DEPARTMENT OF RURAL DEVELOPMENT (DRD)
MINISTRY OF LIVESTOCK, FISHERIES AND RURAL DEVELOPMENT (MLFRD)
THE REPUBLIC OF THE UNION OF MYANMAR

THE PREPARATORY SURVEY REPORT ON THE PROVISION OF EQUIPMENT FOR RURAL WATER SUPPLY PROJECT IN THE CENTRAL DRY ZONE (PHASE 2) IN THE REPUBLIC OF THE UNION OF MYANMAR

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JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

EARTH SYSTEM SCIENCE CO., LTD. (JAPAN)
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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to the consortium consist of Earth System Science Co., Ltd. and Oriental Consultants Global Co., Ltd.

The survey team held a series of discussions with the officials concerned of the Government of Myanmar, and conducted a field investigations. As a result of the further studies in Japan, 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.

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

January, 2016

Kunihiro Yamauchi
Director General
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SUMMARY

1. OUTLINE OF MYANMAR

(1) LAND AND NATURAL CONDITIONS

Myanmar is located in the westernmost of Southeastern Asia and bordered with India, Bangladesh, China, Laos and Thai, and facing the Bengal Bay and Andaman Sea. It occupies about 680 x 10^3 km^2 of land (About 1.8 times that of Japan). The population is 51.49 million persons (2014, the 2014 Myanmar Population and Housing Census). The population density is 76 persons/ km^2.

The study area is three (3) regions, Sagaing, Mandalay and Magway regions, which are called the Central Dry Zone (hereinafter called "CDZ") distributed between the Arakan Mountains and the mountains which occupy the eastern half of Myanmar. The area is about 77 thousand km^2. The population of the area is 15.38 million persons: It is about 31% of the total population. The Irrawaddy River flows to the south in the midwest region of the study area.

Myanmar has a tropical climate and three (3) seasons: a rainy season (May to October), a winter season (November to February), and a summer season (March to April). The average annual rainfall is 2,341 mm whereas annual rainfall in the Central Dry Zone (CDZ) is 760 mm. The maximum average monthly temperature is 30.3 degree Celsius in April to May at Mandalay (Food and Agriculture Organization: FAO) and the daily maximum temperature is about 40 degrees Celsius in the CDZ (measured by the study team). Therefore, the CDZ is the driest area in the country.

The geology of the CDZ consists of the Pegu Layer deposited during the Palaeocene to Eocene and Irrawaddy Layer deposited in Pliocene, and Alluvium and volcanic sediments which cover the Pegu Layer and Irrawaddy Layer. Among them, the target aquifer of the study is the Irrawaddy Layer which stores good quality of groundwater.

(2) SOCIO-ECONOMY

There are eight (8) major tribes in Myanmar, namely Kachin, Kayah, Kayin, Chin, Mon, Burma, Rakhine, and Shan, which are subdivided into 135 minor tribes. The biggest tribe in Myanmar is Burma who commonly inhabits plains located in the center part of Myanmar.

Economic indicators of Myanmar in the last three (3) years are summarized in Table 1.

The GDP of Myanmar in 2013 is 56,400 million USD and per capita is 869 USD. The Real Economic Growth Rate showed a high value, of more than 5% after 2011 and reached 8.3% in 2013.

Table 1 Economic Indicators of Myanmar

Indicator	2011	2012	2013
GDP			
Nominal GDP (million USD)	52,000	54,000	56,400
Real GDP Growth Rate (%)	5.9	7.3	8.3
GDP per capita（USD）	832	876	869

Source: Project referred and edited World Economic Outlook Database (IMF), Basic Economic Indicator (JETRO)

According to statistical data of exported products, natural gas products contributed more than 40% of the total amount of exports. Other major materials exported were crops (beans, rice, etc.), textiles and timber (teak). Thailand, which buys products from Myanmar equivalent to approximately 50% of the total export amount of Myanmar, is the biggest destination county for exports and China is the second biggest with 25%.

(3) INFRASTRUCTURE

A highway is in place from Yangon to Mandalay via Naypyitaw, the capital of Myanmar. Trunk roads which connect Regions and Townships (hereinafter called "T/S") are almost paved, therefore, it is no problem for truck mounted drilling rigs and heavy vehicles to pass these roads. However, it will be difficult in the rainy season because roads between the trunk road and villages are mostly not paved.

About 5,000 km of railways are in place in the country. A trunk line between Yangon and Mandalay passes the study area and other branch local lines reach Magway, Sagaing and Nyaungoo.

The Electrification rate in Myanmar is largely lagging behind: It was 27% (2.42 million households) in 2011. Although the need for electricity has been increasing as the economy grows, chronical electric failure occurs. In order to overcome this situation, many projects by Donors are ongoing, such as National Power Transmission Network Development Project by Japan International Cooperation Agency (hereinafter called "JICA"), the Study for Rural Electrification Plan by the World Bank and the Project for Improvement of Electric Network by the Asia Development Bank. Furthermore, the Department of Rural Development (hereinafter called "DRD" of the Ministry of Livestock, Fisheries and Rural Development (hereinafter called "MLFRD") is implementing the electrification of the rural area by a solar system. As for the target villages of the Project, it was confirmed that 15 villages are connected to the three phase AC grid.

2. BACKGROUND AND OUTLINE OF THE PROJECT

(1) Superior Plan

The government of Myanmar set forth a policy called "Rural Development and Poverty Reduction" in order for achievement of the Millennium Development Goals and poverty reduction. Eight (8) tasks are adopted in the policy to improve the socio-economic life of the rural populace and to narrow the development gap between urban and rural areas. In order to realize the policy, a national workshop on Rural Development and Poverty Alleviation was held and committees were formed. The MLFRD was assigned as the responsible agency for the second task, "Development of Livestock and Fisheries Productivity and Socio-Economic Life of Rural Populace".

Rural water supply projects in Myanmar have been implemented by the Department of Development Affairs (hereinafter called "DDA"). The DDA carried out the Rural Water Supply 10-Years Plan (2000/2001-2009/2010) of which target was to construct at least one (1) borehole in a village. However, the necessity to construct rural water supply facilities was much increased in the CDZ, therefore, the DRD formulated the Rural Water Supply 5-Years Plan (2011/2012-2015-2016) and continued to construct water supply facilities

The DDA changed its name to DRD in June 2012 and shifted to the MLFRD in August 2013. The DRD formulated the Rural Water Supply 20-Years Plan (2011/2012-2030/2031) in October 2012 to accelerate the development of rural water supply facilities. The plan aimed at providing at least one (1) borehole in a village. The plan was divided into four (4) 5-Year Plans and repeats four (4) times of 5-Year Plans. Now (2015) is the last year of the First 5-Year Plan (2011/2012-2015/2016). In the next 5-Year Plan, the Second 5-Year Plan, 1,297 boreholes will be constructed in the whole country. Among them, 580 boreholes will be constructed in the CDZ. The equipment and materials to be provided in the Project are used to construct 100 boreholes out of 580 boreholes.

(2) Current Situation and Issues

The CDZ, the target area of the Project, is the dry area and surface water is not available in the dry season except for the Irrawaddy River. It is necessary to drill deep wells to get groundwater. For these reasons, many villages have no safe and sustainable water sources.

As a result of implementation of the Rural Water Supply 10-Year Plan (2000/2001-2010/2011) and the Rural Water Supply 5-Year Plan (2011/2012-2015-2016) by the government of Myanmar, at least one (1) water supply facilities which supplied safe and sustainable water was constructed in 14,630 out of 16,341 villages in the CDZ. On the one hand, it is an urgent issue to develop water sources in the remaining 1,711 villages (Deep wells are necessary in more than half of the villages). Furthermore, additional water supply facilities are required to meet the water demand in the villages where one water supply facility is already constructed.

There are many villages in the CDZ where deep wells of more than 200m are required to obtain groundwater due to the deep groundwater level. Therefore, it was sometimes difficult to drill deep wells more than 200m deep by the DRD's drilling rig. In addition, efficiency of drilling wells was decreased because of malfunctions and aging of the DRD's equipment. Considering these situations, the government of Japan implemented a Grand Aid Project "Rural Water Supply Project in the Central Dry Zone" in 2012 to provide two (2) drilling rigs (drilling capacity, more than 300m) and materials for drilling of deep wells in 87 villages. However, needs for safe water supply in the CDZ are still high, therefore, it is an urgent issue to provide necessary equipment for development of rural water supply facilities.

(3) Purpose of the Project

The project aims to strengthen the capacity of DRD's rural water supply by providing the equipment necessary for construction of new deep wells, thereby contributing to improve the access of the people in the Central Dry Zone to safe and sustainable water resource.

3. SUMMARY OF THE SURVEY RESULTS AND CONTENTS OF THE PROJECT

(1) Summary of the Survey Results

In response to the request by the government of Myanmar, Japan International Cooperation Agency (hereinafter called "JICA") dispatched a preparatory survey team to Myanmar from 26 April to 10 July 2015 and from 18 October to 24 October 2015. The survey team carried out the survey in the target area, Sagaing, Mandalay and Magway regions, on the selection of the target villages, natural conditions (field reconnaissance, topographical and geological survey, geophysical survey and water quality survey) and socio-economic conditions. A summary of the results of the field survey and analysis in Japan is described below.

1) Selection of the Target Villages

A total of 100 villages were selected as target villages in the study. Criteria applied in the selection were (1) hydrogeological situation of the village, (2) sufficiency of existing water sources, (3) result of geophysical survey and (4) socio-economic conditions of the village.

2) Outline Design

The basic policy on the design in the Project is as described below. The appropriate scale and specifications are decided as the equipment procurement project for the DRD.

(1) Among the requested equipment such as drilling rigs and related tools and materials, well logging equipment and supporting vehicles, equipment of which the verification has been confirmed.

(2) A set of pumping test equipment will be included in the procurement plan, because of the necessity for improvement of the future rural water supply project by the DRD.

(3) Technical transfer (soft component) is planned on the method and analysis of the pumping test and well logging using the procured equipment.

(2) Contents and Scale of the Project

1) Equipment to be Procured

The equipment and materials to be procured in the Project are summarized in Table 2

Table 2 Equipment and Materials to be considered in the Project

Item	Specification	Number
Truck mounted drilling rig (drilling capacity, more than 300m) and ancillary materials	Drilling capacity: 250m	1 set
	Drilling capacity: 200m	1 set
Air compressor		2 sets
Cargo truck with crane	Pay load: more than 10 ton Lifting load: 5 ton	2 cars
Well logging machine	Measuring depth: 400m	1 set
	Measuring depth: 300m	1 set
Consumables for borehole construction (bentonite, CMC, etc.)		For 100 villages
Casing and screen		For 100 villages
Pumping test equipment		1 set

2) Soft Component (Technical Assistance)

Technical assistance is carried out aiming at strengthening of the staff of the DRD on the well logging and pumping test. Expected output of the soft component is as follows.

(i) Output of the Soft Component on the well logging technique

Output (1) : Staff of DRD will acquire the technique for planning and implementation of well logging.
Output (2) : Staff of DRD will acquire the technique on examination of obtained data.
Output (3) : Staff of DRD will acquire the technique to decide the proper well structure by using the analysis result of well logging.

(ii) Output of the Soft Component on the pumping test technique

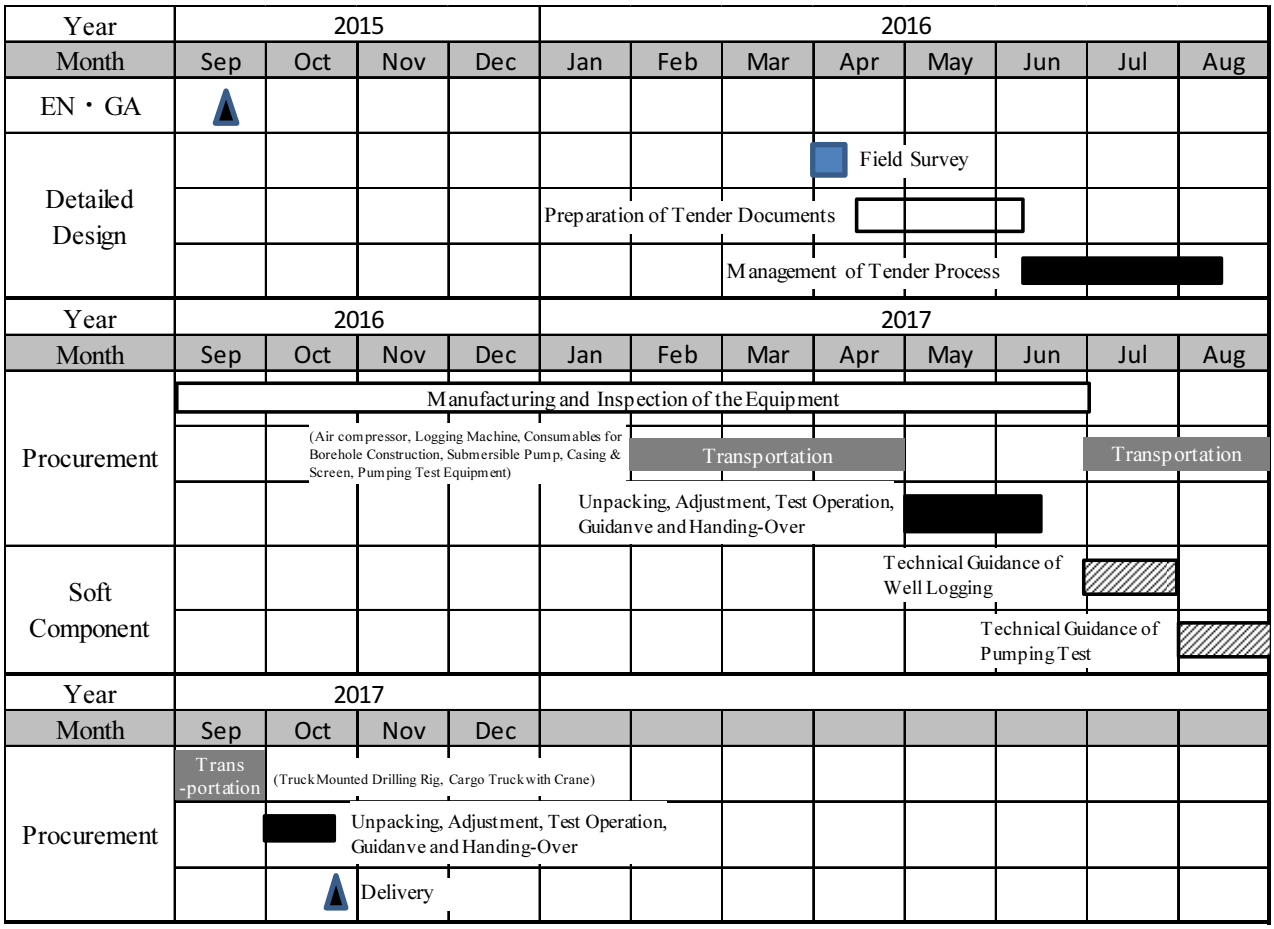
Output (1) : Staff of the DRD will acquire the technique on formulation of the proper pumping test plan.
Output (2) : Staff of the DRD will acquire the technique on the pumping test by submersible pump.
Output (3) : Staff of the DRD will acquire the technique on the data analysis of logging data and to evaluate the aquifer.
Output (4) : Staff of the DRD will acquire the technique on the formulation of proper pumping plan based on the evaluation of the aquifer.

4. IMPLEMENTATION SCHEDULE AND IMPLEMENTATION COST OF THE PROJECT

(1) Implementation Schedule

The implementation period of the Project is 25 months after conclusion of the Exchange of Notes (E/N) and the Grant Agreement (G/A). The implementation schedule is shown in Table 3.

Table 3 Implementation Schedule



(2) Implementation Cost

The implementation cost of the Myanmar side is estimated as 2.29 billion MMK.

5. RELEVANCE AND EFFECTIVENESS IF THE PROJECT

(1) Relevance

Implementation of the Project will provide new safe and sustainable water sources to 100 villages in the CDZ which had no such water sources, and it is expected to have a positive spreading impact to decrease fetching work of water by the community people.

The policy to improve the socio-economic condition of the rural populace and to narrow the development gap between rural and urban areas is advocated in Myanmar. Accordingly, the DRD is accelerating the development of rural water supply facilities in the rural area. In the CDZ where villages are obliged to rely water sources on groundwater, to strengthen the ability of the DRD to develop groundwater and accelerate the development of rural water supply facilities to meet Myanmar's policy.

