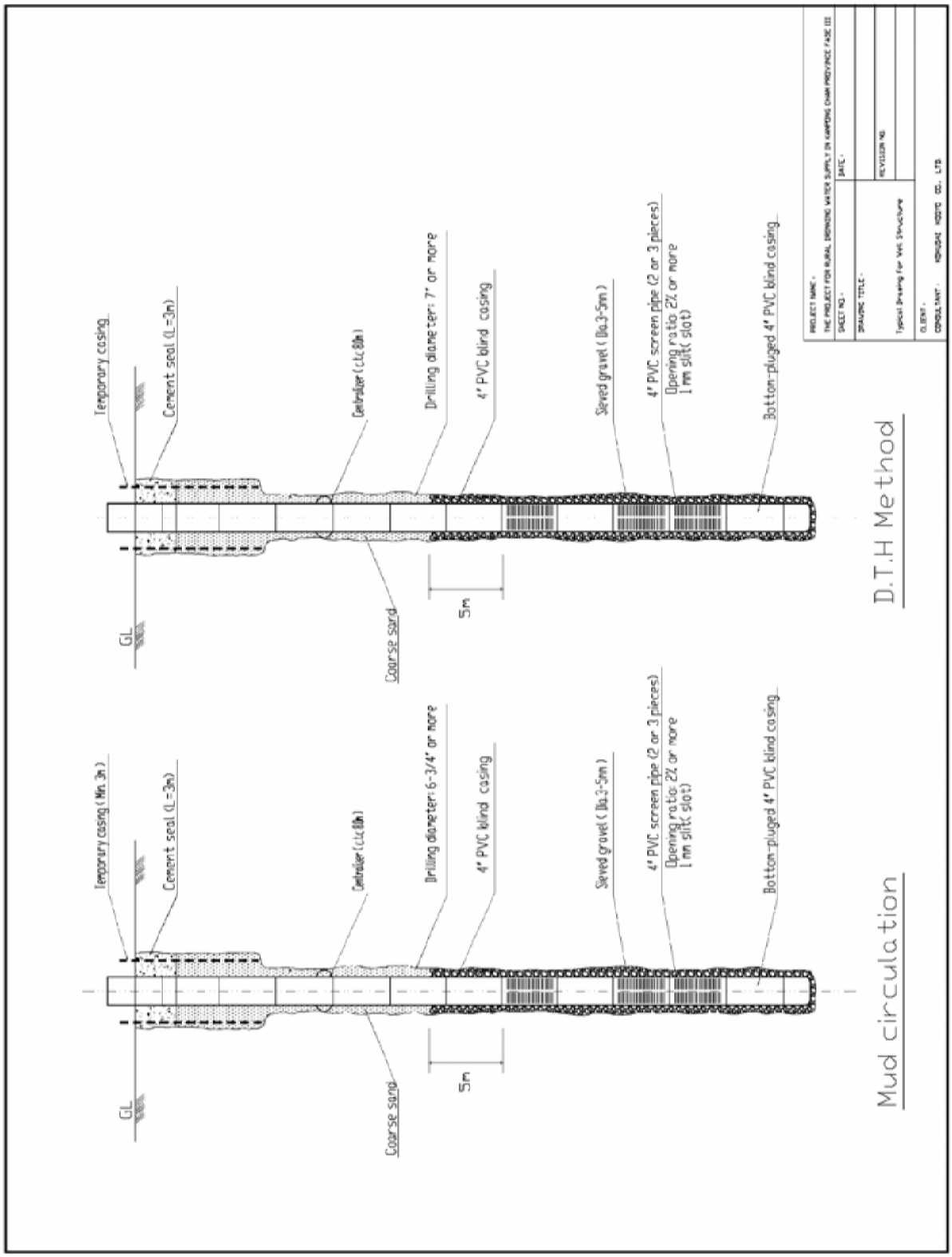


Figure 2-1: Well Structure

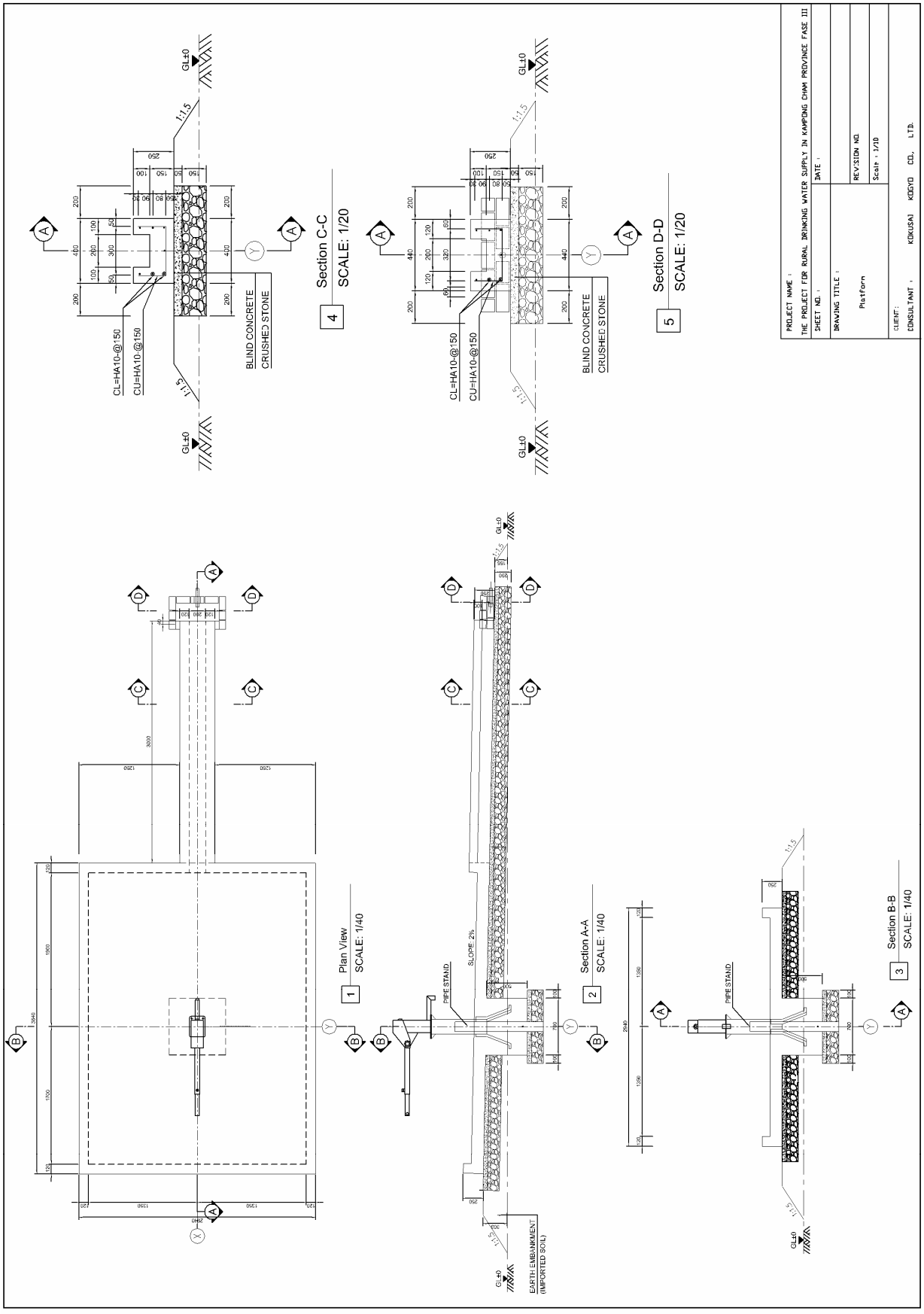


Figure 2-2: Platform

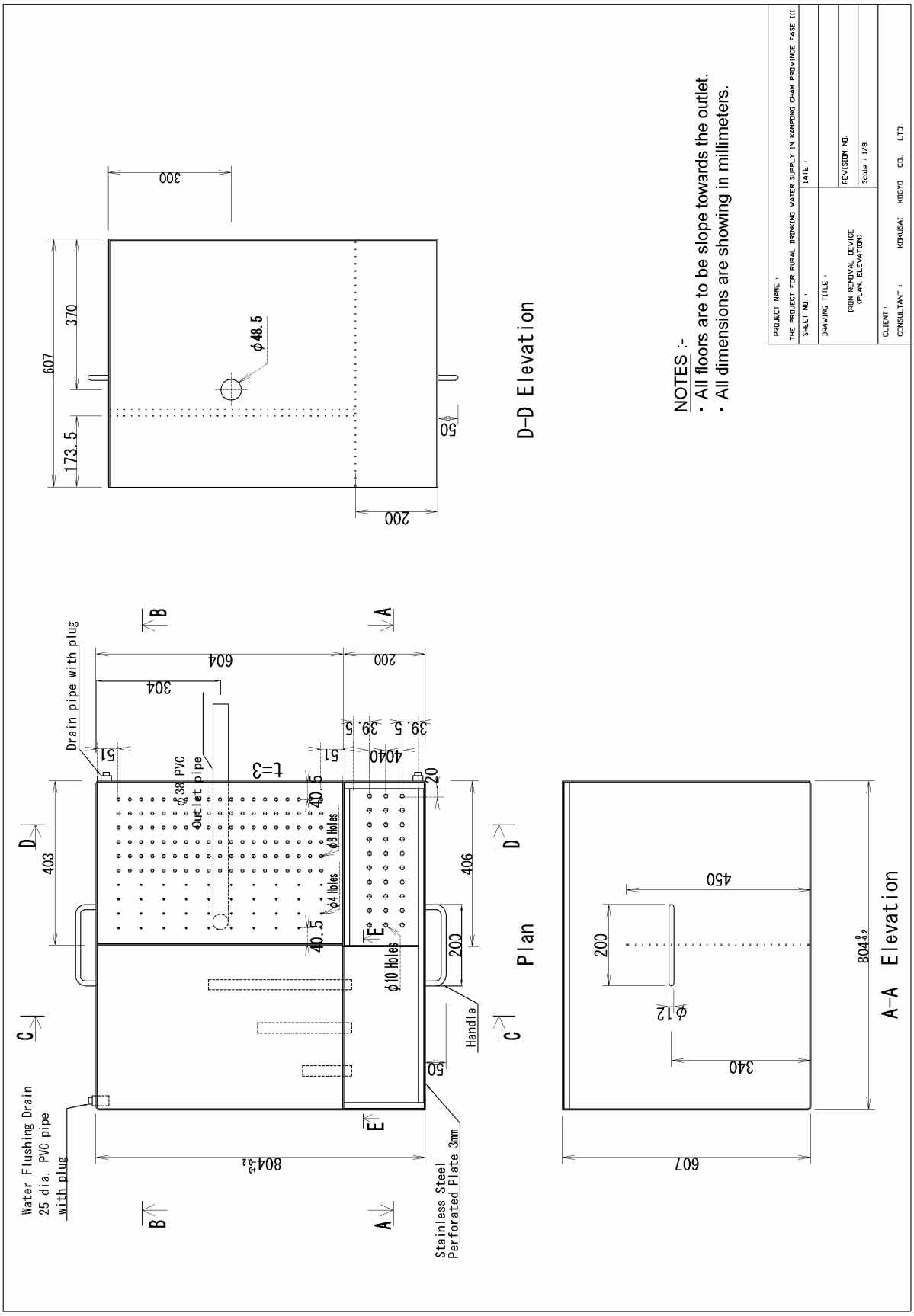


Figure 2-3: Iron Removal Device (plan)

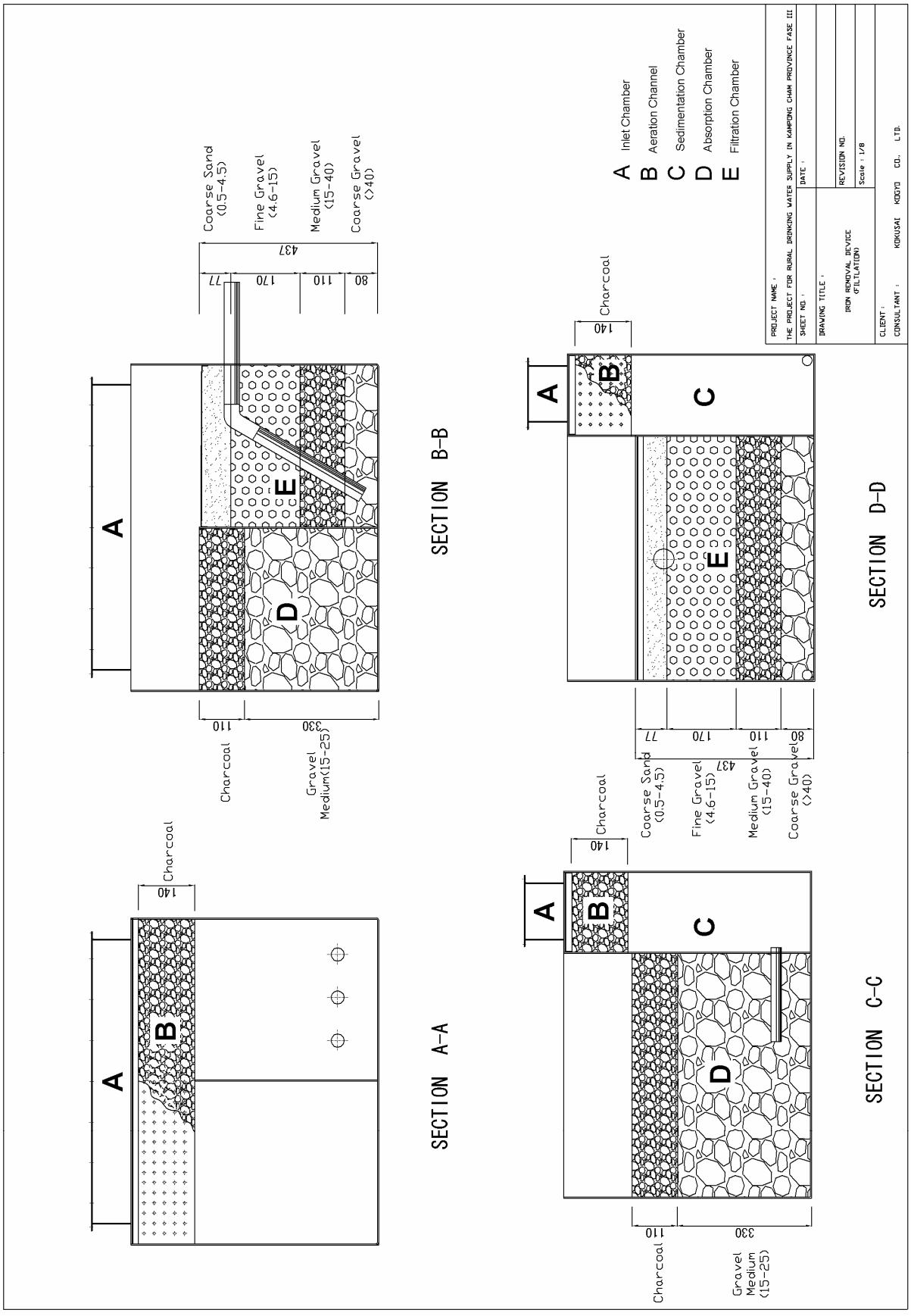


Figure 2-4: Iron Removal Device (section)