The target area of the Project is mainly farming areas and implementation of the Project will contribute improvement of the life of community people and stabilization of the people's livelihood from the viewpoint of basic human needs to supply safe and sustainable water to the people. Since one of the prioritized area of Japan's assistance policy is assistance to improve livelihood of the people (including assistance to ethnic minorities and the poverty group, agricultural development and regional development), implementation of the Project meets Japan's assistance policy.

(2) Effectiveness

The quantitative effectiveness expected is that the total of 100 deep wells are constructed in 100 villages in the CDZ by the DRD after procurement of the equipment and materials (Refer to Table 4). In addition, capacity of the DRD to develop groundwater will be improved by the soft component (technical transfer).

Table 4 Quantitative Effect of the Project

Index	Base Line (2015)	Target (2022) (5 years after completion of the Project)
Number of deep well, newly drilled in the target villages	0	100 deep wells

The implementation of the Project is expected to have following quantitative effects.

- Decreasing of time and work for fetching water by the people in the CDZ.
- Increasing of number of people who have access to safe water source in the target villages.
- Practical use of the procured equipment to the drilling of deep wells.

(3) Conclusion

From the discussion in (1) and (2) above, it is evaluated that the relevance to implementation of the Project is high and great effectiveness is expected.

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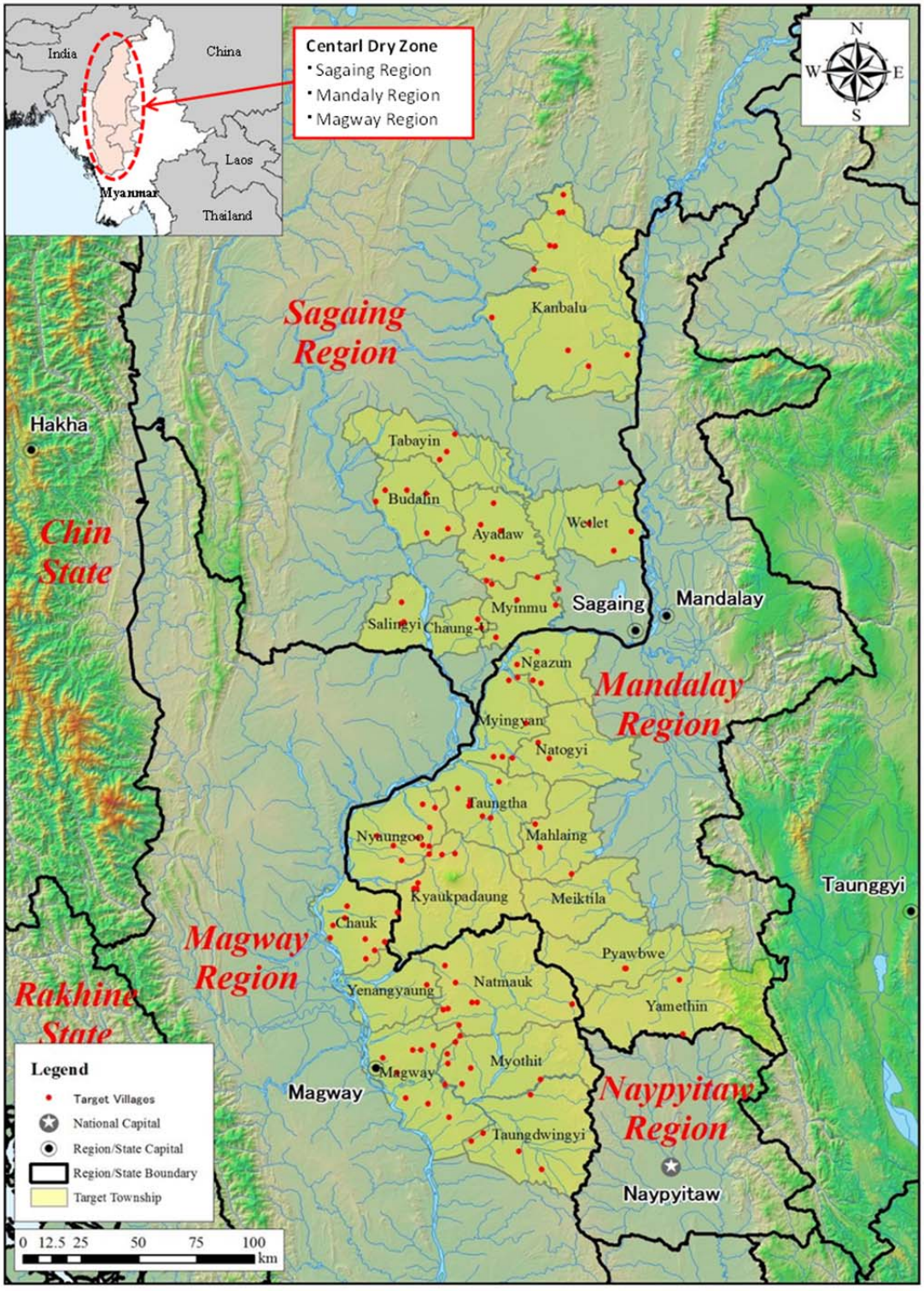
ABBREVIATIONS

APHA	American Public Health Associatin
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
A/P	Authorization to Pay
BAJ	Bridge Asia Japan
BS	British Standard
B/A	Banking Arrangement
CIA	Central Intelligence Agency
CMC	Carboxymethyl Cellulose
CDZ	Central Dry Zone
DDA	Department of Development Affairs
DIN	Deutsches Institut for Normung
DRD	Department of Rural Development
EC	Electric Conduticvity
E/N	Exchange of Notes
EU	European Union
FAO	Food and Agriculture Organization
G/A	Grant Agreement
GDP	Gross Domestic Product
GL	Ground Level
GIS	Geographic Information System
IMF	International Monetary Fund
ISO	International Organization for Standardization
JCS	Japanese Cable Maker's Association Standard
JEC	Japanese Electrotechnical Committee
JEM	Japan Electrical Manufacuture's Association
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
JIS	Japan Industrial Standards
MDGs	Millennium Development Goals
MEB	Myanma Economic Bank
MLFRD	Ministry of Livestock, Fishery and Rural Development
MMK	Myanmar Tyat
MOH	Minstry of Health
MPN	Most Probable Number
NDWQS	National Drinking Water Quality Standards Myanmar
NGO	Non Govermental Organization
NTU	Nephelometric Turbidity Unit
ORP	Oxidation Reduction Potential
TCU	True Color Unit
TDS	Total Dissolved Solid
T/S	Township
SRTM	Shuttle Radar Topography Mission
STPG	Steel Tube Pipe General
UNICEF	Unaited Nations Children's Fund
UTM	Universal Transverse Mercator
VWC	Village Water Supply Committee
WGS	World Geodetic System
WHO	World Health Organization



LOCATION OF THE STUDY AREA

CHAPTER 1 BACKGROUND OF THE PROJECT

1.1 BACKGROUND OF THE REQUEST

The government of Myanmar (hereinafter called "GOM) set forth a policy called "Rural Development and Poverty Reduction" in order for achievement of the Millennium Development Goals and poverty reduction. The GOM had a national workshop called the "National Workshop on Rural Development and Poverty Alleviation" in May 2011. As a result of the workshop, the central committee and (8) working committees were formed for eight (8) tasks of Rural Development and Poverty Alleviation adopted in order to improve the socio-economic life of the rural populace and narrow down development gap between urban and rural area by alleviating poverty. The Ministry of Livestock, Fishery and Rural Development (hereinafter called "MLFRD") was assigned as the responsible ministry for the second task "Development of Livestock and Fisheries Productivity and Socio-economic Life of Rural Populace".

The Department of Rural Development (hereinafter referred to as "DRD") of the MLFRD implemented the "Rural Water Supply 10-Year Plan (2000/2001-2010/2011)". And the DRD is implementing the "Rural Water Supply 5-Year Plan (2011/2012-2016/2017)". These plans target to construct at least one (1) borehole in every village. However, the target has not been attained. Therefore, the DRD formulated the "Rural Water Supply 20-Year Plan (2011/12-2030/31)". The project period is divided into four (4) times of the 5-Year Plans. Currently, it is the last year of the first 5-Year Plan (2011/12-2015/16). The number of boreholes to be constructed in the succeeding second 5-Year Plan is 717 in the CDZ" and 580 in other areas, totaling 1,297 wells (Table 1.1.1).

Table 1.1.1 Planned Number of Borehole to be Drilled in CDZ and Other Areas (2016/17-2020/21)

Region	2016	2017	2018	2019	2020	Total
Central Dry Zone	110	122	155	175	155	717
(1) Sagaing	(45)	(52)	(70)	(61)	(47)	(275)
(2) Mandalay	(35)	(38)	(35)	(34)	(38)	(180)
(3) Magway	(30)	(32)	(50)	(80)	(70)	(262)
Others	111	114	138	116	101	580
Total	221	236	293	291	256	1,297

The DRD set forth following three (3) policies in the plan, "Current Situation of Rural Water Supply, Target Plan & Limitation" for rural water supply in August 2013.

- To assist "the National Rural Development and Poverty Alleviation Program".
- To improve the socio-economic life of the rural populace and to narrow the development gap between urban and rural areas.
- To preserve Myanmar's rural culture.

Under these policies, rural water supply is given the second priority following the top priority of "development of rural roads" in the ten major tasks of the DRD. Corresponding to the second policy above, the DRD changed the principle from "to construct at least one (1) borehole in every village" to "to construct the necessary number of borehole considering the water demand in each village". The necessary number of boreholes is decided considering the unit water demand, 20 gallon/capita/day (about 90 L/ capita/day) and yield of boreholes.

The target area of the survey is the Central Dry Zone (hereinafter referred to as "CDZ") (Sagaing, Mandalay and Magway Regions) located in the central part of Myanmar, where about 15.4 million people (about 30% of the total population in 2014 (The 2014 Myanmar Population and Housing Census)) live. Annual precipitation in the area is small, 400 to 880 mm/year. Rainfall is

concentrated in the rainy season, May to October. Therefore, the area is the hottest and driest area in Myanmar. People in the area depend water sources on ponds and groundwater. However, those water sources become unusable in the dry season because water is dried up or water quality is worsened. Many people oblige to fetch water several times a day from the water sources several km away from their homes. These circumstances make many villages difficult to get safe water source.

The DRD, responsible organization for rural water supply in the MLFRD, has been developed groundwater in the CDZ using the drilling rigs provided by Japan's Grant in 1980s. However, capacity of the existing drilling rigs of the DRD was not enough to drill more than 200m of deep wells because groundwater is distributed in the deeper zone due to lack of aquicludes such as mud formation or mud stone in the shallower zone in many villages in the CDZ. In addition, progress of drilling deep wells was lowered because of breaking down and aging of rigs. In order to overcome these situation, a Japan's Grant Aid project "The Rural Water Supply Project in the Central Dry Zone " (hereinafter called "Phase 1") was implemented providing two (2) drilling rigs (drilling capacity more than 300m) and, equipment and materials for construction of new deep wells in the 87 villages. However, demand of safe and sustainable water sources are still high in the CDZ. Therefore, it is the urgent issue to provide equipment and materials necessary for construction of deep wells.

Under these circumstances, the GOM requested the government of Japan a Grant Aid to implement the Rural Water Supply Project in the Central Dry Zone (Phase 2) " (hereinafter called " the Project").

1.2 CONTENTS OF THE REQUEST

In order to overcome the situation described in 1.1 above, the government of Myanmar requested Japan's Grant Aid to procure the drilling rigs and related equipment and materials. The contents of the request are shown in Table 1.2.1.

Table 1.2.1 Contents of the Request

Item	Number
Truck mounted drilling rig (drilling capacity, more than 300m) and ancillary materials	2 sets
Air compressor	1 set
Cargo truck with crane	2 sets
Consumables for borehole construction (bentonite, CMC, etc.)	1 lot
Submersible pump (with generator and ancillary materials)	120 sets
Casing and screen	For 120 boreholes

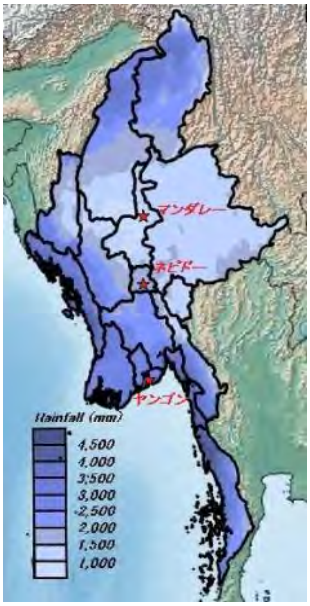
1.3 NATURAL CONDITIONS

1.3.1 CLIMATE AND HYDROLOGY

(1) Climate

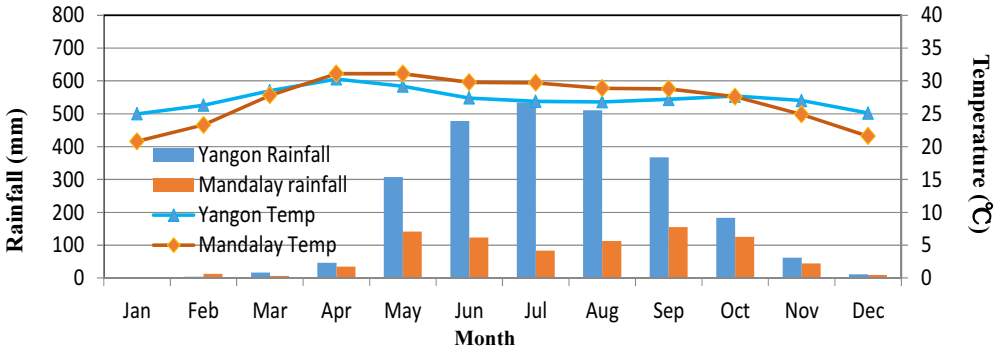
Myanmar has a tropical climate and three (3) seasons: a rainy season (May to October), a winter season (November to February), and a summer season (March to April). Average annual rainfall is 2,341 mm, which can exceed 5,000 mm in the north and 2,500 mm in the south. Central Myanmar is called the Central Dry Zone (CDZ) and its annual rainfall is 760 mm. The annual rainfall Myanmar is shown in Figure 1.3.1. In addition, the monthly rainfall and temperature of the cities of Mandalay and Yangon are shown in Figure 1.3.2 and Table 1.3.1 and 1.3.2.

The average fluctuation between day and night temperatures in Yangon, which is close to the sea, is 5.3 degrees Celsius and there is significant rainfall. However, in Mandalay, located in the center of the CDZ, the average fluctuation between day and night temperatures is as much as 10.3 degrees Celsius; the maximum average temperature is somewhat warmer at 31.1 degrees Celsius, whereas Yangon's average temperature is 30.3 degrees Celsius.



(Source: FAO)

Figure 1.3.1 Rainfall



(Source: World Climate)

Figure 1.3.2 Rainfall and Temperature in Mandalay and Yangon

Table 1.3.1 Monthly Average Rainfall and Temperature in Yangon

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall*1	3.5	4.1	16.9	46.7	307.3	477.5	534.5	510.5	367.7	183.4	62.0	11.3	2,525.0
Temperature*2	25.0	26.3	28.5	30.3	29.2	27.4	26.9	26.8	27.2	27.7	27.0	25.1	-

*1: 1870～1989 (1,231 months) *2: 1876～1988 (1,163 months) (Source: World Climate)

Table 1.3.2 Monthly Average Rainfall and Temperature in Mandalay

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall*1	2.0	13.3	6.5	35.0	141.5	124.0	83.3	113.1	154.9	125.1	45.1	9.8	853.6
Temperature*2	20.8	23.3	27.8	31.1	31.1	29.8	29.7	28.9	28.8	27.6	24.9	21.6	-

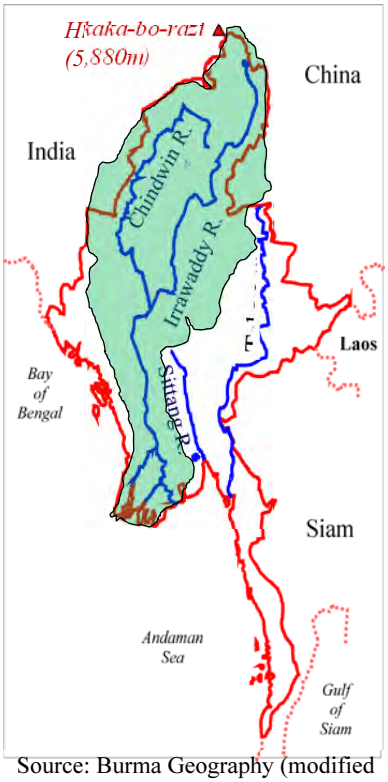
*1: 1889～1990 (1,028 months), *2: 1931～1990 (517 months) (Source: World Climate)

(2) Hydrology

The total area of Myanmar is about 676,580 km^2, 1.8 times larger than Japan. Surrounded by Thailand and Laos to the east and India to the west. It is divided by a mountain (except the border with Laos is the Mekong River), and altitude of Naga Hill, on the border with India, increases its altitude to the north, leading to the northernmost mountain, Hkaka-bo-razi (5,880 m above sea level).