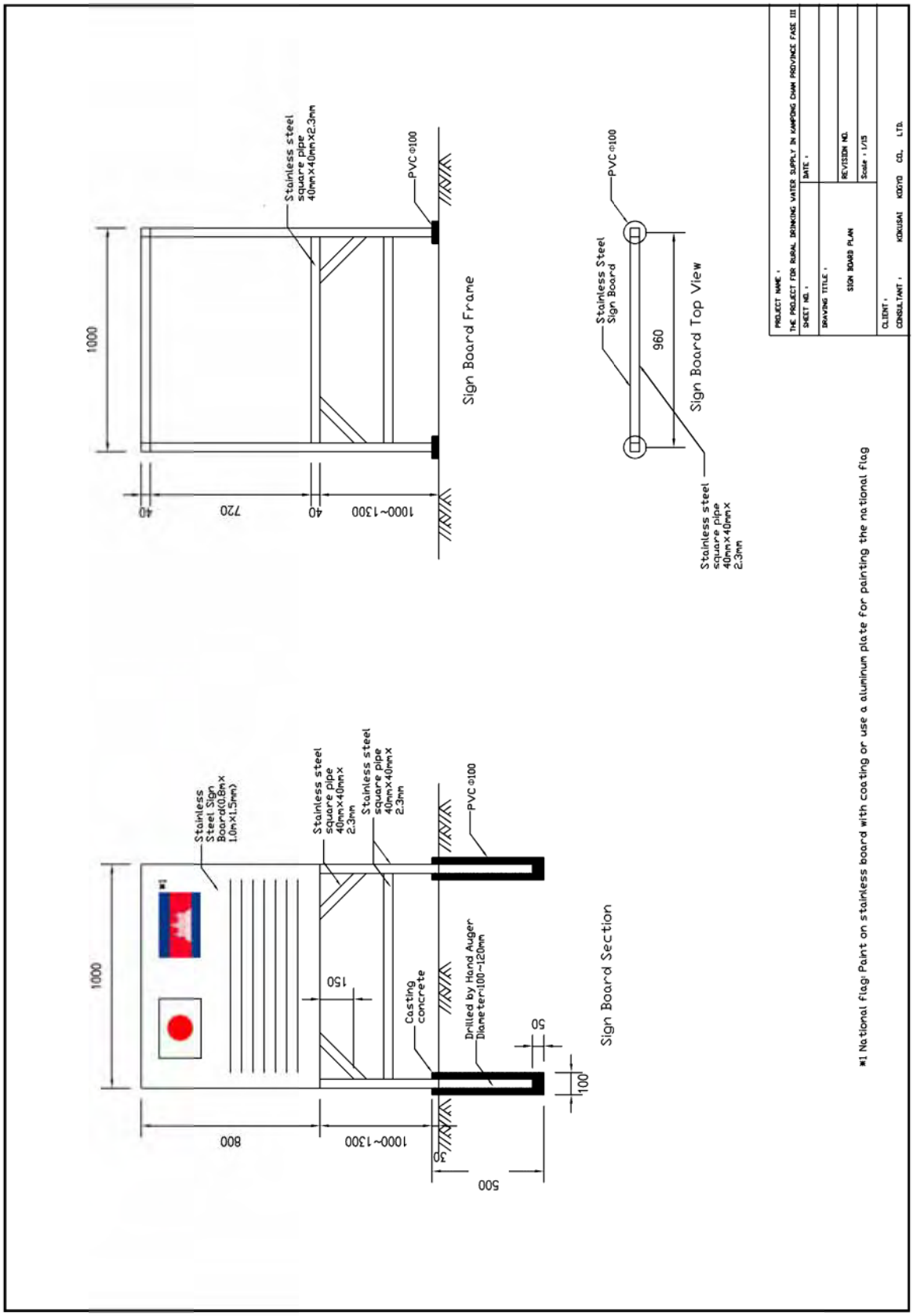


Figure 2-5: Sign Board

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

(1) Project Implementation System

One well drilling construction team will be formed using DRWS well drilling equipment, which was provided by Japan in the previous Project. In addition, 2 well drilling teams will be formed by local well drilling constructors, as subcontractor teams. The well drilling works to be constructed by the total of 3 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 2 working teams using DRWS equipment provided by Japan in the previous Project, under the supervision of the Japanese contractor.

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 so that, construction in villages with poor access will be implemented in the dry season, and during the rainy season, in villages with good access.

(2) Cooperation with PDRD and DORD

From the viewpoint of its existing organization and personnel, PDRD is the best implementing organization to support residents' organizations, and provide the hygiene education necessary for sustainable maintenance of the wells. DORD should play an assisting role for PDRD. On the other hand, DORD should be the implementing organization to provide maintenance support after the residents' organizations have been formed, because its activities place it closer to the villages. It is planned to include PDRD and DORD in the project implementation system when executing this plan.

(3) Interaction with Soft Component

The soft component relating to maintenance and operation, and hygiene education, during implementation of the previous Grant Aid Project has been highly evaluated in Cambodia. This plan intends to continue to implement soft component relating to operation and maintenance, and hygiene education.

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

Local well drilling constructors can be judged capable of implementing the well drilling work to meet the scale and specifications of this Project, and of acting as subcontractors. 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, 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 impossible to procure locally will be compared between Japan and a third country, with the cheaper option to 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 and ground levelling		○	WSUG
Access improvement to well construction sites for carrying of the equipment and materials		○	WSUG
Wells construction	○		
Filling solids for fore slope around wells	○		
Platform/ Drainage construction	○		
Installation work of hand pumps	○		
Fore slope planting		○	WSUG
Installation work of iron removal device	○		
Installation work of hygiene 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 will be undertaken by the construction contractor 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: Supervision/ Management Personnel on Japanese Side

Criteria	Supervisor/ Manager	No. of Staff	Responsibility	Dispatch Period
Consultants	Project Manager	1	General Supervision of Project	Spot
	Engineer for hydrogeology and drilling	1	Supervision of drilling	Spot
	Inspector	1	Inspection of hand-pump factory	Short term
	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	Conduct drilling	Full term
	Civil Engineer	1	Management of concrete structure	Sport
	Machine mechanic	1	Maintenance of Japanese Grant Aid Project equipment	Sport
	Inspector	1	Inspection of hand-pump factory	Short term

2-2-4-5 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 affects the concrete compressive strength; therefore, the measurement method of concrete materials is described in Table 2-18.

Table 2-18: 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 on 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 on every lot from the manufacturer for each product type and diameter.

3) Water Quality Test

The water quality tests shall be conducted on-site and sent for testing to a laboratory run by an independent organization in Cambodia. The judgment of the success or failure of the well drilling for water quality standard of this project is based on the on-site test. The aim of the water quality test by an independent laboratory is to check the results of the on-site tests. Moreover, the independent laboratory is to test the Cambodian water quality standards not included in this project's standards. However, the

independent laboratory is unable to analyze four items: barium, hydrogen sulphide, selenium, and sodium. These four items are not included in Cambodian small-scale water supply standards that apply to this plan. About barium and selenium, since problems such as damage to health have not been reported in Cambodia until now, pollution risk is regarded as low. Moreover, hydrogen sulfide and sodium are not mentioned as a health risk in the WHO Guidelines for drinking water quality. Since these four items cannot be analyzed in Cambodia, it would have to be conducted in Japan or a third country. However, in consideration of the cost of sample transportation, time, export-and-import procedure, etc. it is judged that the necessity for these water quality tests is low. For this reason, the water quality test of these four items will not be conducted.

Judgment criteria of water quality testing, on-site and at an independent laboratory, are shown in Appendix.

4) Quality Control for hand-pump

Quality control for hand pump is shown in Table 2-19.

Table 2-19: Items of Quality Control for Hand-Pump

Item	Inspection place	Inspector	Contents
Factory inspection	Factory in India	Maker, Japanese contractor and consultant	Inspect whether any problems occurred in the product manufacturing process.
Inspection at local agency before shipping package	Local Agency in Phnom Penh	Local Agency, Japanese contractor	Exclusion of inferior goods
Inspection at sites before instillation	Each Site	Japanese contractor	Exclusion of inferior goods
Guarantee of quality	Local Agency in Phnom Penh	Local Agency, Japanese contractor	Submission of a warranty letter

2-2-4-6 Soft Component (Technical Assistance) Plan

(1) Background of Soft Component

1) Background

It is prescribed by "National Policy on Water Supply and Sanitation," and "Guideline on Water and Sanitation User Group," that O&M of water supply facilities is mainly carried out by WSUG.

In the past donor projects encountered problems such as no WSUG type organization being established, deposit of O&M fund, understanding of repair method, repair tools or spare parts, and no sense of ownership, because of the lack of an O&M organization or training on a village level. For this reason, many wells that broke down were left without being repaired. Only 6 sites are working among 45 sites installed from 2000 to 2001 due to insufficient O&M.

On the other hand, WSUG organized by soft component of previous Grant Aid Project are still continuing activities such as storage of O&M fund, spare part replacement, etc., and the constructed facilities that provide safe water are being used sustainably.

Moreover, although traditional dug wells serve as the main water source, sewage flows into the wells during the rainy season. So residents are forced into a life with unsanitary water. Residents in the target village do not have sufficient knowledge about health issues, so waterborne diseases (diarrhoea, dysentery, typhoid fever, etc.) are widespread.

2) Basic Concept

Under such circumstance, the following issues should be considered for improving the sustainability of water supply facilities constructed in this project in order to achieve the project goal which is "To supply safe and stable drinking water in target villages."

i) Setting up of sustained O&M organization at the village level,

ii) Improvement of residents' awareness of ownership,

iii) Improvement of residents' awareness of hygiene,

iv) Enhancement of O&M skills at the village level

A soft component is planned for the purpose of solving these subjects.

(2) Target of Soft Component

1) Objective

In order to achieve the project goal of "To supply safe and stable drinking water in target villages," and the Primary Objective of "To improve living and hygienic environment of the residents in target villages," the following soft component objectives are given in Table 2-20, and soft component relating to the formation of resident's organization, resident participation, hygiene education, and to the instruction of O&M will be implemented in this project.

Table 2-20: Objectives of Soft Component

Target 1: The support system of O&M of PDRD and DORD is strengthened.
Target 2: WSUG is established as a sustainable O&M organization.
Target 3: Residents will conduct O&M with a sense of ownership.
Target 4: Residents' hygiene consciousness is improved, supplied safe water is used effectively, and correct habits and actions regarding health are taken.
Target 5: Residents gain village level O&M capability.

2) Points to consider for support organization

The soft component will be implemented at village level encompassing every WSUG, in order to assure work efficiency. The soft component is actively carried out by PDRD and DORD, and a Japanese and a local consultant lead and supervise this. The soft component activities are actively carried out by PDRD. However, DORD and PDRD staff do not have sufficient English capability, meaning communication with the Japanese consultant and making reports in English is difficult. Therefore, local consultants superintend and manage these activities.

(3) Output of soft component

The soft component activities and output are summarized as follows.

Table 2-21: Project Activities and Output

Item	Activities	Output
Workshop for PDRD・DORD	A workshop will be held for PDRD and DORD staff in order to determine project contents, and implementation plan and method for soft component activities.	The support system of O&M of PDRD and DORD is strengthened.
Formation of resident organization	The objective and the contents of the project are explained. The residents' participation and cooperation intentions shall be confirmed. The necessity for WSUG is explained and shall be established. The necessity for O&M fund is explained and shall be collected. The bank account to deposit O&M fund shall be established.	WSUG is established as a sustainable O&M organization.
Residents' participation	Construction site for water supply facilities shall be determined through democratic discussion. Residents' responsibilities shall be explained and their intent to cooperate confirmed. Access roads to and the cleaning of well drilling sites shall be constructed by residents. Fore slope planting, construction of drainage canal, and livestock protection fence shall be constructed by residents.	Residents will conduct O&M with a sense of ownership.
Hygiene education	Participatory Hygiene and Sanitation Transformation program (PHAST) of MRDs DRHC, shall be implemented.	Resident's consciousness of health and healthy habits improved.

Item	Activities	Output
Instruction of O&M	The role which WSUG should perform shall be explained. Management method of the O&M fund deposited in a bank account shall be explained. Daily Management method shall be instructed. Maintenance of fore slope planting, construction of drainage canal, and livestock protection fence, shall be instructed. Replacement and procurement method of spare parts shall be instructed. Correspondence procedure for the request of maintenance support to DORD shall be instructed. Maintenance method for iron removal device shall be instructed.	WSUG will master the techniques for O&M.

Output 1 The support system of O&M of PDRD and DORD is strengthened

It is stipulated in "National Policy on Water Supply and Sanitation," and "Guideline on Water and Sanitation User Group," that PDRD and DORD will support O&M of water supply facilities, which is mainly carried out by WSUG. PDRD and DORD staff will proactively carry out soft component activities so that a system of close cooperation with WSUG will be built, and a support system for O&M will be strengthened in future.

Output 2 WSUG are established as sustainable O&M organizations

As shown in the "National Policy on Water Supply and Sanitation" and "Guideline on Water and Sanitation User Group," WSUG is an O&M organization by residents and should mainly carry out the O&M for water supply facilities. Since establishment of WSUG is indispensable in order to use water supply facility sustainably, it shall be organized as a soft component activity.

Output 3 Residents will conduct O&M with a sense of ownership

In order for residents to sustainably implement O&M activities, it is necessary to enhance their sense of ownership of the project. In order achieve this, it is important for the residents to be involved in the decision making for the well drilling site, and for residents to participate in construction work.

Output 4 Resident's consciousness of health and sanitary habits improved

Many shallow wells that are unsanitary exist in the target area, so it is important for water problems in

the target area to solve water quality, rather than water volume. Even if good water sources are secured by this project, if the conversion for water supplies is not made from the unsanitary water sources which residents use for drinking, water supply facilities will not be used sustainably, and the aim of decreasing waterborne diseases will not be fully realized. Residents shall have the right health knowledge and fully understand the importance of using safe water with the aim of improving sanitary habits.

Output 5 WSUG will master the techniques for O&M

In order to use facilities sustainably, WSUG needs to master required O&M. Most hand pump breakdowns are slight and can be fixed by the residents themselves. For this reason, WSUG shall master technology required for O&M so that water supply facilities can be used sustainably.

(4) Indicators of output achievement

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 2-22: Indicators of achievement

Output	Indicator	Measurement
The support system of O&M of PDRD and DORD is strengthened.	Are the objectives and contents of the project understood?	Interview
	Is the hygiene education by PDRD carried out?	Interview
	Is the role of support activities of O&M by DORD understood?	Interview
WSUG is established as a sustainable O&M organization.	Is WSUG established?	WSUG by-law
	Is WSUG's board selected?	WSUG by-law
	Do the members of each WSUG understand their roles?	Interview
	Is the O&M fund deposited in a bank account?	Bank book
Residents will conduct O&M with a sense of ownership.	Is the construction site of the water supply facility determined democratically by resident consensus?	Interview
	Has fore slope planting, construction of drainage canal, and livestock protection fence been carried out?	Site survey

Output	Indicator	Measurement
Resident's consciousness of health and sanitary habits improved.	Is waterborne disease understood?	Questionnaire
	Is the neighbourhood of a water supply facility cleaned?	Questionnaire
	Is safe water used?	Questionnaire
WSUG will master the techniques for O&M.	Is daily usage, rules, and check method for facility understood?	Questionnaire
	Is the management method of the bank account for O&M fund understood?	Interview
	Can hand pump dismantling, raising, and re-installation be performed?	Interview
	Are the tools and spare parts kept?	Interview
	Can replacement of spare parts be performed?	Interview
	Is the procurement method of spare parts understood?	Interview
	Is the maintenance method for iron removal device understood?	Interview
	Is the correspondence procedure for the request of maintenance support to DORD understood?	Interview

(5) Activities of the soft component (Input plan)

1) Category of Activities

The soft component activities are categorized into two sections: formation of resident's organization and resident participation before construction; and hygiene education and instruction of O&M during and after construction. Japanese consultant will supervise and instruct the whole activity using local resources. Category of activities is shown in Table 2-23.