Myanmar has a north-south geological structure caused by Indian plate movement up north, and a north-south vertical Sagaing fault dividing the flat, low land to the west and mountainous area to the east (refer to 1.3.2 (2) Geology in this section). Due to its geological structure, the rivers in Myanmar extend from north to south and are mainly divided into three (3) basins: Irrawaddy (including the Chindwin River), Talween, and Sittang River basins as shown in Figure 1.3.3. Significantly, the Irrawaddy River basin dominates 58% of the country, and the CDZ is located in the middle basin of the Irrawaddy River. A small part of the Irrawaddy River basin belongs to China; however, most of it does not cross the border.

The Talween River basin occupies 18.4% of the country. It begins in China and crosses the Shan highland from north to south, and in the lower reaches, approximately 110 km of it forms a border with Thailand.



Source: Burma Geography (modified by the Study Team)

Figure 1.3.3 Main River in Myanmar

The Sittang River basin is located between the Irrawaddy River basin and the Talween River basin; the whole basin belongs to the country. It occupies 5.4% of the country.

Other basins are small basins in front of the coastal area and Mekong River basin, which flows to Vietnam.

Based on the annual average rainfall, total rainfall is estimated to be 1,580 km^3/year and 1,000 km^3/year is estimated to river run-off amount. River flow amount is shown in Table 1.3.3.

Table 1.3.3 Annual River Flow in Myanmar

River Basin	River Gauging Station	Area of Catchment (km^2)	Annual Average Flow (km^3/year)
Irrawaddy	Chindwin (Monywa)	115,300	146.3
	Upper Irrawaddy (Sagaing)	193,300	244.8
	Lower Irrawaddy (Pyay)	95,600	85.8
Talween	Thanlwin	158,000	157.1
Sittang	Bago Shittaung. Bilin	48,100	81.1

River Basin	River Gauging Station	Area of Catchment (km^2)	Annual Average Flow (km^3/year)
others	Streams of Rakine State	58,300	139.2
	Streams of Taninthayi	40,600	130.9
	Mekong at Lao border	28,600	17.6
Total		**737,800**	**1002.8**

Source: Government of Myanmar 1995 (Water Profile of Myanmar (edit: 2008 Jim Kundell)/ www.eoearth.org/view/article/156974)

The CDZ is a big grain farming area that uses a significant amount of water through irrigation canals from Irrawaddy and Chindwin River; they flow down from the rainy area in the north Sagaing Region.

1.3.2 TOPOGRAPHY AND GEOLOGY

(1) Topography

Topography of the target area is classified into four (4) areas: (i) hilly terrain continues to form the Pago Mountains in northern Yangon, (ii) flatland that extends to the west of the hilly terrain to the Irrawaddy River, (iii) flatland that extends east of the hilly terrain until the Sian Mountains, and (iv) flatland that expands to the north side of the Irrawaddy River.

(i) In the northern end of the hilly terrain, the Popa volcano (1,518 m) is steep and its south side hilly terrain shows gentle undulation to an altitude of 400 m to 500 m (the highest point is 619 m). There are very few villages in this hilly area. Almost all hills are covered by forest and only the part of the basin terrain that has a small, flat area is plowed. Dams for large- and small-scale irrigation have been built.

(ii) The flatland that extends west of the hilly terrain gently decreases in altitude from the foot of the hill to the west toward the Irrawaddy River (400 m to 80 m). Small hills, 30 to 100 m in height, dot the flatland (Photo-1). Also small valleys and small-scale river terraces are formed from a branch of the Irrawaddy River. Most of the flatlands are used for cultivated land and by the village also located on it (Figure 1.3.4). The flatlands are covered by silty sand with a gravel layer that includes quartz sandstone and silicified wood stone; therefore, it is estimated that the flatlands are old terrace of the Irrawaddy River. New terraces are developed beside the current stream of the Irrawaddy River.

(iii) The flatland extends SSE to NNW between the hilly terrain and Shan Mountains in the Mandalay Region from Yametin T/S to Pyawbwe, Mahlaing, Natogyi, Myingyan, and Ngazun T/S (Photo-2). This flatlands are made up of a flood plain near the Saman River that flows into the Irrawaddy River in Mandalay. The altitude of the lands is 400 m in the upper reaches and 80 m in the confluence of the Irrawaddy River. Small hills, 30 to 100 m high, dot the flatlands, similar to the above.

(iv) Sagaing flat terrain extends north of the Irrawaddy River in a region between Irrawaddy River and the Chindwin River. This flatland is formulated as a flood plain of the Irrawaddy and Moo Rivers which flow between the Irrawaddi River and the Chindwin River. North of the flatland, mountain ridges with an altitude of 600 to 1700 m lie in a NE-SW direction and have many irrigation dams. Rice cultivation has been actively carried out for a long time using the water in this area. This flatland gently slopes from north to south, from an altitude of 200 m to 70 m, and target villages are located in this area.
The hilly area relative in elevation from 50 to 100 m extends NNW-SSE between Chindwin River and Moo River; it forms micro-basin boundaries.

22% of rice production in Myanmar is produced in the CDZ (JICA 2010 "Regional Development Plan for Poverty Reduction in the Central Dry Zone"), and it is mainly this Sagaing rice field that uses this irrigation water. Irrigation canal development has been still promoted.

Photo-1 Small hills dot the flatland
At the Zeebwar village (MG2-12) Chouk T/S

Photo-2 The Flatland in Mandaray
Chasay village (MA2-04) Myingyan T/S

Figure 1.3.4 Flatland and Eroded Valley by a branch of the Irrawaddy River
The flatland is the only cultivated area; eroded areas are just rough wasteland.
Tharmyar village (MG2-21), Myothite T/S, Magway Region, (Google Earth)

(2) Geology

The geology of the CDZ consists of tertiary sediment (Pegu and Irrawaddy formations) that accumulated in the structural depression called the Central Lowland, separated by the Sagaing Fault which runs north-south in the east end and along the normal fault in the west end. The center of the Central Lowland is divided into two areas by the hills from NNW to SSE with a volcano called the Central Igneous Line (Source: Regional Geology of Myanmar: Pramumijoro et al, 2010). The Central Igneous Line is equivalent to the volcano line from the Bago Mountains to the Twin Mountains in Monywa T/S, Sagaing Region, through the Quaternary volcano in the Mt. Popa described in topography section. This Central Igneous Line was made by the eruption of magma melted by frictional heat caused by a two-plate collision (Mitchell, 1973, 1977).

A geological map of the CDZ is shown in Figure 1.3.5.

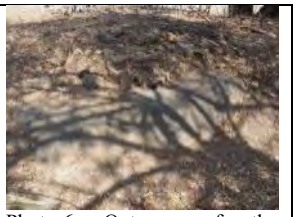
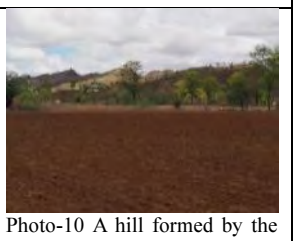
i) Pegu Formation

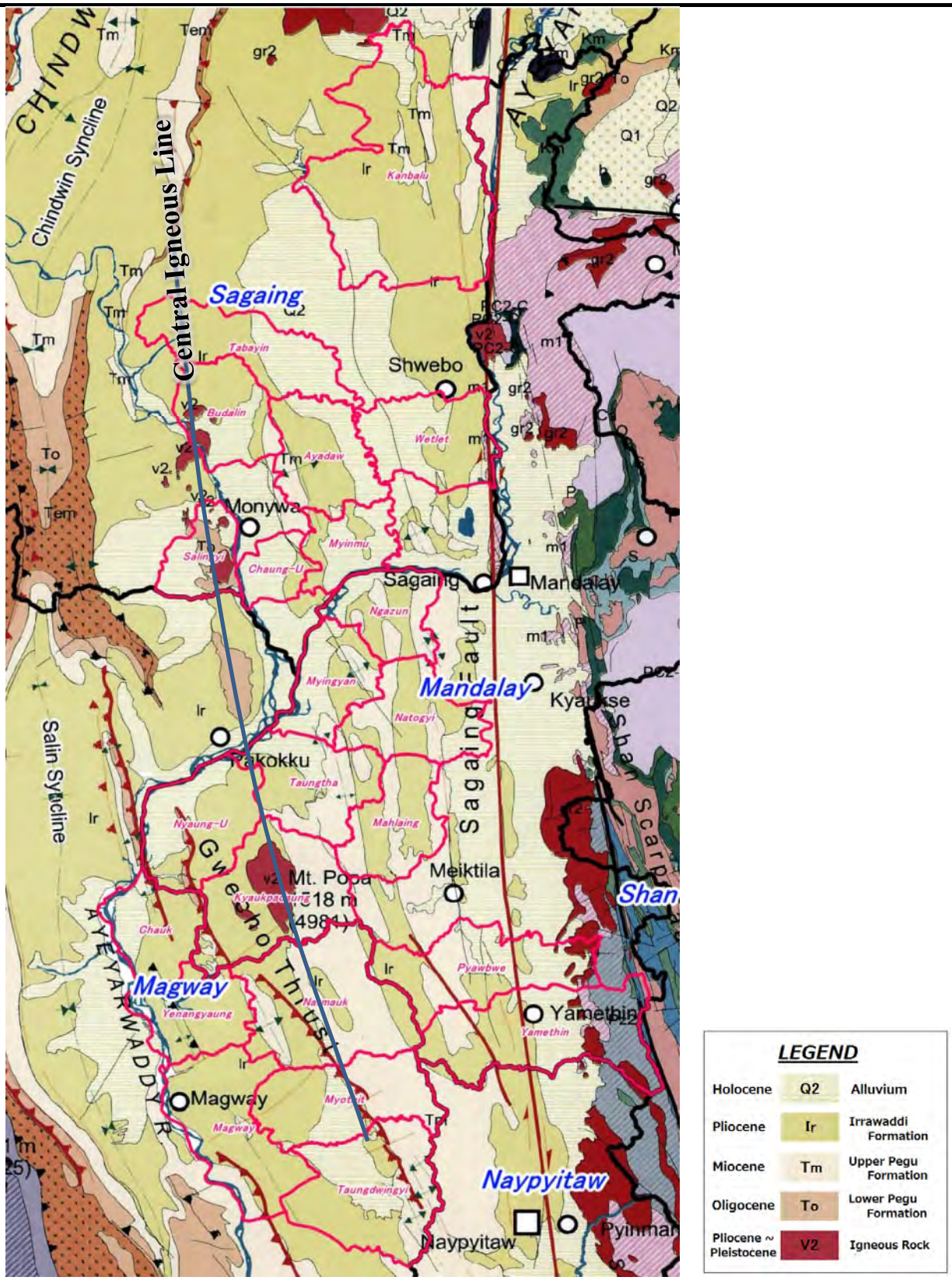
Sand stone and gravel stone accumulated during the Palaeocene to Eocene eras and distributed along the normal fault in the west end of the Central Lowland, Magway Region, Tilin

T/S. Also, sedimentary rock that accumulated in the Oligocene to Miocene eras, called the Pegu formation, is distributed in the hill zone along the Central Igneous Line and small hills that dot the flatland.

The Pegu formation consists of a medium/coarse sandstone, mudstone, muddy limestone, Conglomerate, etc. (Photos-3 to 5). It is famous for containing oil and natural gas, and oil is mined along the Irrawaddy River near Milaungbya village 10 km north of Chauk village in Chauk T/S, Magway Region.

All of the small hills in the flatland along the Central Igneous Line consists of the Pegu formation. Some of the flatlands also consist of the Pegu formation (Photos-6~10).

<table>
<tr>
<td> 
Photo-3 Alternating sandstone and muddy limestone in the Pegu formation. It can be seen in a riverbed between Chasay village (MA2-04) and Kuywar village in Myingya T/S.</td>
<td> 
Photo-4 Alternating medium to coarse sandstone and muddy limestone in the Pegu formation. It dips 40° to the west. The stream flows into an irrigation dam located Sellel village (MG2-30), north of Natmauk T/S.</td>
<td> 
Photo-5 A Calcareous nodule in the mud formation of the Pegu formation. The stream flows to an irrigation dam located to the north of the Selel village in Natmauk T/S.</td>
<td> 
Photo-6 Outcrop of the sandstone formation in the flatland area. It is close to the target drilling point in Tawbyar village (MA2-27) inNyangoo T/S.</td>
</tr>
<tr>
<td> 
Photo-7 Table using sandstone from the Pegu formation.
Wayongone village (MG2-33) in Natmauk T/S.</td>
<td> 
Photo-8 A dug well drilled into the Pegu formation in the riverbed. Slightly high fluoride is held in check compared to wells dug in alluvium.
Wayongone village (MG2-33) in Natmauk T/S.</td>
<td> 
Photo-9 A deep well located near a small hill formed by the Pegu formation. The Pegu formation dips to the opposite side of the small hill. Water quality is not too bad. The well point and small hill are assumed to be divided by fault.
Zeebwa Village (MG2-12) in Chauk T/S.</td>
<td> 
Photo-10 A hill formed by the Pegu formation in Zeebwa (MG2-12), Chauk T/S.
Pegu formation dips to the northwest (the left side of the picture). The border of the hill and flatland is assumed to be a fault.</td>
</tr>
</table>



(Source: Myanmar Geosciences Society, 2014)

Figure 1.3.5 Geological Map of Myanmar

(ii) Irrawaddy Formation

The Irrawaddy formation (Pliocene) consists of sandstone, mudstone and muddy limestone, and is widely distributed in the flatland of the CDZ. The formation occupies a well-stratified, semi-consolidated medium-to-coarse sandstone that is easy to break by hammer.

In addition, it is characteristic that there is a zone containing many petrified nodules and well-stratified layers and cross-lamina layers in the sandstone layer. The Irrawaddy formation covers the Pegu formation irregularly. A lot of silicified wood is contained in the Irrawaddy formation (Photos-12 and 13); therefore, silicified wood has gotten into the alluvium formed by the old Irrawaddy and old Chindwin Rivers.

Photo-11 A well-stratified sandstone layer in the Irrawaddy formation. Interjected mudstone is semi-consolidated and easy to break up by hammer. A lithified sandstone layer is interspersed within the layer.
Cliff at right bank of Yin River close to Manawtgone Village (MG2-26), Myothit T/S

Photo-12 Silicified wood in the sandstone of the Irrawaddy formation.
The outcrop on the main road connects Magway and Naypyitaw through Myothit.

Photo-13 Silicified wood excavated from the Irrawaddy formation (length: 42 m).
A silcified wood girden in Kanbalu T/S

Photo-14 Cliff of sand and mud alternating at the right bank of the Yin River. Mudstone is soft enough for swallows to make a nest.
Photo from the bridge at Yin River on the main road from Magway to Naypyidaw.

(iii) Alluvium

The Irrawaddy formation is covered with a conglomerate inconsistency on the west side of the Central Igneous Line. The gravel is round, however, not well sorting such as fingertip to head-size (Photo-15).

The gravel is mostly orthoquartzite, although petrified wood chips are mixed in occasionally. The layer is approx. 4 m thick where it was confirmed and it is estimated to be approx. 10 m thick. The gravel layer is estimated to be terrace gravel from the Irrawaddy and Chindwin rivers.

Relatively thick sediment that is likely to be flood plain sediment from the Chindwin and Moo Rivers in Sagaing Region and the Saman River in Mandalay Region is distributed extensively in their lower reach. The alluvium of the Chindwin River consists mainly of sand and gravel layers with a thin interbedded mud layer. It is estimated to be approx. 150 m thick in the thickest area (Water Resource Assessment of the Dry Zone of Myanmar: Mac Cartney et al, 2013) (Figure 1.3.6). The paper says that the border between the thick alluvium and the Irrawaddy formation can be recognized as the colors of the layers change from yellowish to blue-gray, which is a characteristic of the latter.

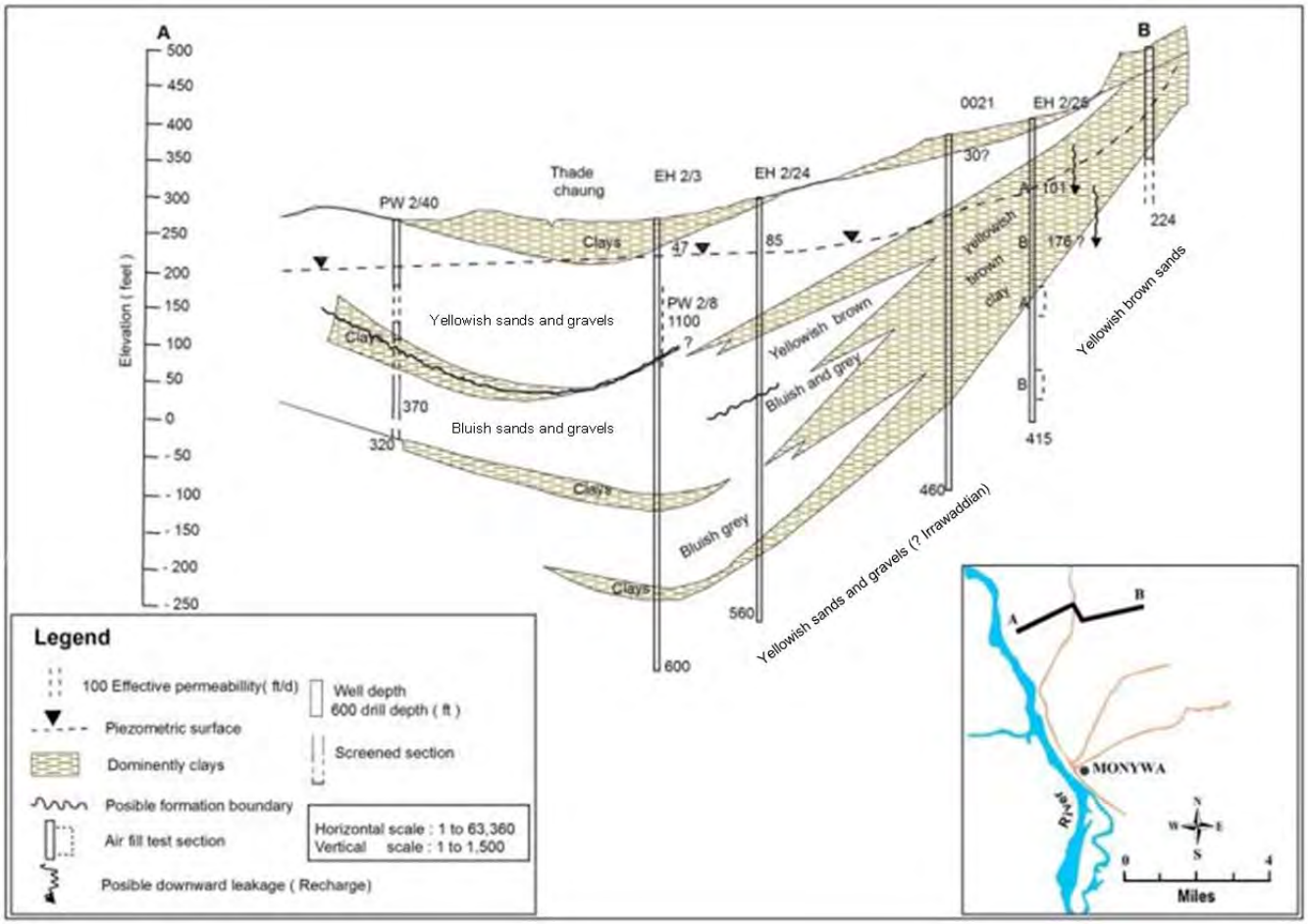
Flood plain sediment of small rivers covering the Irrawaddy formation was spotted at various locations, and the terrace gravel was also observed on the flat terrain west of the Central Igneous Line (Photo-16).

Photo-15 A layer of round gravel on the surface of the flat terrain, west of the Central Igneous Line. Gravel is not well sorting. The layer is about four meters thick. A sand layer with a thickness of approx. 1 m is distributed within the gravel layer. Chauk T/S, Winkabar (MG2-15)

Photo-16 Bank terrace gravel near the Kyungyaung River. It is approx. 5 m thick. A gravel layer is partially interbedded. The upper branch of the Dag Well in Taungdwingyi T/S, Kyugyaung (MG2-35)

Photo-17 Massive andesitic lava observed around the edge of volcanic mudflow from the hillside of Mt. Popa of the Quaternary. The drilling work for existing wells hit massive volcanic rocks and the drilling points had to be changed twice. Kyawpadaung T/S, Lelgyi (MA2-38)

Photo-18 Stock on the hillside of Mt. Popa in the Quaternary. It is considered that magma that solidified underground was pushed up by pressure from magma below. A temple built on the top has become a tourist destination.



(Source: Water Resource Assessment of the Dry Zone of Myanmar: MacCartney, et. al. (2013))

Figure 1.3.6 East-West Geological Section of the Chindwin River Middle Basin in the Sagaing Region

(iv) Volcanic Rocks and Volcanic debris

The Mt. Popa volcano (1,518 m) created in the Pleistocene era is situated approximately 10 km northeast of Kyaupadaung along the Central Igneous Line. One of the target villages, Lelgyi village (MA2-38), Kyaupadaung T/S is covered with volcanic mudflow that contains a large quantity of massive lava, which occurred secondarily after the flow of andesitic and basaltic lava from the volcanic mountain. Various volcanic rocks are distributed all the way to the arterial road of Kyaupadaung–Meiktila on the southwest side of the mountain along the Central Igneous Line. Stocks that formed as a result of magma that solidified underground and was pushed up to the surface by magma pressure from below are observed on the mountainside.

1.3.3 HYDROGEOLOGY

(1) Hydrogeological Unit

The geology of the aquifers in the survey area in the CDZ is composed of Pegu, Irrawaddy, and alluvium formations from the lower layer.

1) Pegu Formation

This formation comprises sandstones, mudstones, argillaceous limestone, etc. The water has high levels of salt and iron and thus is not regarded as a good aquifer. The salt level of the water is almost brackish in some areas. There is also a very hard sandstone bed in some areas, and it is a layer where water supply development is very challenging, as mud drilling requires much time. The formation forms hilly terrain along the Central Igneous Line and small hills and hills that stretch north-northwest to south-southeast over flat terrain in the survey target area.

2) Irrawaddy Formation

This formation consists mainly of a semi-consolidated sandstone bed and mudstone layer and hard consolidated sandstone blocks have formed in layers as petrified nodules. In comparison with the Pegu formation, water quality is expected to be good in general. However, field survey results reveal that there were many wells that contain salt not suitable for drinking and there are wells with high iron levels in some areas in Magway. The formation is formed where the ground settles, and the thickness increases in the center of the valley. Confined aquifers are formed and artesian wells are also observed in some areas.

The Pegu formation lies under the Irrawaddy formation. Deep wells reach the Pegu formation in some areas; therefore, it is necessary to consider blocking the groundwater from the Pegu formation and taking water from aquifers in the Irrawaddy formation in such areas.

3) Alluvium Formation

It is likely to be a formation of good aquifers with the fastest water circulation. Areas with thick alluvium include the lower branches of the Chindwin River and mid-to-lower branches of the Moo River in the Sagaing Region, alluvial lowland that spreads along the Sagaing Fault in the Mandalay Region, and part of Nyangoo T/S and Chauk T/S along the Irrawaddy River in the Mandalay and Magway regions. The alluvium mainly consists of sand and gravel layers with an interbedded mud layer in some areas. The groundwater level is 5–15 m and it is often used for dug wells (5–15 m) and shallow wells (10–30 m). The main source of groundwater is rainfall. Most of the dug wells cannot be used during the dry season in the CDZ as they receive little rainfall and seasonal fluctuations are significant throughout the year there. Aquifers in the alluvium may become the target of development in the alluvial flats and lowland along the Moo and Chindwin rivers in the Sagaing Region.

(2) Hydrogeological Information

Many wells have been built in the CDZ and they include many JICA projects. Table 1.3.4 provides a list of existing hydrogeological data (well location, elevation, drilling depth, static level, pumping test data, geological information, borehole logging data, geophysical exploration data, water volume, and water quality).

Table 1.3.4 Existing Hydrogeological Information

No	Data Type	Region			Coordinates	Elevation	Depth of Well	Static water level	Discharge	Geology	Well Logging	Electric Exploration	Water Quality Test	Number of Wells	Note
		Sagaing	Mandalay	Magway											
①	GIS Database	○	○	○	○	―	○	○	○	―	―	―	―	4458	※1
②	JICA Test Well①	―	○	―	―	―	○	―	―	○	○	―	―	6	※2
③	JICA Test Well②	―	○	○	―	―	○	○	―	○	○	―	―	22	※3
④	Water Quality Test for Existing Well	―	○	○	―	―	―	―	―	―	―	―	○	100	※4
⑤	Phase 1 Water Quality Test	○	○	○	―	―	―	―	―	―	―	―	○	190	※5
⑥	Phase 1 Drilled Well	○	○	○	○	―	○	○	○	―	―	○	○	60	※6
⑦	JICA TA Data	―	○	○	○	―	○	○	○	○	○	○	―	14	※7
⑧	DRD Water Quality Test	―	○	○	―	―	○		○	―	―	―	○	459	※8
⑨	Existing Well in Magway Region	―	―	○	―	―	○	○	○	―	―	―	―	2533	※9
⑩	Dabayin Artesian Well	○	―	―	―	―	○	―	○	―	―	―	―	11	※10

※1: Although this is a village database developed in the Study on Water Supply Systems in Mandalay City and in the Central Dry Zone (JICA, 2003) and owned by the DDA, it has not been updated since 2008 and the DRD does not use it. Because it is a village database and multiple deep and shallow wells are registered in one record, the "Number of Wells" indicates the number of villages. Data on the well depth and static level is unavailable frequently and thus data that can be used for the examination is less than 50 percent of all data.

※2: Six test wells were built in Mandalay City in "The Study on Water Supply Systems in Mandalay City and in the Central Dry Zone" (JICA, 2003). Although no coordinate data is available, there is a location map and the rough location can be identified (outside survey target area).

※3: Data from 22 test wells (2 wells selected from each of 11 target townships) that were drilled in "The Study on Water Supply System in Mandalay City and in the Central Dry Zone" (JICA, 2003) is arranged into a column section. Although no coordinate data is available, there is a location map.

※4: Water quality analysis results of 100 wells performed in the Study on Water Supply System in Mandalay City and in the Central Dry Zone (JICA, 2003)

※5: Water quality analysis results of existing water sources performed in Phase 1. It is partially brought back to Japan for analysis.

※6: Well data of 60 villages from the 87 villages selected in Phase 1. Data on borehole logging, geological information, and pumping test results cannot be confirmed, as it was not stored. As for water quality analysis, it was partially carried out (for 15 locations) in ⑤.

※7: Data of 20 wells that were drilled in "The Project on Rural Water Supply Technology in the Central Dry Zone" (JICA, 2007)

※8: Water quality of wells managed by the DRD was analysed at a laboratory of the Ministry of Health and includes test results of other areas besides the CDZ. It is for wells drilled between 2012 and 2015, excluding those in the Sagaing Region. (The sampling team in the CDZ office took well water in the Sagaing Region in early June 2015). It includes water quality test results of 15 wells that were built in Phase 1.

※9: This includes all townships in the Magway Region. The total number of wells in the survey target townships is 797. Although it is likely that many of them overlap with wells in the GIS database in ①, it is difficult to crosscheck them.

※10: A list of artesian wells in Dabayin T/S in the Sagaing Region. Because there is a location map of the village, the general location can be identified.

Although such maps as the drilling depth distribution map, static water level map, groundwater level contour map, and water quality distribution map are produced from the data, it is difficult to understand the aquifer structure, as the geological information other than that of wells drilled in JICA projects was not stored. As most data does not contain the coordinates of wells and ground elevation, it cannot be used in GIS as it is, and it is also difficult to make a groundwater level contour map. In the survey, a rough coordinate was read from the map if an existing well location map was available. When it was unavailable, the study team crosschecked village location maps that are open to the public and names of the villages to estimate their location where wells were built, registered them as the coordinates of villages where the wells are located, and selected usable data for analysis for the hydrogeological study.

A list of hydrogeological data gathered in the survey is shown in Table 1.3.5.

Table 1.3.5 Hydrogeological Information Collected in the Survey

No	Data Type	Region			Coordinates	Elevation	Depth of Well	Static water level	Discharge	Geology	Well Logging	Electric Exploration	Water Quality Test	Number of Wells	Note
		Sagaing	Mandalay	Magway											
⑪	Reconnaissance	○	○	○	○	○	○	○	○	―	―	―	○	120	※11
⑫	Electric Exploration	○	○	○	○	―	―	―	―	―	―	○	―	110	※12
⑬	Water Quality Test	○	○	○	○	―	○	○	―	○	○	―	―	30	※13

※11: Data of the existing water source survey in each village. Water quality was measured on site using a simplified method.
※12: Performed in 110 target villages. Vertical exploration or two-dimensional exploration was performed.
※13: Performed in 30 villages where water quality needed to be checked for the hydrogeological survey.

The drilling depth and water level in each village were estimated based on information ⑪ to ⑬ performed in the survey. As for the data on existing wells, the altitude of wells whose location was confirmed was estimated from the topographic data of the Shuttle Radar Topography Mission (SRTM) and their hydrogeological conditions were analysed, which was used as a reference for the water level estimated from the field survey and geophysical exploration. The estimated depth and water level are provided in Appendix 5.1 List of Village Evaluation at the end of the report.

(3) Wide-Area Hydrological Conditions

Distribution maps of the well drilling depth and groundwater level produced based on the gathered data are provided in Figure 1.3.8 and 1.3.9, respectively. As they indicate, the distribution of the drilling depth and groundwater level differ on both sides of the Central Igneous Line.

The east side of the Central Igneous Line is a hilly district from Naypyidaw to the Sagaing Region and the drilling depth and groundwater level of most of the wells are 150 m or less and 50 m or less, respectively. As for geological conditions, a band of the Irrawaddy and Pegu formations is distributed north-south and the distribution of the former becomes dominant toward the north. As for the difference in the north-south direction, there is more exposure of the Pegu formation on the south side of the Irrawaddy River (Mandalay Region) and the Irrawaddy formation is thin even in the Irrawaddy formation distribution zone; it reaches the Pegu formation when it is drilled deeply and water quality deteriorates frequently. The well drilling depth is less than 100 m in most cases. In comparison with the Mandalay side, for the north side of the Irrawaddy River (Sagaing Region), the well-drilling depth is deeper in general. It is probably because the Irrawaddy formation becomes thicker toward the north and the aquifer depth is also deeper accordingly. Deep wells that are deeper than 300 m were built from the south of Dabayin T/S to Ayadow T/S. An artesian-confined aquifer is located at GL-200 m to 400 m in the area and wells are built with the aquifer as the target.