Table 2-23: Contents of soft component activity

	Activity Items				Contents	Feature	Target Audience
Community development	A	Workshop for Implementing Agency	A1	Workshop for Implementing Agency	After giving explanation of contents of project, role of implementing organization, implementation method, etc. to PDRD and DRWS staff, a detailed plan for soft component activity is determined. The role of PDRD and DORD in soft component activity is determined, and a consensus reached to carry it out with responsibility.	Workshop	PDRD staff/ DORD staff
	B	Formation of resident organization	B1	Kick-off meeting (Explanation to village leaders)	The intention of participation and cooperation in this project is confirmed after explanation of the contents of the project to the village chief and the village leader of VDC. Establishment of WSUG, determination of the well construction point in village and arrangement of WSUG is requested.	Workshop	Village chairman/VDC members
			B2	Workshop for formation of resident's organization-1 (Explanation to villagers)	A resident meeting will be held for all residents in the target villages which will focus on contents of this project, and understanding of the necessity of O&M and an O&M fund. Intention of cooperation for this project is confirmed and explanation of construction work where resident participation is necessary, such as preparation of well construction sites, securing road access, planting on slope faces, protection fence from livestock, and drainage canal. The contents of activities next time, which shall be determined by establishment of WSUG, and criteria for democratically determining well construction point, is explained, and preparation for next activities is requested.	Village meeting	Residents
			B3	Workshop for formation of resident's organization-2 (Establishment of WSUG)	A resident meeting will be held for all residents in the target villages which will focus on understanding of the necessity and role of WSUG. WSUG members in each village are elected by a democratic method, and internal regulation of WSUG is made. Collection of O&M fund before construction and deposit in a bank will be explained by WSUG, and the amount of collection for O&M fund from each household shall be determined by a democratic method. Moreover, deadline for collection of O&M fund shall be determined. And, an explanation that well construction work will not commence until collection of O&M fund is completed. Moreover, it is requested that the well construction point should be selected by a democratic method for every WSUG by next workshop.	Village meeting	Residents
			B4	Workshop for formation of resident's organization-3 (Final confirmation of well construction)	A workshop will be held by WSUG members. Collection of O&M fund shall be confirmed, and how to start a bank account, make deposits, and manage deposits is explained to WSUG, and if necessary support of banking procedures is given. The well construction point selected for every WSUG shall be decided after confirming there are no obstacles to the construction work.	Workshop	WSUG members
	C	Residents' participation	C1	Resident participation-1 (Securing road access)	Securing road access and preparation of well construction site, etc. are practically instructed to WSUG members and residents, and confirmation that there are no obstacles to the well construction work.	On-the-job training	WSUG members/ Residents
			C2	Resident participation-2 (Neighborhood maintenance of water supply facility)	After completion of well construction, planting on slope faces, construction of protection fence from livestock, and drainage canal by WSUG members and residents is implemented in the form of on-the-job training.	On-the-job training	WSUG members/ Residents
Hygiene education	D	Hygiene education	D1	Hygiene education [Participatory Hygiene and Sanitation Transformation (PHAST)]	The PHAST program of DRHC is introduced into the hygiene education of this plan, the improvement activities of sanitary habits by the resident themselves are carried out after their education in health facts and knowledge.	Workshop	WSUG members/ Residents
Operation and maintenance	E	Instruction of O&M	E1	Instruction of O&M-1 (Classroom lecture)	A workshop will be held for WSUG members, and an explanation given so that they can gain an understanding of their individual responsibilities: O&M of facilities, rules of use, daily checking, cleaning of the neighborhood, the correspondence method in the event of breakdown, procurement method of spare parts, and management method of bank account for O&M fund.	Workshop	WSUG members
			E2	Instruction of O&M-2 (On-the-job training)	A workshop will be held for WSUG members with practical instruction in how to repair hand pumps. An understanding of hand pump structure is given, repair tools distributed, and method of use is explained. Spare parts are distributed and replacement method explained. A hand pump is taken apart, and practical training in how to re-install it after the spare parts have been replaced.	On-the-job training	WSUG members

2) Role

The role of the parties concerned, including the implementing agency, are shown in Table 2-24.

Table 2-24: Role of concerned parties

Concerned Party	Role
Japanese consultant	Overall supervision of soft component Coordination and discussion among DRWS, PDRD, DORD, and local consultant Preparation of execution plan for soft component program Training of local consultants in soft component implementation contents and procedure Holding of workshops for PDRD and DORD Holding of workshops to organize WSUG Technical guidance relating hygiene education Technical guidance relating to repair and O&M of facilities
Local consultant	Overall supervision and implementation of soft component during absence of Japanese consultant Consensus and discussion among DRWS, PDRD, DORD, and local consultant during absence of Japanese consultant Making activity report in English during absence of Japanese consultant Holding of workshops for PDRD, DORD, Village, and WSUG Holding of workshops to organize WSUG Supervision and making activity reports in English relating to hygiene education conducted by PDRD Training relating to repair and O&M of facilities for WSUG
DRWS	Overall management of program with cooperation of Japanese consultant Request for cooperation to PDRD and DORD regarding implementation of program
DRHC	Instruction of the method of hygiene education to PDRD
PDRD	Implementation of hygiene education
DORD	Holding of workshops to organize WSUG Instruction of resident participation activities Training relating to repair and O&M of facilities for WSUG
VDC/ village chairman	Consensus formation throughout the village about participation in the project

Concerned Party	Role
	Layout plan of water supply facilities of entire village
WSUG/residents	Formation of WSUG organization and election of a board Collection of O&M fund Establishment of a bank account, making deposits into the O&M fund bank account, storage of bank book Determining construction site of water supply facilities Construction work residents are responsible for Participation in hygiene education Participation in training relating to repair and O&M of facilities Storage of a repair tools Storage of a spare parts

3) Contents of Activities

a. Workshops for Implementing Agency

A1 Workshop for Implementing Agency

After giving explanation of contents of project, role of implementing organization, implementation method, etc. to PDRD and DRWS staff, a detailed plan for soft component activity is determined. The role of PDRD and DORD in soft component activity is determined, and a consensus reached to carry it out with responsibility.

b. Formation of resident's organization

B1 Kick-off meeting (Explanation to village leaders)

The intention of participation and cooperation in this project is confirmed after explanation of the contents of the project to the village chief and the village leader of VDC. Establishment of WSUG, determination of the well construction point in village, and arrangement of WSUG is requested.

B2 Workshop for formation of resident's organization-1 (Explanation to villagers)

A resident meeting will be held for all residents in the target villages which will focus on contents of this project, and understanding of the necessity of O&M and an O&M fund. Intention of cooperation for this project is confirmed and explanation of construction work where resident participation is necessary, such as preparation of well construction sites, securing of road access, planting on slope faces, protection fence from livestock, and drainage canal. The contents of activities next time, which shall be

determined by establishment of WSUG, and criteria for determination of well construction point by a democratic method, is explained, and preparation for next activities is requested.

B3 Workshop for formation of resident's organization-2 (Establishment of WSUG)

A resident meeting will be held for all residents in the target villages which will focus on understanding the necessity and role of WSUG. WSUG members in each village are elected by a democratic method, and internal regulation of WSUG is made. Collection of O&M fund before construction and deposit in a bank will be explained by WSUG, and the amount of collection for O&M fund from each household shall be determined by a democratic method. Moreover, deadline for collection of O&M fund shall be determined. And, an explanation that well construction work will not commence until collection of O&M fund is completed. Moreover, it is requested that the well construction point should be selected by a democratic method for every WSUG by next workshop.

B4 Workshop for formation of resident's organization-3 (Final confirmation of well construction)

A workshop will be held by WSUG members. Collection of O&M fund shall be confirmed, and how to start a bank account, make deposits, and manage deposits is explained to WSUG, and if necessary support of banking procedures is given.

The well construction point selected for every WSUG shall be decided after confirming there are no obstacles to the construction work.

c. Resident participation

C1 Resident participation-1 (Securing road access)

Securing road access and preparation of well construction site, etc. are practically instructed to WSUG members and residents, and confirmation that there are no obstacles to the well construction work.