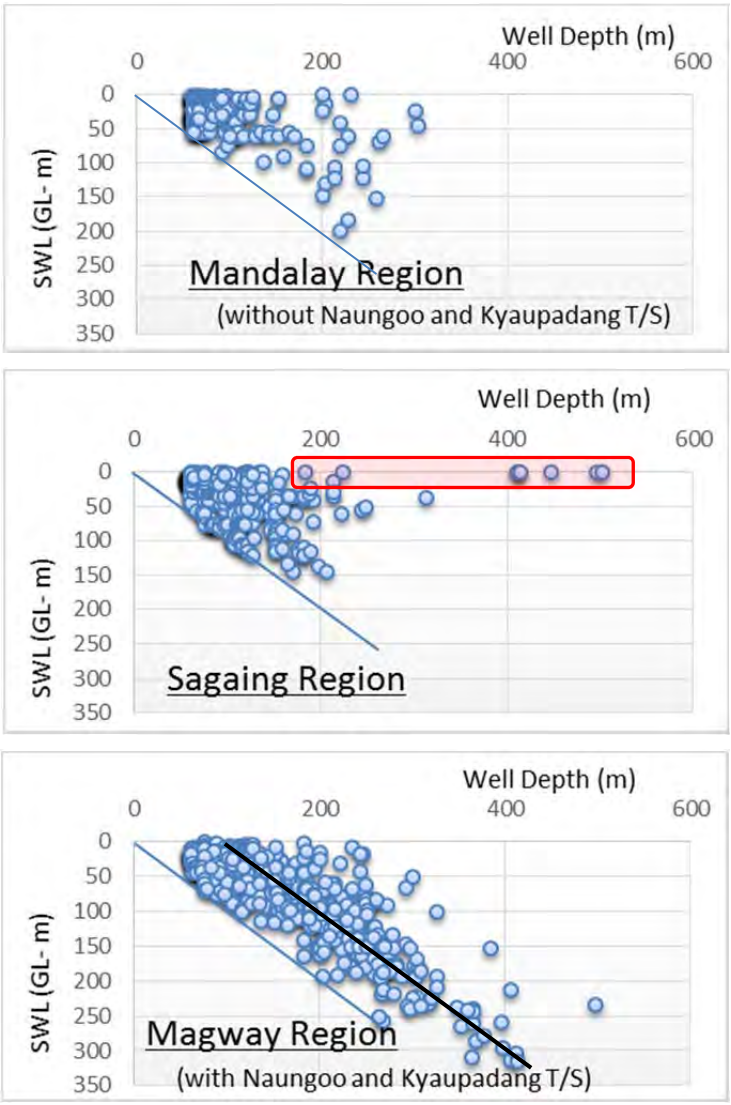
Many deep wells deeper than 250 m distribute on the west side of the Central Igneous Line (Magway Region). It is believed that effective aquifers are deep because the river basin that supplies groundwater is limited in the region due to the hills along the line and because it has little rainfall, as it is situated in the central CDZ. There is an area where wells with a depth of 300 m or more concentrate in the east of Chauk T/S. The effective aquifer is deep because the elevation in the area is high.

Many relatively shallow wells with a depth of less than 100 m are constructed on the alluvial lowland along the Irrawaddy River. The development target there is the groundwater in the

alluvium or free groundwater in the surface layer.

The well drilling distribution map, Figure 1.3.8, shows that the distribution tendency is similar to the tendency of the groundwater depth shown in Figure 1.3.9: The deeper the well, the deeper the water level. The relationship of the water and well depth by regions is shown in Figure 1.3.7. The majority of the wells are less than 150 m in the southern region (Mandalay Region) and northern region (Sagaing Region) of the east side of the Central Igneous Line, and there is no clear relationship between well depth and water level. Highly confined aquifers are observed for wells with a drilling depth of 200 m or more in the Sagaing Region with many artesian wells (the red zone in the Sagaing Region graph).

On the west side of the Central Igneous Line (Magway Region), there is a tendency that the water level becomes deeper in proportion to the drilling depth. There is a correlation of the groundwater level being 100 m less than the drilling depth (the black line in the Magway graph). The correlation is significant for wells with a drilling depth of 300 m or more. It indicates that the drilling depth becomes deeper as the water level becomes deeper due to few continuous aquifers in the region.

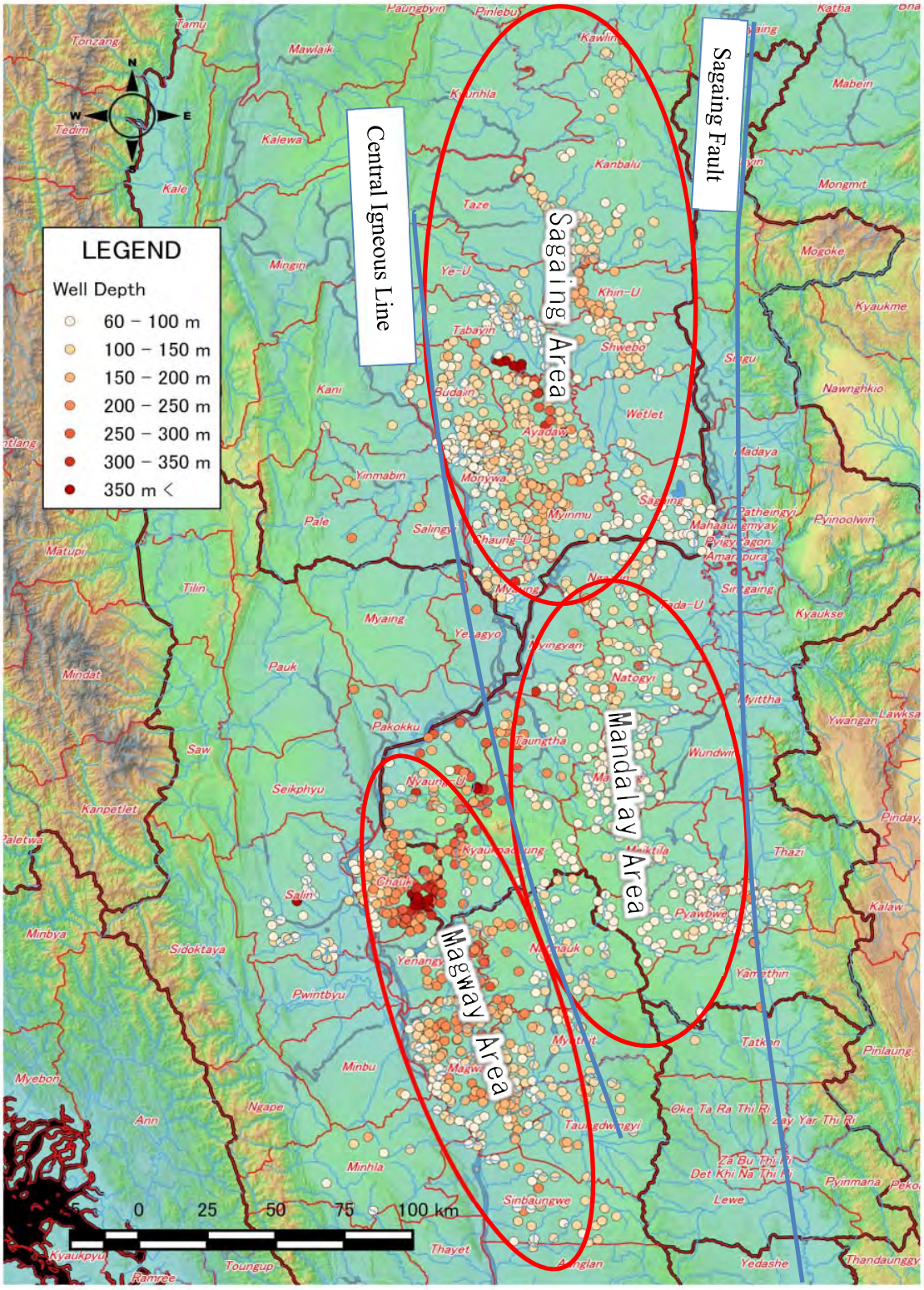


(Developed in the Study using the DRD data.)

Fig. 1.3.7 Drilling Depth and Groundwater Level

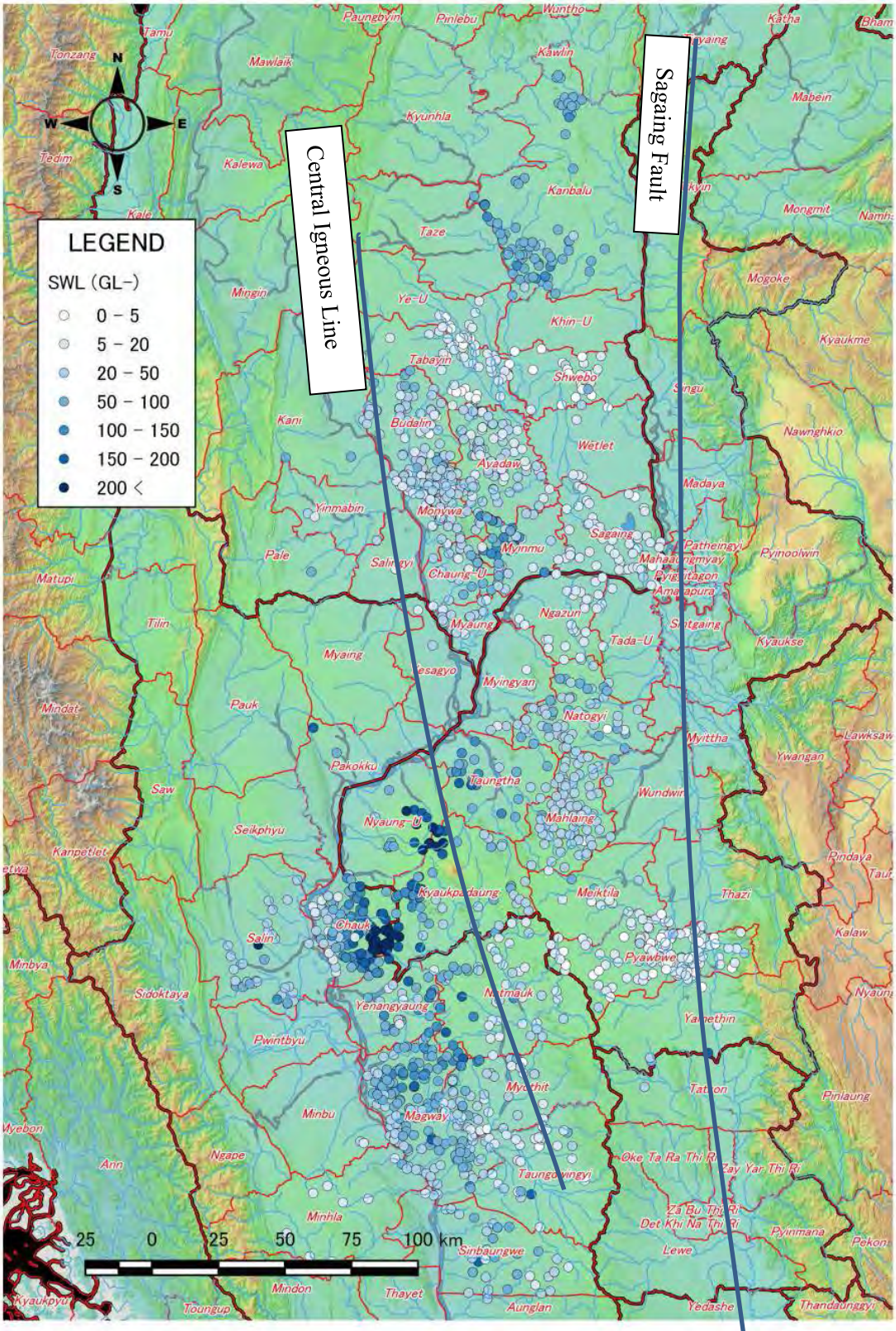
(4) Groundwater Level

Because the groundwater level is usually distributed along the terrain, the groundwater level contour is similar to the terrain contour. Figure 1.3.10 provides the relationship of the water level elevation per ground elevation of wells based on well data in the survey target area.



(Developed in the Study using the DRD data.)

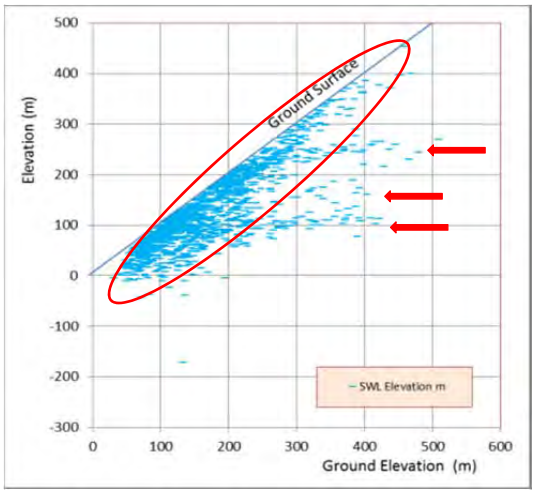
Figure 1.3.8 Drilling Depth Distribution Map



(Developed in the Study using the DRD data.)

Figure 1.3.9 Water Depth Distribution Map

Groundwater that is distributed along the ground surface is believed to be mostly non-confined free groundwater (the red circle in Figure 1.3.10). Meanwhile, it also shows the horizontal distribution of the water level at around 100 m, 160 m, and 250 m elevation (the red arrows in Figure 1.3.10). It is likely to show the well water level where water is taken from the confined aquifer in the Irrawaddy formation and indicate the different levels of confinement by aquifer.



(Developed in the Study using the DRD data.)

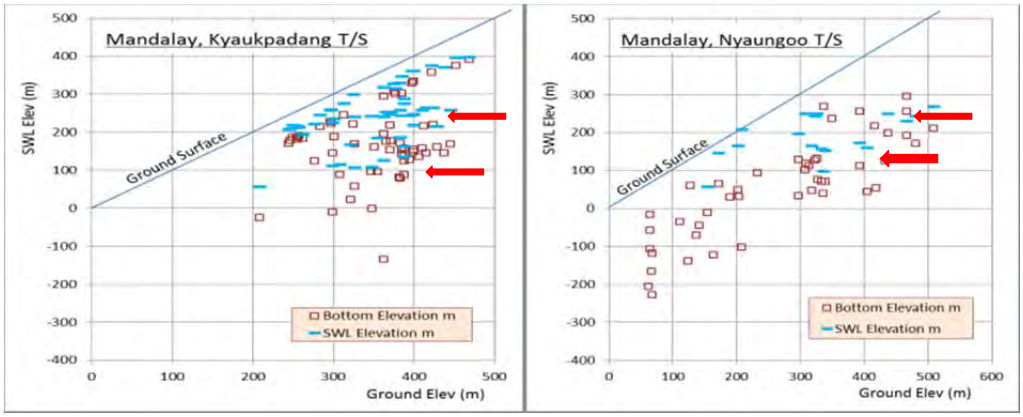
Figure 1.3.10 Distribution of Groundwater Level Elevation in Well

The study team selected T/Ss of which there is relatively more data and are regarded to be capable of representing the regions classified in (3) Wide-Area Hydrological Condition and produced Figure 1.3.12 to show the relationship between the elevation of the water level and bottom of the wells

The main development in the Sagaing Region is free groundwater in the surface layer and the water level that is distributed along the ground surface level. There are water levels that are distributed slightly horizontally at around 100 m and 170 m elevation in Budalin T/S and at around 80 m elevation in Chaungoo T/S. However, they are not so clearly recognizable and it is likely to be a shallow confined aquifer based on free groundwater. In the Sagaing Region, many artesian wells were developed near the border of the Irrawaddy and alluvium layers from Dabayin T/S to Ayadow T/S. The well digging is around 200 to 500 m, which suggests that it is a confined aquifer in the Irrawaddy formation.

The main development in the Mandalay Region is free groundwater in the surface layer, as in the case of the Sagaing Region. Particularly, the tendency is significant in Pyawbwe, Meiktila, and Nahlaing T/Ss situated on the east side of the hilly area that stretches north to south. On the other hand, as the river basin is small and there is little rainfall in Taungtha and Myingyan T/Ss situated on the west side of the hilly area, there is little groundwater recharging and deep groundwater development will be needed. The graph of the groundwater elevation in Taungtha T/S shown in Figure 1.3.12 also indicates slightly deeper free groundwater level of the surface layer as well as water level distribution of a confined aquifer at an elevation of around 90 m. There is also a record of an artesian well in Pyawbwe T/S, which also indicates that deep confined aquifers are also the target of groundwater development.

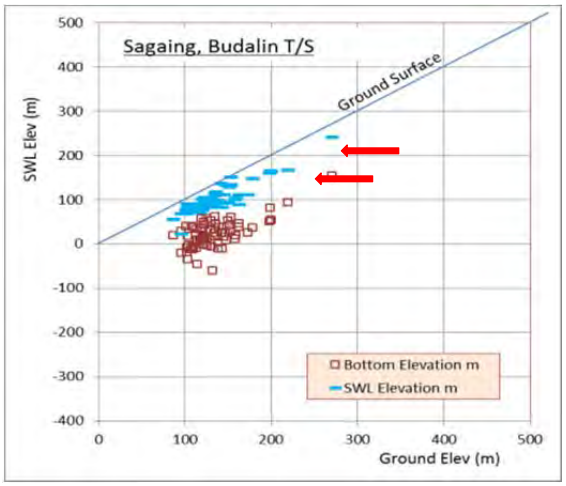
In the Magway Region, the water level of confined aquifers (at around 100 m, 160 m, and 250 m elevation) shown in Figure 1.3.10 appears at the water level elevation of Chauk T/S. As the Magway Region, particularly Chauk T/S, is one of areas with the least rainfall and the groundwater volume is low due to too little groundwater recharging, more deep wells are drilled and thus the water level of the confined aquifers was clearly recognized. The water level distribution that is likely to be the extension of confined aquifers in Chauk T/S is also observed in Kyaupadang T/S and Nyaungoo T/S that are adjacent to Chauk T/S (See Figure 1.3.11).

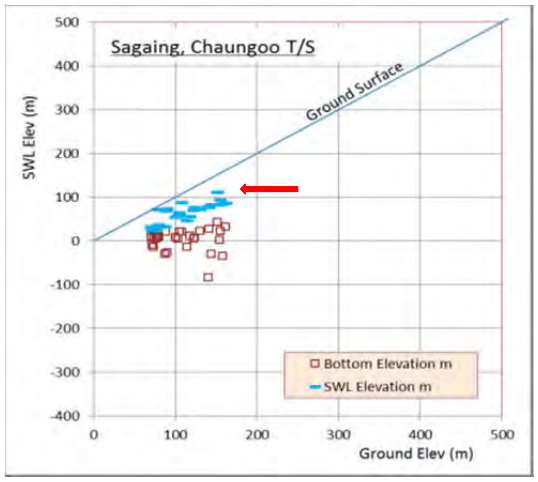


(Developed in the Study using the DRD data.)

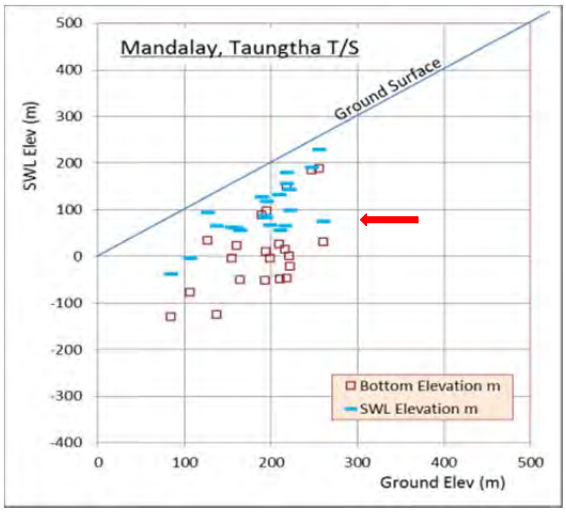
Figure 1.3.11 T/Ss where Confined Aquifer Distribution is Confirmed

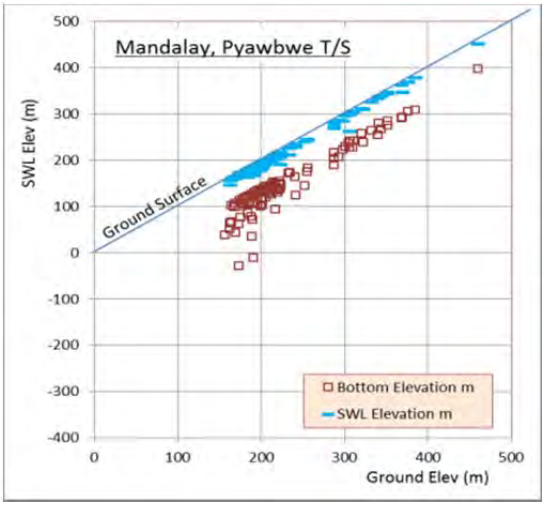
There are confined aquifers in many layers in the survey target area. Because the aquifer structure is not clarified, although the groundwater level differs by aquifer, the contour by aquifer cannot be drawn from the data gathered in the survey. Classification of aquifers is expected to clarify the water quality difference by aquifer as well as the water level, and thus future data accumulation and analysis is expected to be carried out. Figure 1.3.13 provides water level elevation distribution and a rough water level contour map drawn based on it. The contour is generally consistent with terrain undulation, as it does not include artesian wells, etc.



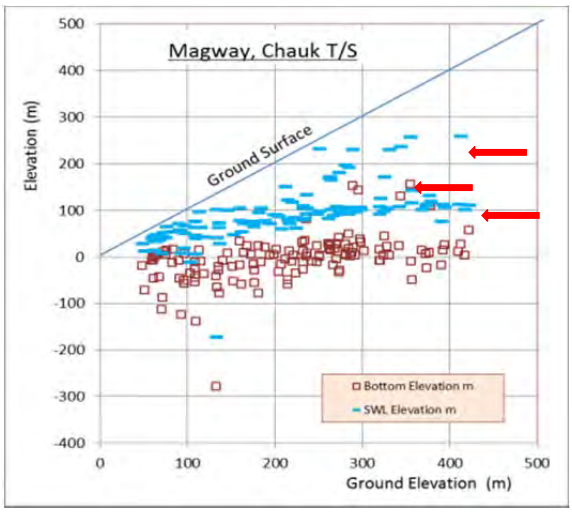


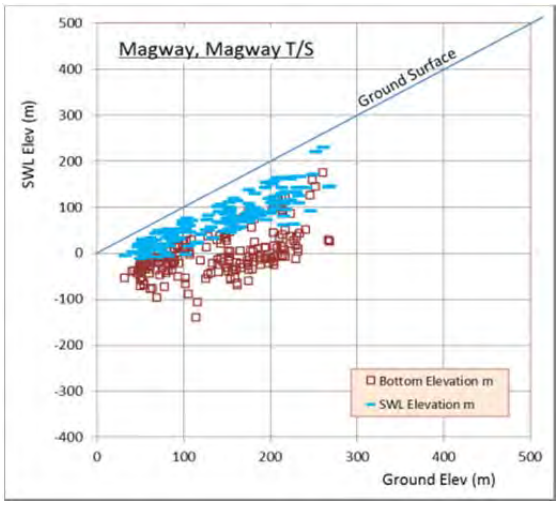
Sagaing Region





Mandalay Region

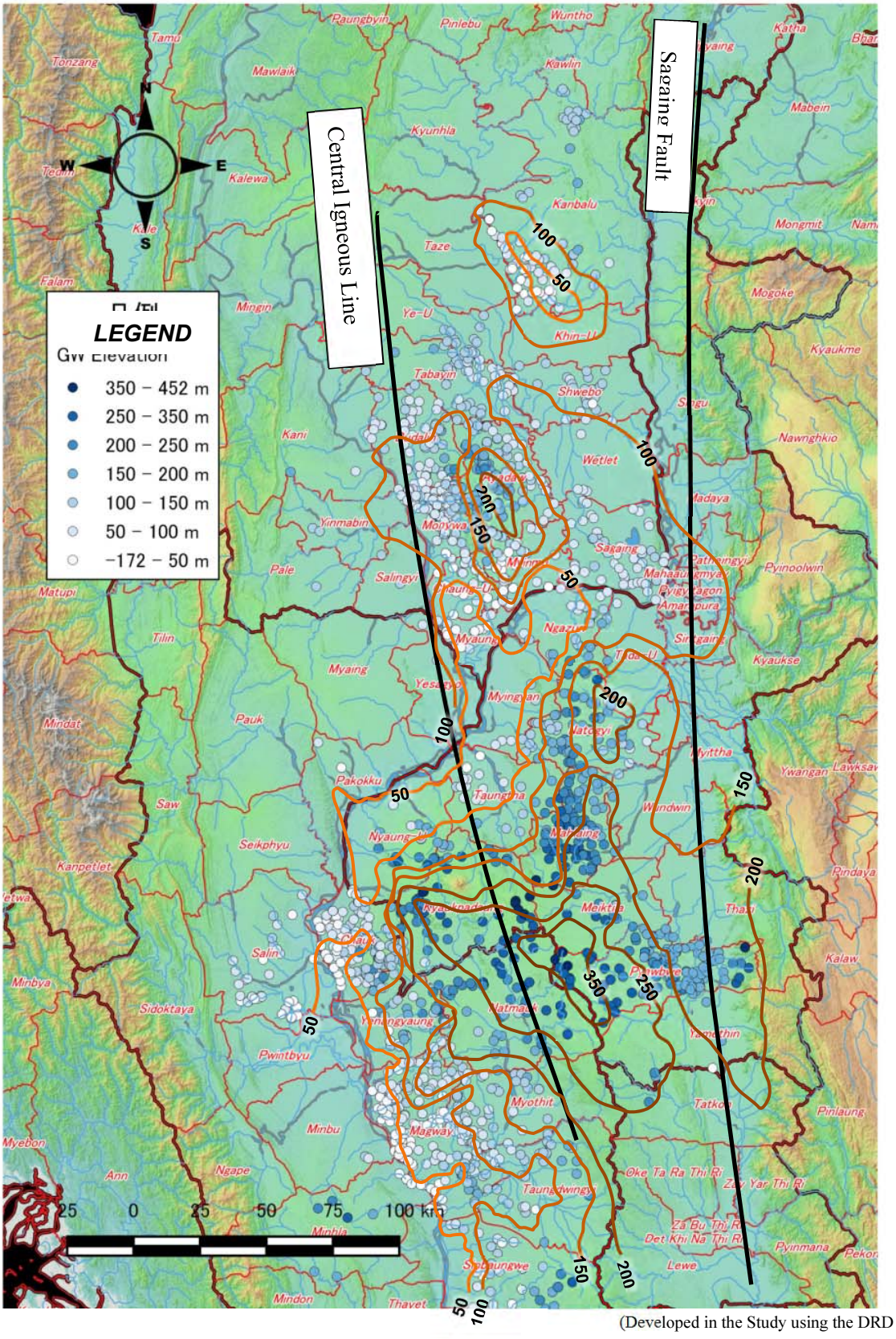




Magway Region

(Developed in the Study using the DRD data.)

Figure 1.3.12 Graph of Groundwater Level



(Developed in the Study using the DRD data.)

Figure 1.3.13 Groundwater Elevation and Water Level Contour Map

1.3.4 WATER QUALITY

(1) Objective of Survey

Field water quality measurement was conducted in 120 villages for understanding of water quality in around area and the safety use of existing water sources for drinking in villages. The survey investigated focusing on the deep wells. Based on the result of the field water quality measurement, target water sources were selected for the detailed water quality analysis in laboratory.

(2) Method of Survey

Field water quality measurement for the existing water supply facilities had conducted by the study team using potable pH/EC meter and colorimetric method when team member visited to the target villages. In case fetching water is done from the deep wells in the neighbouring villages, such wells are also included in the target of this measurement for understanding of local conditions.. The measurement parameters were set to a total of 9 (nine) like the general condition (such as pH, EC, water temperature and Coliforms), and Manganese, Fluoride, Iron, Nitrate and Nitrite referring to the past survey.

Field water quality measurement was carried out in 185 existing water supply facilities in total such as dug well, shallow well, deep well, pond and etc. Most of target villages have 1 (one) or 2 (two) public water supply facilities for drinking, and some villagers have their own private well. The amount of existing water supply facility of target of field measurement is shown in Figure 1.3.14.

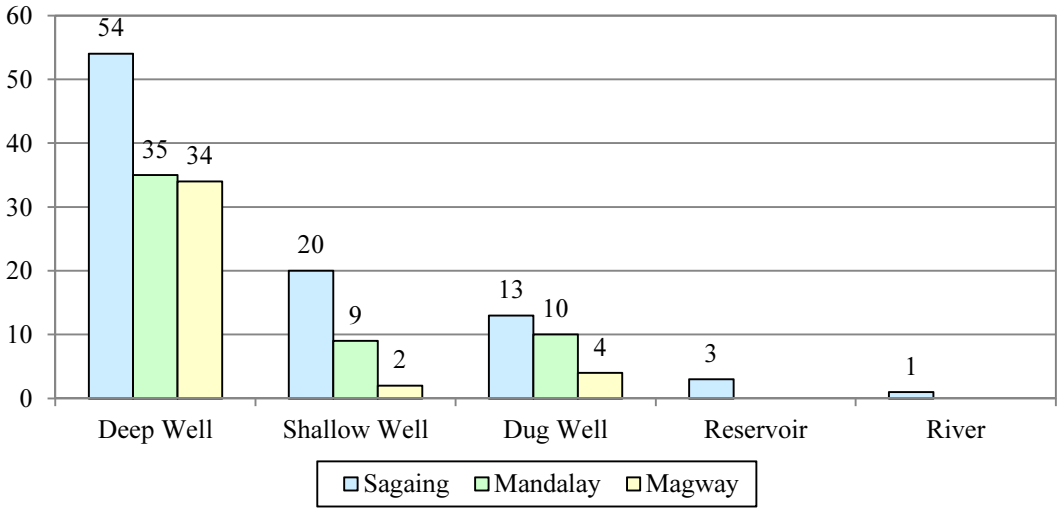


Figure 1.3.14 Amount of Existing Water Supply Facility of Field Water Quality Measurement

Based on the result of field water quality measurement, the total of 30 facilities (10 facilities from each region) were selected as the target of detailed water quality analysis. The target of detailed analysis was basically selected from deep wells. However, surface water and shallow wells are used for drinking in the villages. Therefore, some of those water sources are also included in the target of detailed water quality analysis in order to check the effect of health to villagers. Analysis parameter are set 33 items shown in Table 1.3.6, the list and location of target villages are shown in Table 1.3.7 and Figure 1.3.15.

Table 1.3.6 Parameter of Detailed Water Quality Analysis

Classification	Quantity	Parametr
General Condition	10	On Site : Water Temparture, ORP (Oxidation Reduction Potential) Faecal Coliforms, General Coliforms, pH, Turbidity, Electrical Coudutivity (EC), Hardness, TDS, Total Alkalinity
Metal	14	Iron, Copper, Lead, Zinc, Magnesium, Calcium, Potassium, Sodium, Aluminium, Cadmium, Chromium, Manganese, Nickel Mercury
Non Metal	9	Aresnic, Fluoride, Boron, Chloride, Carbonate, Nitrate, Nitrite, Sulphate, Phosphate

Table 1.3.7 List of Target Village of Detailed Water Quality Analysis

Region	Township	Village	ID No.	Type
Sagaing	Budalin	Yonedaw	SA2-01	Deep Well
		Mhonehtoo	SA2-05	Deep Well
	Chaungoo	Thanbinkan	SA2-07	Deep Well
		Natyaygan	SA2-08	Deep Well
	Myinmu	Kalarpyan	SA2-18	Deep Well
		Magyidaw	SA2-23	River Water
	Kanbalu	Koetaungboh(Kyunkone)	SA2-26	Deep Well
		Inngoteto	SA2-27	Deep Well
		Nyuangkanthar	SA2-30	Deep Well
		Myaymon	SA2-31	Deep Well
Mandalay	Myingyan	Chaysay	MA2-04	Deep Well
		Kuywar	MA2-06	Deep Well
	Natogyi	Nyaunggone	MA2-15	Deep Well
	Taungtha	Chaungnar	MA2-16	Dug Well
		Tharyarmyaing	MA2-21	Shallow Well
	Yamethin	Oakpo	MA2-22	Deep Well
		Kangyi	MA2-23	Deep Well
	Nyaungoo	Setsetyo	MA2-28	Deep Well
	Kyaukpadaung	Aleywar-2	MA2-36	Deep Well
		Lelgyi(Ma)	MA2-38	Deep Well
Magway	Chauk	Kanyaygyi	MG2-10	Deep Well
		Myaysoon(Ywarthit)	MG2-11	Deep Well
		Zeebwar	MG2-12	Deep Well
		Winkabar	MG2-15	Deep Well
	Yenangyaung	Legyinyo	MG2-19	Deep Well
	Myothit	Htanaungkwin	MG2-25	Irrigation Canal
		Manawtgone	MG2-26	River Water
	Natmauk	Ywartharlay	MG2-32	Tube Well
	Taungdwingyi	Kokkohla	MG2-36	Tube Well
		Kangyigone	MG2-37	Tube Well