C2 Resident participation-2 (Neighbourhood maintenance of water supply facility)

After completion of well construction, planting on slope faces, construction of a protection fence from livestock and a drainage canal by WSUG members and residents is implemented in the form of on-the-job training.

d. Hygiene education

D1 Hygiene education [Participatory Hygiene and Sanitation Transformation（PHAST）]

Hygiene education is given to WSUG members and residents. The Participatory Hygiene and Sanitation Transformation (PHAST) involving (i) the spread of toilets, (ii) rigid enforcement of

hand-washing, (iii) sanitary use of safe drinking water; is tackled by Department of Rural Health Care, MRD, that assumes National policy on water sanitation in rural areas. DRHC made a PHAST kit which serves as a manual text of activities in cooperation with UNICEF. The PDRD staffs, who received instructor training from DRHC, carry out the actual activities using the PHAST kit. Also in projects of other donors or NGOs, such as “Project for rural water supply and sanitation in Tonle Sap,” and the project for rural water supply and sanitation in Kampong Cham Province conducted by NGO "Plan International Cambodia" (PIC), PDRD staffs are conducting these activities based on DRHCs plan.

For this reason, the PHAST program of DRHC is introduced into the hygiene education of this plan, the improvement activities of sanitary habits by the residents themselves are carried out after enforcement of the education of health knowledge. Concrete contents of PHAST program activities are shown in Table 2-25.

Table 2-25: Outline and time schedule of PHAST Program

N0	Content	Time
1	Objectives of Training	10 min
2	PHAST test on health knowledge	30 min
3	General hygiene for health	2 h
4	PHAST Program	
	1. Problem identification (Phase I): –Community stories, and –Health problems in our community.	2 h:50 min
	2. Problem analysis (Phase II): –Mapping water and sanitation in our community, –Good and bad hygiene behaviours, –Investigating community practices, and –How diseases spread.	5 h : 15 min
	3. Planning for solutions (Phase III): –Blocking the spread of disease, –Selecting barriers, and –Tasks of men and women in the community.	3h :10 min
	4. Selecting options (Phase IV): -Choosing sanitation improvements, -Choosing improved hygiene behaviours, –Taking time for questions.	3h :10 min
	5. Planning for new facilities and behaviour change (Phase V): –Planning for change, –Planning who does what, and –Identifying what might go wrong.	4 h : 30 min
	6. Planning for monitoring and evaluation (Phase VI) –Preparing to check our progress	2 h
	7. Participatory evaluation (Phase VII) –Checking our progress	4 h : 50 min
	Total time	28 hours 25 minutes = 4 days

Source：WHO

e. Instruction of O&M

E1 Instruction of O&M-1 (Classroom lecture)

A workshop will be held for WSUG members, and an explanation given so that they can gain an understanding of their individual responsibilities: O&M of facilities, rules of use, daily checking, cleaning of the neighbourhood, the correspondence method in the event of a breakdown, procurement method of spare parts, and management method of bank account for O&M fund.

E2 Instruction of O&M-2(On the job training)

A workshop will be held for WSUG members with practical instruction in how to repair hand pumps. An understanding of hand pump structure is given, repair tools distributed, and method of use is explained. Spare parts are distributed and replacement method explained. A hand pump is taken apart, and practical training in how to re-install it after the spare parts have been replaced.

(6) Method of procurement of implementing resource for Soft Component

Soft component activities shall be conducted mainly by the Japanese consultant, and the activities will take a long time so a local consultant shall be effectively employed. In order to select a suitable local consultant, a Japanese consultant examines specialty, experience, English capability, etc. individually by screening of their curriculum vitae and holding an interview exam.

Request for the dispatch of a staff member who can carry out "hygiene education" is made to PDRD through the implementing agency. Moreover, request is made to DORD for the dispatch of a staff member to carry out "formation of resident's organization," "resident participation," and "instruction of O&M."

(7) Output of Soft Component

The output of the Soft Component Activities is summarized as below.

- Completion report
- Soft component implementation status report (every detachment of Japanese consultant)
- Operation and maintenance manual
- Rules for use of facilities
- O&M training implementation report
- Hygiene education manual
- Hygiene education implementation report

(8) Role of Implementing Agency

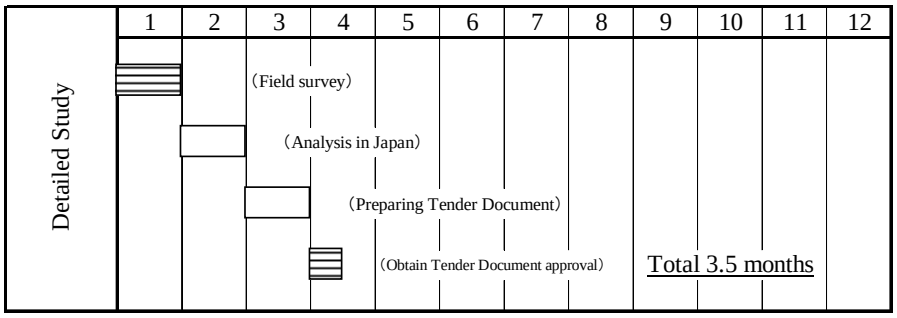
The implementing agency bears the following responsibility.

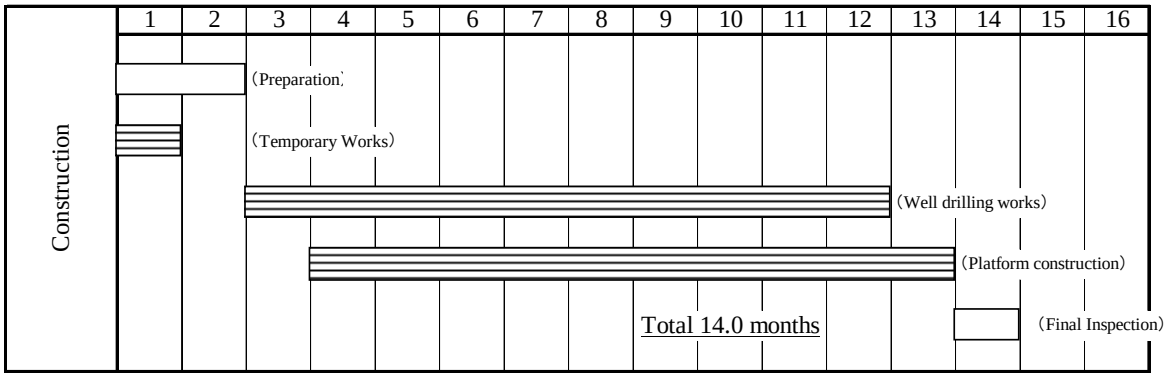
- Dispatch of the PDRD staff for hygiene education implementation
- Dispatch of the DORD staff for formation of resident organizations, villager participation, and instruction of O&M.

2-2-4-7 Implementation Schedule

The implementation schedule of this project is shown below

Table 表 2-26: Implementation schedule





2-3 Obligation of recipient country

(1) Specific items for this Project

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

1) To lend DRWS's equipment relating to drilling work, as agreed by minutes of discussion, to the Japanese contractor free of charge

2) To assign some C/P personnel who will work together with Japanese consultant for establishing the operation and maintenance system and conducting hygiene education during the soft component programme (PDRD and DORD)

3) To bear the allowances and other expenses related to the activities for C/Ps

4) To attend the inspection

5) To prepare temporal roads, secure well construction sites, and level land enabling trucks with drilling materials to access the sites (by beneficiary）

6) To plant grass on the slope faces of the platform (by beneficiary）

7) To install fence for prevention of invasion by livestock (by beneficiary）

8) To construct terminal drainage channels from the well drainage ditches for water supply facilities (by beneficiary）

(2) General items

In the implementation of the Grant Aid project, the recipient country is required to undertake such necessary measures as the following:

1) To secure land necessary for the sites of the Project and to clear, level, and reclaim the land prior to commencement of the construction,

2) To provide facilities for the distribution of electricity, water supply and drainage, and other incidental facilities in and around the sites,

3) To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation, and internal transportation of the products purchased under the Grant Aid.