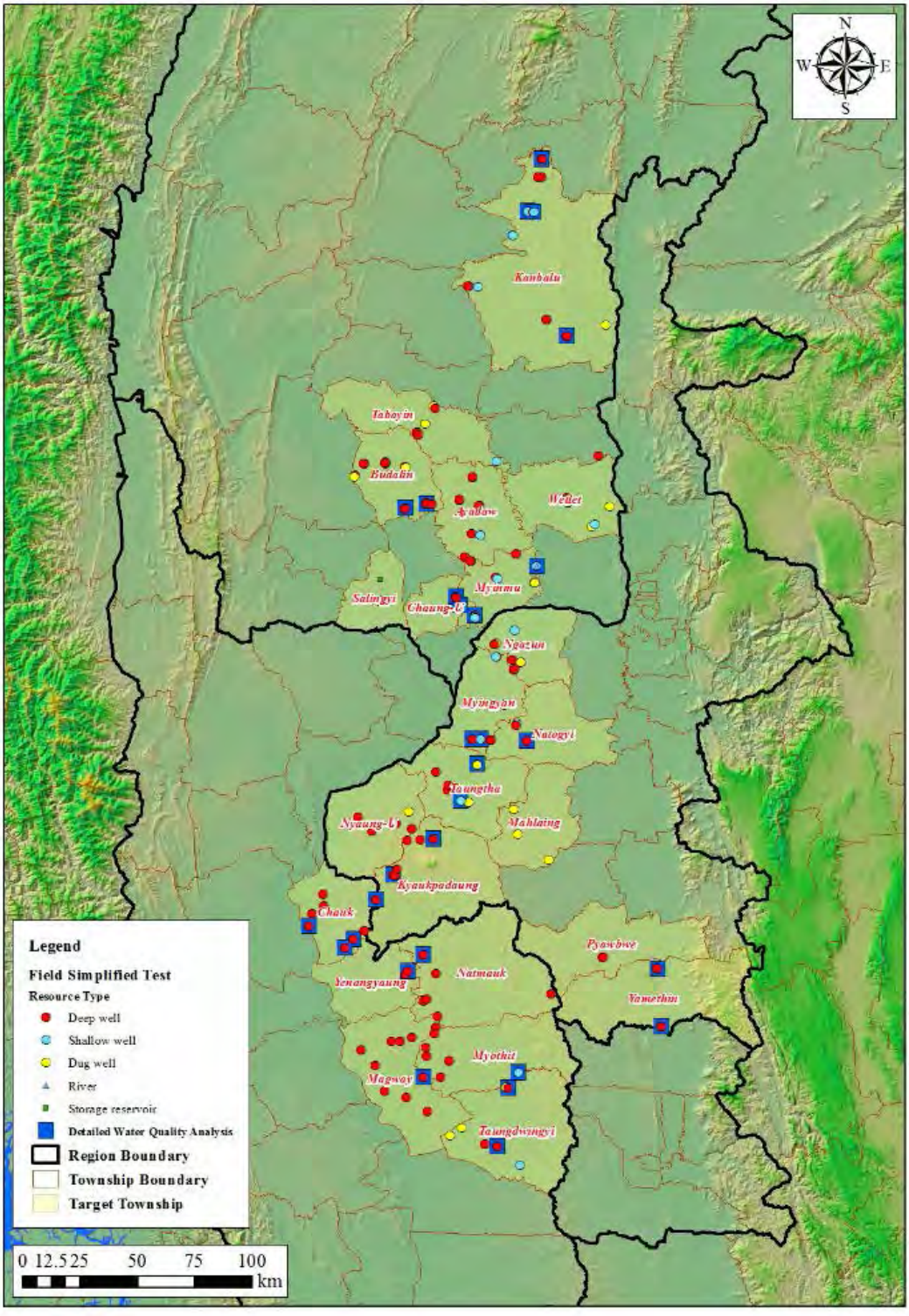


Figure 1.3.15 Location of Target Villages of Detailed Water Quality Analysis

(3) Result of Survey

1) Field Water Quality Measurement

The summary of the field water quality measurement is shown in Table 1.3.8. The relationship between each parameter and the well depth is shown in Figure 1.3.16 and Figure 1.3.17. The results of detailed water quality analysis is summarized in Table 1.3.10.

Table 1.3.8 Result of Field Water Quality Measurement

Region	Type	Qty*[1]	Number of exceed the NDWQS standard value							
			pH	EC*[2]	Mn	Fe	F	NO_3	NO_2	Coliforms
Sagaing	Deep Well	54	2	8		1	6	2		-
	Shallow Well	20		1			4	1		2
	Dug Well	13		1			2	1		6
	Reservoir	3	3				1			1
	River	1	1							
Mandaly	Deep Well	35	6	11	2	6	5	2	1	-
	Shallow Well	9		3			3	2		3
	Dug Well	10		3			2			6
Magway	Deep Well	34	4	5	1	6	3			-
	Shallow Well	2								
	Dug Well	4								1
Total*[3]		185	16	31	3	13	26	8	1	18

*[1]: Villagers don't know the depth of deep well, so that some contents is not equal to Figure 1.3.14.

*[2]: Standard value of EC is not defined inNDWQS, therefore the standard value of the Drinking Water Direction (DWD) in EU (2,500 micro-S/cm) was applied (Source: Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption).

*[3]: The amount of exceed standard value is included duplicates of multiple items.

The number of water supply facilities which satisfy the NDWQS is 65 deep wells, 18 shallow wells and 9 (nine) dug wells, 92 facilities in total (49.7% of the target facilities). Parameters which exceeds the standard value were EC, Fluoride and Coliforms.

EC is one of the indicators of evaluating the salty taste. A lot of villagers had been used water supply facilities that have exceeded the DWD for EC (2,500 micro-S/cm) even though the water is salty. It was revealed that the EC value exceeded the WHO guideline in shallow wells , dug wells and deep well of 100m - 250m depth. The maximum EC value is 34,800 micro-S/cm (as reference, the standard for piped water in Japan is around 100 - 200 micro-S/cm, sea water is around 50,000 micro-S/cm).

It was ascertained that Iron and Manganese contents exceed the standard value in the wells deeper than 200m in Mandalay and Magway. The Maximum is around 10 times of the standard value. In the such villages, smell and odor of the water source greatly exceeds the standard value. But if water quality was same level as the standard value, the water is routinely used even if it was not comfortable, because there were no other available water sources.

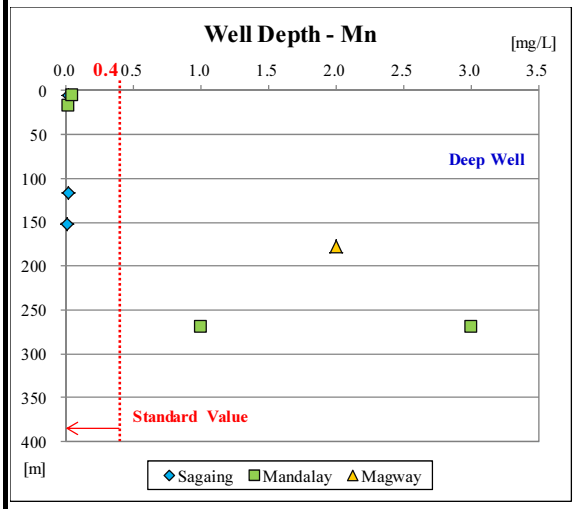
According to the previous reports, Fluoride and Nitrate also exceed the standard in the study area. Some villages have used such water for drinking since villagers do not know such information. Water quality analysis for the existing water supply facilities have carried out by the DRD when requested from the VWC. Of course villagers and the VWC do not have any expertise in the water quality. Therefore, it is considered that the analysis has not been requested even though some harmful substance such as Fluoride, Nitrate and etc. are included.

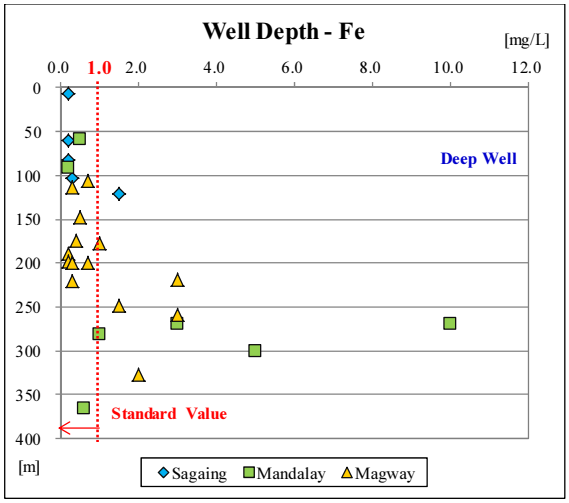
The serious cases of water-borne diseases related to Arsenic and Fluoride were not reported to the DRD. However, daily use of water sources that exceed the standard value of Arsenic or Fluoride may cause generation of serious diseases. Considering these situations, it is advised to

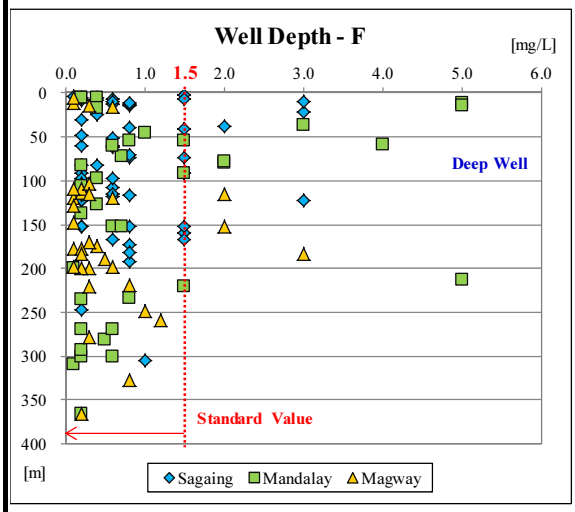
the DRD to carry out water quality monitoring and to inform the results to the villages. And it is also important to share the results of analysis with Township offices.

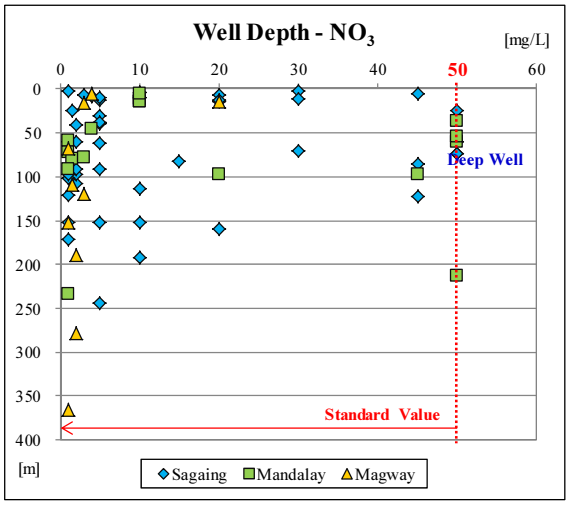
※the outside of detectable range was excluded for simplification of the graph.

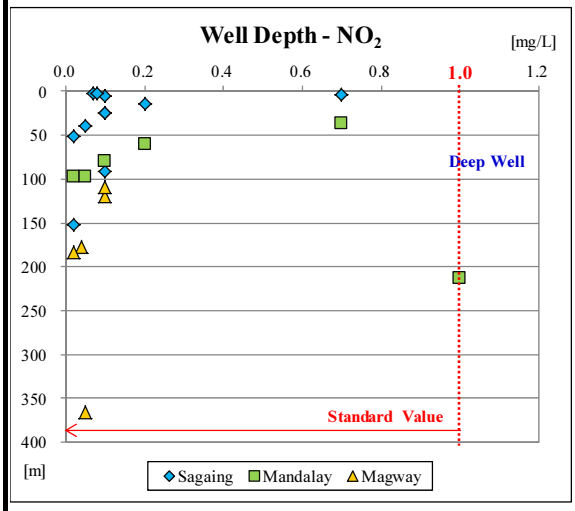
Figure 1.3.16 Relationship between Parameters and Well Depth (1)











※the outside of detectable range was excluded for simplification of the graph.

Figure 1.3.17 Relationship between Parameters and Well Depth (2)

2) Detailed Water Quality Analysis

Detailed water quality analysis for existing water sources was conducted in 30 target villages (refer to Table 1.3.7). Faecal and General Coliforms were generally not detected in deep wells but these were detected in several deep wells. The reason why these were detected is supposed that deteriorated shallow groundwater is mixed due to construction failure of well facilities or samples were collected from the water tank because direct sampling from the well was not possible by the structure of well facilities. The risk of health by coliform is possible to be reduced by the heating treatment, so that it is important that such information should be given to villagers to refrain from drinking of raw water. But the serious diseases due to the water have not been reported to the DRD from target villages using these water sources. Therefore, it is supposed that villagers already understand such kind of the correspondence or have tolerant of raw water.

It was confirmed that turbidity exceeded the standard in some water sources in Mandalay and Magway. The characteristic of these wells which yield is relatively small (less than 5 m^3/hour).

It is considered that reduction of the yield is caused by clogging of the screen or groundwater potential is originally small. But some of such wells can be improved by the well washing. In fact, the yield had already been recovered by well washing and repairing by the DRD, the VWC and other donors. As for aquifer evaluation of wells to be drilled in the Project, it is expected that the capacity the DRD staff is improved by the technical transfer planned in the Project and the pumping test equipment to be procured in the Project.

As for the ion of the metal (dissolved inorganic substances), heavy metals were not detected in target villages by detailed water quality analysis. And the major pollution sources like factories, mines and etc. are not located near the target villages. Therefore, there is no possibility of contamination by heavy metals to the existing water sources and new wells to be drilled in the Project. On the other hand, Calcium, Sodium and Manganese exceeded the standard value in some water sources. Iron also exceeded the standard value in the field water quality measurement. It is estimated that these items are naturally derived (geological origin) although the distinct evidence was not obtained within the Project. These items are indicators for determining the acceptability of drinking in terms of taste and odor. If high contents of such parameter is detected in the villages such as Mhonehtoo (SA2-05) and Ywartharlay (MG2-32) villages, the possibility of acceptance from villagers is very low. This is also same in the cases of Chloride and Sulphate. In fact, it was revealed by interview results at the villages that water was highly contaminated so that it was not suitable for drinking. However, the villagers reluctantly drink such water daily due to lack of water in dry season. It is necessary to announce to villagers based on the analysis results after the construction of new water supply facilities and continuous water quality monitoring. Among the parameters that exceed the NDWQS, the general threshold in the WHO guideline of acceptability of drinking water by taste and odor is shown in Table1.3.9.

It was confirmed that Arsenic, Fluoride and Boron did not exceed in the target villages. But these parameters had been infrequently detected at each region according to the past survey and existing analysis results of the DRD.

Results of the detailed analysis and comparison with the filed measurement are shown in Table 1.3.10 and Table 1.3.11. As well, when comparing the results of flied measurement and detailed analysis, the detailed analysis result of Iron, Fluoride, and Nitrate tends to be low.