4) To exempt Japanese nationals from customs duties, internal taxes, and other fiscal levies which

will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts,

5) To accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the Verified Contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

6) The recipient country is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

7) The products purchased under the Grant Aid should not be re-exported from the recipient country.

8) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under Verified Contracts. The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

9) The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions to the Bank..

2-4 Project Operation Plan

Operation and Management of a water supply facility shall follow the “National Policy on Water Supply and Sanitation" and "Guideline on Water and Sanitation User Group (WSUG) in Cambodia," like the last plan.

(1) Operation and Maintenance System

1) Segregation of duties for concerned parties

WSUG is established for each water supply facility and shall actively conduct operation and maintenance (O&M). DORD, PDRD, DRWS, and a private company shall support this O&M. Segregation of duties for concerned parties concerning O&M is shown in Table 2-28. Moreover, structure of WSUG and common duties is shown in Table 2-29.

Table 2-27: Segregation of duties for concerned parties concerning O&M

Organization	Duties
WSUG	- Maintenance and check of a water supply facilities - Spare parts replacement - Minor repairs of the water supply facilities - Storage of O&M fund - Payment of the spare parts and repair costs - Request technical assistance from DORD
DORD	- Inspection tour of water supply facilities - Instruction on WSUG organization - Stock management of spare parts - Management of the spare part payment of WSUG - Procurement support of spare parts - Technical guidance to WSUG on repairs - Repair support of major failures - Request technical assistance from PDRD
PDRD	- Supervise and support DORD - Repair support of major failures -Request technical assistance from DRWS
DRWS	- Supervise and support PDRD - Repair support of major failures
Private Company	- Repair of major failures

2) WSUG

Based on the "Guideline on Water and Sanitation User Group," the structure and common duties of WSUG members is shown in below.

Table 2-28: The Structure and Common Duties of WSUG of Members

Member	Duties
Chief	- Represents the water and sanitation user group in consultation and discussion with the local authority, the village development committee and the donators, as well as keeping good relationship with representatives of those aid agencies who deal with water and sanitation supply issues. - Leads monthly meeting and other necessary meetings. - Ensure that the properties provided by donators are managed and controlled carefully. - Leads the group in monitoring and evaluating all activities related with water and sanitation supply program. - Making report to the village development committee and village chief in case any well is broken and can not be repaired by the people in the village etc.
Deputy Chief	- Assistant to chief and do all works when a chief is absent - In charge of minor technical works - Effectively keeps spare parts and equipment - Monitors the funds collected from the community - Takes responsibility and completes works delegated by the chief - Participates in all meetings invited by the chief of water and sanitation user group
Member in charge of finance	- Encourages villagers to contribute money, materials, or labour before and after drilling the well. - Collects and keeps the budget for repairs and maintenance - Controls and reports on funds collected at each water source to the chief, deputy chief and other members of the WSUG. - Preparing list of income and expenditure of the budget in order to report to chief, deputy chief, the WSUG members and other people living in the village. - Participates in all meetings invited by the chief of the WSUG.
Member in charge of water supply	- Collaborates and coordinates with technical officers on the construction of the water supply service system. - Controls and promotes water source protection in the village. - Reports on damage of the water supply service in the village to chief of the WSUG. - Joins in the training regarding the maintenance and repairing of the wells or the water source by technical officer. - Takes responsibility in maintenance and repairing the water source (wells etc.) - Participates in all of the various meetings invited by chief of the WSUG.
Member in charge of sanitation	- Collaborates and coordinates with the technical officer on providing sanitation services such as latrines, sewage drainage, removing muddy holes, and digging waste holes etc. - Control and promote implementation of water sanitation and hygiene around the house by making a gate around the well or building bath room etc. - Join in training concerning utilization of water and sanitation, and pass on to other villagers to educate them. - Report on lack of hygiene to the chief of WSUG if there is any member who does not change theirs habits impacting public health in the community. - Participate in all meetings invited by chief of WSUG.

(2) Repair System of the Water Supply Facilities

1) Spare parts replacement and minor repairs

Member in charge of water supply who receives technical training in O&M under the soft component of this plan shall conduct spare parts replacement.

2) Major repairs

Repair for breakdowns, requiring special equipment and expert well technology, is entrusted to a private company. DORD, PDRD, and DRWS serve as an intermediary between the company and WSUG. However, in case the private company cannot handle the repair technically, DORD, PDRD, and DRWS shall fix it directly.

3) The burden of repair cost

As a rule, the total cost of the repairs is borne by the WSUG.

(3) Spare Parts Supply System

1) Stock Control

Two sets of standard spare parts are procured for each WSUG in this plan. WSUG keeps one set, while DORD keeps the other set for each WSUG. When the WSUG has used the set of spare parts in their keeping, they apply to DORD for additional parts. DORD charges WSUG for the parts. DORD makes a ledger of spare parts in order to keep stock control and administer expenses of the spare parts.

2) Procurement

If DORD's stock of spare parts decreases, a replacement is purchased. The money paid from WSUG turns into a fund for these purchases. Although candidate procurement places are shown in Table 2-30, it is determined in consideration of price and quality.

Table 2-29: Procurement place of spare parts

Procurement place	Place	Points of concern
Import agent of Afridev hand-pump	Phnom Penh	Although it is an import agent from India, the original manufacturer's spare parts are sold and are always in stock.
Agent of Afridev hand-pump manufactured in Cambodia	Phnom Penh	Cambodian made spare parts are always in stock. Quality of products manufactured in Cambodia is not so good.
Store (building material)	Suong, Kampong	Suong is in about 50km distance from Memot district.

	Cham Province	Although there is a store which sells spare parts, supply is unstable and quality is not uniform. Moreover, selling price is high.

(4) Operation and Maintenance Costs

1) Collection Method of O&M Costs

The result of monitoring the pilot facilities constructed in the Study on Groundwater Development show that there is: ①limited availability of safe means of storing the money, ②difficulty of assuring accountability for stored funds, ③possibility of using money stored insecurely for something other than the intended purpose, ④low amount of money in circulation, ⑤lack of understanding of the need for repair funds among residents, ⑥infrequent need for repair costs due to infrequent breakdown, ⑦repair cost of a hand pump is not so expensive, and ⑧in case of breakdown, residents have a mutual-aid spirit to pay money and to fix facilities. For such reasons, the practice of regularly contributing money for repair costs into a reserve fund often stopped after it had been started. Therefore, the periodical reserve of O&M costs is expected to be difficult.

On the other hand, in order to attain the project objective of sustainable O&M of the facilities into the future, O&M costs need to be secured somehow. For this reason, an O&M fund will be created by collecting O&M costs before the construction the facilities. This is a successful example from the pervious Grant Aid project. An O&M fund of 200,000 Riels (about 50 dollars) is collected from users for every WSUG. Payment of the O&M fund is a condition of well construction, before it commences, when the incentive to pay is highest. It is collected as a one-off payment. If O&M fund is imposed uniformly, those in poverty may have a problem paying, so the collection method of O&M costs is determined by every WSUG to give aid to those in poverty, and to ensure the democratic and fair collection of the O&M fund.

2) Storage Method of O&M Costs

O&M fund is kept after the establishment of a bank account for every WSUG at the Memot branch of the ACLEDA bank, which is a major bank in Cambodia. The points of concern of bank account management are shown in Table 2-31. This is to be put into practice by the WSUG when the soft component technical assistance of O&M is carried out.

Table 2-30: The points of concern of bank account management

Item	Points of concern	Countermeasure
Commission charges of bank account number	If there are no transactions in a bank account, such as deposits or withdrawals, for one year, a commission of 20,000 Riels (about $5 US) is charged. This is not charged if transactions are made.	WSUG goes to the bank and carries out a deposit or withdrawal at least once a year.
Bank interest	Residents do not understand that the bank pays interest (an annual rate of 4%).	WSUG goes to a bank to write up and confirm that interest has accumulated.

2-5 Project Cost Estimations

2-5-1 Initial Cost Estimation

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

(1) Obligation of Cambodia side

Cambodia's obligations are as shown in the table below.

Table 2-31: Cambodia's Obligation

Project Expenses	Total amount (US$)	Remarks
Bank Charge	1,839	Opening of B/A, Issuing of A/P

(2) Condition of Quotation

1) Time of Estimation

Project cost was estimated in March 2009 when the field survey of the Basic Design Study was completed.

2) Exchange rate

Project cost was calculated using the average rate in six months from May 1, 2008 to October 31, 2008.

1US$=106.75 Yen

3) Schedule for Facility Construction

Schedule for facility construction is shown in "2-2-4-7 Implementing Schedule".

4) Others

Project cost was estimated according to the Guideline of Japanese Grant Aid.

2-5-2 Operation and Maintenance Cost

Annual operation and maintenance cost of a well with hand pump is estimated as shown in Table 2-33,

inclusive of the cost of spare parts, well cleaning, and hand pump replacement. The O&M cost for one facility (average number of users: 210 people) is $51.6 US, and it must be secured at annual cost of $1.2 US per household (5 family members), as shown in the table below.

According to the social economy survey, the average annual income per household in 2007 is 7,587,167 Riels (approximately $1900 US) and the average annual amount of willingness to pay for operation and maintenance per house hold is 6,468 Riels (approximately $1.6 US).

Therefore the cost for operation and maintenance is payable by the villagers so that villages sustain operation and maintenance of water supply facilities without any funds supported by the government.

Table 2-32: Annual O&M Cost per facility

No.	Item	Cost per unit	Qty	Amount	Remarks
1	Spare parts replacement	2	1	2.00	Once a year
2	Regular check-up DORD staff daily allowance	5	1	5.00	ditto
3	Roundtrip car cost for No. 2	5	1	5.00	ditto
4	Well cleaning cost	160	0.1	16.00	Once ten years
5	DRWS staff daily allowance of No. 4	10	0.1	1.00	ditto
6	Roundtrip car cost for No. 4	20	0.1	2.00	ditto
7	Hand pump replacement	400	0.05	20.00	Once 20 years
8	DRWS staff daily payment for No. 7	10	0.05	0.50	ditto
9	Roundtrip car cost for No. 7	20	0.05	0.10	ditto
	Total			51.60	

Chapter3 Project Evaluation and Recommendations

Chapter 3. Project Evaluation and Recommendations

3-1 Project Effect

In this Project, it is aimed that water supply facilities be developed to supply safe drinking water in a stable manner to residents of 52 villages of Memot District, Kampong Cham Province. This has been established as the project purpose.

The following effects are expected through this Project as shown in below.

Table 3-1: Project Effect

Current condition and problems	Project actions/ countermeasures	Direct effects and degree of improvement	Indirect effects and degree of improvement
- Residents of target areas cannot obtain safe water in a stable manner, because, for drinking water, they have to rely on water supplied from shallow wells that can easily dry up during the dry season and can often be contaminated coli bacteria. Illness caused by contaminated water often spreads among residents and water drawing labor is also a burden to them.	- Construction of hand-pump well facilities	- Hand-pump well facilities will be constructed at 136 locations. - Safe water supply rate in the target site will be improved from 6.5% to 92.7% (2015). - Illness due to contaminated water will be reduced. - Residents' burden of water drawing labor will be reduced.	- Annual average medical expenses per household will be reduced to less than the baseline of 762,169 riel. - Daily average time spent on water drawing will be reduced to less than the baseline of 63 minutes.
- Water and Sanitation User Groups (WSUGs) to maintain and manage water supply facilities have not been established among residents of the target site.	- Support to activities related to formation of residents' organization (soft component)	- A total of 136 WSUGs will be established.	- Sustainable maintenance and management of water supply facilities will become possible. - Support to sustainable maintenance and management will be provided by PDRD and DORD.
- Since residents have not been trained on how to maintain, manage and repair hand pumps, some pumps constructed by other donors are broken and left unrepaired.	- Support related to training on how to maintain, manage and repair water supply facilities for residents (soft component)	- Residents themselves will master how to maintain, manage and repair water supply facilities. - Funds for maintenance and management will be collected and secured.	- Failure incidents of water supply facilities will be reduced. - Sustainable maintenance and management of water supply facilities will become possible.
- Awareness of the sanitation regarding use of safe water is low and people often drink	- Support to activities related to sanitation education (soft component)	- Residents' awareness of sanitation and the importance of safe water will improve.	- The number of users of water supply facilities will increase.

water which is contaminated with coli bacteria.		- Illness caused by contaminated water will be reduced.	- The cleaning frequency of perimeter areas of water supply facilities will increase.

The water supply rate is calculated based on an estimation that each deep well with hand pump can supply water to a population of 210.

3-2 Recommendations

(1) Recommendations to the Recipient Country

1) Securing of Work Force and Budget of the Cambodian Side

In implementing this Project and related soft component programs, it is necessary to take appropriate measures to allocate personnel of the Cambodian government (at PDRD and DORD) and secure budgets necessary for their activities.

2) PDRD and DORD Personnel's Active Participation in the Project

It is planned that water supply facilities to be constructed in this Project will be maintained and managed by residents' organization through their initiative. In order to make such water supply facilities useful in a sustainable manner and make the project effect continuous, it is indispensable that PDRD and DORD carry out monitoring, provide support for maintenance and management activities and offer training to increase awareness of sanitation. Therefore, it is desired that personnel of PDRD and DORD will participate actively in this Project, particularly from the earlier phases of the Project.

3) Residents' Contribution to the Project through Participation

In order that water supply facilities to be constructed in this Project will be maintained and managed in a sustainable manner, residents who are supposed to maintain and manage the facilities through their initiative need to participate in the Project and foster a sense of ownership themselves. Therefore, in this Project, it is intended that residents themselves will be responsible for and perform minor woks such as installation of fences for water supply facilities and water plumbing and construction of drainage. It is important that DORD will take the initiative to promote residents' participation in this Project and to improve their sense of ownership.

(2) Technical Cooperation and Partnership with Other Donors and NGOs

1) Coordination with Technical Cooperation Projects

In this Project, it is planned to implement soft component activities in the form of initial training and

guidance for residents, in order to develop a maintenance and management system for water supply facilities for which residents will be responsible as well as to improve residents' awareness of sanitation. Over the medium term, however, it is necessary to monitor and follow up their activities appropriately so that the maintenance and management system can be fully developed and residents' awareness of sanitation can be improved in a sustainable manner.

In addition, based on the fact that broken wells constructed by other donors are left unrepaired, it is considered that repair techniques of PDRD and DORD need to be improved.

In order to achieve the overall goal of this Project, "Improvement of living and sanitary environment of residents in the Project site," it is indispensable to develop sanitary facilities (rest rooms) and expand the use of those facilities. The development of such sanitary facilities, however, is slow in the Project site.

It is desired, therefore, that technical cooperation projects be implemented aimed at enhancing capabilities to maintain and manage water supply facilities and at expanding the use of sanitary facilities.

2) Coordination with Other Donors

Currently, IMF has a plan to implement a rural water supply and sanitation project in 11 provinces in Cambodia including Kampong Cham Province. Since Memot District is not included in the IMF plan, however, there will be no overlap with our Project. According to PDRD, the government of India also plans to construct a total of 1,100 hand-pump wells targeting at Kampong Cham Province but it is said that details of the plan are not yet determined. It is necessary, therefore, to reinforce coordination between other donors to avoid overlap with other projects.

Water supply facilities constructed through the previous grant aid program entitled "Project for Rural Drinking Water Supply in Kampong Cham Province" have been highly recognized as having excellent quality by other donors such as ADB and UNICEF. For its ongoing project, ADB even has adopted the design, specifications and water quality standard used in the above-mentioned previous project of ours. Meanwhile, in sanitation training to be carried out in this Project, it is planned to use training materials that DRHC developed obtaining assistance from UNICEF. It is desired that exchanges of techniques and information related to water supply and sanitation activities be actively enhanced between other donors so that we and other donors can further improve the way to implement assistance programs in this field.