Table 1.3.9 Comparison of Threshold of Acceptability of Drinking Water in WHO Guideline and Standard Value in NDWQS

Parameter		Threshold of Acceptability of Drinking Water in WHO Guideline	WHO Guideline Value	NDWQS Standard Value
Iron	(Fe)	0.3 mg/L	No health-based guideline value	1.0 mg/L
Calcium	(Ca)	100 – 300 mg/L (depend on the assoiacted Anion)	No health-based guideline value	200 mg/L
Sodium	(Na)	200 mg/L	No health-based guideline value	200 mg/L
Manganese	(Mn)	0.1 mg/L	No health-based guideline value	0.4 mg/L
Chloride	(Cl)	250 mg/L (depend on the assoiacted cation)	No health-based guideline value	250 mg/L
Sulphate	(SO_4)	250 mg/L (depend on the assoiacted cation)	No health-based guideline value	250 mg/L

(Source: Guideline for Drinking Water Quality, Forth Edition by WHO (2011) and NDWQS)

Table 1.3.10 Result of Detailed Water Quality Analysis

Sr.	ID	Village	Water Source Type	General Condition										Metal																		Non Metal								
				Water Temperature	ORP	Feacal Coliforms	General Coliforms	pH	Turbidity	EC*1	Hardness	TDS	Alkalinity	Fe	Cu	Pb	Zn	Mg	Ca	K	Na	Al	Cd	Cr	Mn	Ni	Hg	As	F	B	Cl	HCO3	NO3-N*2	NO2-N*2	SO4	PO4
National Drinking Water Quality Standards				-	-	0	3	6.5 -8.5	5	2,500	500	1,000	-	1.0	2.0	0.01	3.0	150	200	-	200	0.2	0.003	0.05	0.4	0.07	0.001	0.05	1.5	2.4	250	0.007	11	0.9	250	-
1	SA 2-01	Yonedaw	Deep well	31.7	82	0	0	7.5	2	1,203	84	601	624	ND	ND	ND	ND	ND	28.06	0.91	262.86	0.01	0.0000	ND	ND	ND	ND	ND	0.3	0.12	16.0	ND	1.21	<0.01	51	ND
2	SA 2-05	Mhonehtoo	Deep well	31.8	103	0	122	7.2	3	6,290	320	3,150	450	0.140	ND	ND	ND	ND	128.26	5.33	1617.00	<0.01	0.0003	ND	ND	ND	ND	ND	0.4	0.62	420.0	ND	ND	<0.01	2,140	ND
3	SA 2-07	Thanbinkan	Deep well	35.0	96	0	0	6.9	2	1,203	288	602	536	ND	ND	ND	0.007	ND	128.26	3.82	186.66	<0.01	ND	ND	ND	0.025	ND	ND	0.5	0.11	61.0	ND	0.45	<0.01	65	ND
4	SA 2-08	Natyaygan	Deep well	35.6	104	0	0	7.6	3	2,730	280	1,365	988	0.090	ND	ND	0.009	ND	112.22	4.63	529.00	<0.01	ND	ND	ND	0.02	ND	ND	0.3	0.16	202.0	ND	0.32	<0.01	178	ND
5	SA 2-18	Kalarpyan	Deep well	33.0	113	0	10	8.1	2	3,520	100	1,763	1,516	ND	ND	ND	0.002	ND	16.03	1.91	848.50	<0.01	0.0004	ND	ND	0.002	ND	ND	0.5	0.17	245.0	ND	ND	<0.01	256	ND
6	SA 2-23	Magyidaw	River Water	30.0	181	0	0	7.4	2	1,525	148	763	784	ND	ND	ND	ND	ND	60.12	0.40	320.25	<0.01	ND	ND	0.3	ND	ND	ND	0.2	0.15	43.0	ND	0.25	<0.01	33	ND
7	SA 2-26	Koetaungboh	Deep well	27.4	124	0	0	7.3	57	956	256	478	452	0.370	ND	ND	ND	26.75	76.15	0.81	110.10	<0.01	ND	ND	0.3	ND	ND	ND	0.4	0.19	64.0	ND	1.39	0.01	24	ND
8	SA 2-27	Inngoteto	Deep well	28.2	261	0	0	7.1	5	760	230	380	88	ND	ND	ND	ND	17.02	68.14	3.23	48.04	0.02	ND	ND	0.4	ND	ND	ND	0.3	0.21	194.0	ND	1.14	<0.01	19	ND
9	SA 2-30	Nyuaungkantha	Deep well	28.4	210	0	0	7.6	3	1,210	400	605	444	ND	0.004	ND	ND	12.16	212.42	1.41	85.05	0.01	ND	ND	ND	ND	ND	ND	0.3	0.17	178.0	ND	1.40	<0.01	47	ND
10	SA 2-31	Myaymon	Deep well	28.6	19	0	0	7.8	3	1,691	328	845	712	ND	ND	ND	ND	7.3	220.44	1.51	660.50	<0.01	ND	ND	ND	ND	ND	ND	0.4	0.09	39.0	ND	0.83	<0.01	64	ND
11	MA2-04	Chaysay	Deep well	31.0	177	0	80	7.9	2	3,740	90	1,872	1,580	0.012	ND	ND	ND	ND	12.02	0.50	0.50	<0.01	ND	ND	ND	ND	ND	ND	0.3	0.22	156.0	ND	0.32	<0.01	300	ND
12	MA2-06	Kuywar	Deep well	31.6	38	0	0	8.5	2	1,949	40	974	260	0.037	ND	ND	ND	ND	ND	1.31	345.25	0.01	ND	ND	ND	ND	ND	ND	0.2	0.34	85.0	24	0.76	<0.01	620	ND
13	MA2-15	Nyaunggone	Deep well	31.1	200	0	14	8.2	22	2,930	120	1,467	1,296	ND	0.014	ND	ND	9.73	20.04	1.61	690.50	<0.01	ND	ND	ND	ND	ND	ND	0.1	0.26	75.0	ND	9.47	<0.01	490	ND
14	MA 2-16	Chaungnar	Dug Well	31.7	146	0	3	8.0	35	1,497	168	749	536	ND	ND	ND	ND	17.02	36.07	0.50	260.20	<0.01	ND	ND	ND	ND	ND	ND	0.8	0.32	41.0	ND	0.32	<0.01	248	ND
15	MA 2-21	Tharyarmyine	Deep well	30.6	223	0	0	7.7	2	2,470	488	1,235	752	ND	ND	ND	ND	41.34	80.16	1.82	340.25	<0.01	ND	ND	ND	ND	ND	ND	0.3	0.17	134.0	ND	0.38	<0.01	192	ND
16	MA 2-22	Oakpo	Deep well	32.0	97	0	0	7.5	3	623	150	311	324	0.128	ND	ND	0.135	5.64	65.12	2.23	55.05	0.01	ND	ND	ND	0.033	ND	ND	0.3	0.03	113.0	ND	0.38	<0.01	21	ND
17	MA 2-23	Kangyi	Deep well	30.7	129	0	0	8.4	2	1,918	36	959	688	0.069	ND	ND	0.001	2.05	5.07	1.11	430.00	0.01	ND	ND	ND	0.041	ND	ND	0.3	0.03	23.3	ND	0.38	<0.01	120	ND
18	MA2-28	Setsetyo	Deep well	32.5	101	0	17	6.5	72	1,620	396	810	316	0.987	ND	ND	0.159	29.43	108.62	5.12	186.65	0.01	ND	ND	1.2	ND	ND	ND	0.8	0.08	144.0	ND	0.76	<0.01	170	ND
19	MA2-36	Aleywar	Deep well	33.5	21	0	0	5.9	48	1,286	328	643	204	0.564	ND	ND	0.219	30.16	78.56	4.72	132.65	0.03	ND	ND	0.9	ND	ND	ND	0.6	0.12	81.0	ND	0.32	<0.01	148	ND
20	MA2-38	Laigyi	Deep well	31.0	137	0	100	6.9	116	1,096	392	548	436	0.417	ND	ND	0.231	37.7	103.41	8.43	108.05	<0.01	ND	ND	ND	ND	ND	ND	0.3	0.03	94.0	ND	0.38	<0.01	112	ND
21	MG2-10	Kanyaygyi	Deep well	29.5	51	0	10	7.1	15	985	320	492	376	0.537	ND	ND	0.029	19.46	94.19	4.32	108.05	0.01	ND	ND	ND	ND	ND	ND	0.4	ND	20.5	ND	0.38	<0.01	31	ND
22	MG2-11	Myaysioon	Deep well	32.0	15	0	0	6.9	19	1,066	264	534	376	0.843	ND	ND	0.007	22.37	63.73	4.02	147.35	0.02	ND	ND	ND	0.012	ND	ND	0.6	0.05	82.0	ND	1.40	<0.01	77	ND
23	MG2-12	Zoebwar	Deep well	32.0	120	6	10	7.1	2	1,336	176	668	608	0.019	ND	ND	0.583	18.24	39.68	3.13	260.35	0.01	ND	ND	ND	ND	ND	ND	0.1	0.03	113.0	ND	0.51	<0.01	45	ND
24	MG2-15	Winkabar	Deep well	31.0	24	0	0	7.8	5	670	62	335	316	0.053	ND	ND	0.002	3.08	18.61	1.21	140.05	0.01	ND	ND	ND	0.038	ND	ND	0.2	ND	44.0	ND	1.46	0.07	25	ND
25	MG2-19	Legyinyo	Deep well	32.4	10	0	0	6.6	60	1,445	312	722	452	0.280	ND	ND	0.412	14.88	108.25	4.75	4.75	0.02	ND	ND	0.3	0.042	ND	ND	0.1	ND	144.0	ND	0.25	<0.01	62	ND
26	MG2-25	Htanaungkwin	Ir. Channel	32.2	141	15	15	7.5	122	861	260	431	420	0.082	ND	ND	0.002	22.07	73.57	3.24	85.05	0.01	ND	ND	ND	0.057	ND	ND	0.1	0.08	2.9	ND	0.32	<0.01	61	ND
27	MG2-26	Manawtgone	River Water	28.2	17	17	30	8.3	86	786	150	393	372	0.148	ND	ND	ND	5.64	50.74	3.14	125.05	0.01	ND	ND	ND	0.044	ND	ND	0.2	0.09	9.6	ND	ND	<0.01	57	ND
28	MG2-32	Ywartharlay	Deep well	29.6	39	13	20	5.8	570	4,190	990	2,100	136	0.082	ND	ND	0.470	71.84	279.08	9.81	490.25	0.05	ND	ND	25.1	0.038	ND	ND	0.8	0.26	18.2	ND	ND	<0.01	590	ND
29	MG2-36	Kokkohla	Deep well	29.0	180	Numerous	Numerous	7.2	3	1,322	200	661	700	0.091	ND	ND	0.013	12.32	61.74	0.71	245.15	<0.01	ND	ND	ND	0.041	ND	ND	0.3	0.03	2.9	ND	0.38	<0.01	56	ND
30	MG2-37	Kangyigone	Deep well	29.5	183	0	0	7.1	3	1,085	160	542	552	0.049	ND	ND	0.006	2.57	61.74	0.51	215.10	<0.01	ND	ND	ND	0.041	ND	ND	0.4	ND	13.6	ND	0.45	<0.01	32	ND
Quantity of Excess Sandards Value				-	-	**5**	**12**	**2**	**12**	**6**	**1**	**7**	-	**0**	**0**	**0**	**0**	**0**	**3**	-	**15**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**6**	**0**

*1 : EC applied EU DWD value.

*2 : NO3-N and NO2-N applied WHO Guideline Value.

Note) Red characters in Table is exceed the standard value

ND : No Detectable

Table 1.3.11 Comparison of Results of Field Water Quality Measurement and Detailed Water Quality Analysis

ID No	Village	Water Source Type	pH		EC*[1]		Mn		Fe		F		NO3-N*[2]		NO2-N*[2]		General Coliforms	
			-		µS/cm		mg/L		mg/L		mg/L		mg/L		mg/L			
			6.5 - 8.5		2,500		0.4		1.0		1.5		11		0.9		0	
			Field	Detailed	Field	Detailed	Field	Detailed	Field	Detailed	Field	Detailed	Field	Detailed	Field	Detailed	Field	Detailed
SA 2-01	Yonedaw	Deep well	7.95	7.5	1,230	1,203	<0.02	ND	<0.2	ND	1.5	0.3	5.0	1.21	<0.005	<0.01		0
SA 2-05	Mhonehtoo	Deep well	7.91	7.2	628	6,290	<0.02	ND	<0.2	0.140	0.6	0.4	<0.02	ND	<0.005	<0.01		122
SA 2-07	Thanbinkan	Deep well	8.68	6.9	1,224	1,203	<0.02	ND	<0.2	ND	0.8	0.5	2.0	0.45	<0.005	<0.01		0
SA 2-08	Natyaygan	Deep well	7.81	7.6	2,820	2,730	<0.02	ND	<0.2	0.090	0.8	0.3	<0.02	0.32	<0.005	<0.01		0
SA 2-18	Kalarpyan	Deep well	8.24	8.1	3,600	3,520	<0.02	ND	<0.2	ND	1.5	0.5	<0.02	ND	<0.005	<0.01		10
SA 2-23	Magyidaw	River Water	8.66	7.4	474	1,525		0.3	<0.2	ND	0.2	0.2	<0.02	0.25	<0.005	<0.01		0
SA 2-26	Koetaungboh	Deep well	7.60	7.3	1,113	956	0.01	0.3	<0.2	0.370	0.2	0.4	<0.02	1.39	<0.005	0.01		0
SA 2-27	Inngoteto	Deep well	7.30	7.1	796	760	<0.02	0.4	0.2	ND	0.2	0.3	10<	1.14	<0.005	<0.01		0
SA 2-30	Nyuaungkantha	Deep well	7.50	7.6	1,905	1,210	<0.02	ND	<0.2	ND	0	0.3	10.0	1.40	<0.005	<0.01		0
SA 2-31	Myaymon	Deep well	8.10	7.8	3,210	1,691	<0.02	ND	<0.2	ND	1.5	0.4	10<	0.83	<0.005	<0.01		0
MA2-04	Chaysay	Deep well	8.06	7.9	2,880	3,740	<1	ND	0.2	0.012	0	0.3	<0.02	0.32	<0.005	<0.01		80
MA2-06	Kuywar	Deep well	8.69	8.5	2,450	1,949	<1	ND	<0.2	0.037	2.0	0.2	0.5	0.76	0.05	<0.01		0
MA2-15	Nyaunggone	Deep well	8.48	8.2	2,800	2,930	<0.02	ND	<0.2	ND	1.5	0.1	0.2	9.47	<0.005	<0.01		14
MA 2-16	Chaungnar	Dug Well	8.16	8.0	2,030	1,497	<0.02	ND	<0.2	ND	3~8	0.8	2~5	0.32	<0.005	<0.01	Too much	3
MA 2-21	Tharyarmyine	Deep well	8.41	7.7	4,440	2,470	<0.02	ND	<0.2	ND	1.5~3	0.3	10<	0.38	0.2～0.5	<0.01	7	0
MA 2-22	Oakpo	Deep well	8.18	7.5	635	623	<0.02	ND	<0.2	0.128	0~0.4	0.3	<0.02	0.38	<0.005	<0.01		0
MA 2-23	Kangyi	Deep well	8.51	8.4	1,983	1,918	<0.02	ND	<0.2	0.069	1.5	0.3	<0.02	0.38	<0.005	<0.01		0
MA2-28	Setsetyo	Deep well		6.5		1,620		1.2		0.987		0.8		0.76		<0.01		17
MA2-36	Aleywar	Deep well	6.00	5.9	1,343	1,286	1	0.9	3.0	0.564	0.2	0.6	<0.02	0.32	<0.005	<0.01		0
MA2-38	Laigyi	Deep well	7.48	6.9	1,203	1,096	<0.02	ND	5.0	0.417	0.6	0.3		0.38	<0.005	<0.01		100
MG2-10	Kanyaygyi	Deep well	7.37	7.1	1,013	985	<1	ND	2.0	0.537	0.8	0.4	<0.02	0.38	<0.005	<0.01		10
MG2-11	Myaysioon	Deep well	7.42	6.9	1,109	1,066	<1	ND	3.0	0.843	1.2	0.6	<0.02	1.40	<0.005	<0.01		0
MG2-12	Zoebwar	Deep well	7.86	7.1	1,409	1,336	<1	ND	<0.2	0.019	2.0	0.1	0.2	0.51	<0.005	<0.01		10
MG2-15	Winkabar	Deep well	8.37	7.8	703	670	<1	ND	<0.2	0.053	0.2	0.2	0.5	1.46	0.05	0.07		0
MG2-19	Legyinyo	Deep well	6.50	6.6	2,370	1,445	<1	0.3	1.5	0.280	1.0	0.1	<0.02	0.25	<0.005	<0.01		0
MG2-25	Htanaungkwin	Ir. Channel	7.34	7.5	1,085	861	<0.02	ND	<0.2	0.082	0.1	0.1		0.32	<0.005	<0.01		15
MG2-26	Manawtgone	River Water	8.31	8.3	662	786	<0.02	ND	<0.2	0.148	0.1	0.2		ND	<0.005	<0.01		30
MG2-32	Ywartharlay	Deep well	7.29	5.8	3,840	4,190	2	25.1	1.0	0.082	0.2	0.8		ND	0.008	<0.01		20
MG2-36	Kokkohla	Deep well	8.67	7.2	1,587	1,322	<1	ND	<0.2	0.091	2.0	0.3	<0.02	0.38	<0.005	<0.01		Numerous
MG2-37	Kangyigone	Deep well	8.82	7.1	4,520	1,085	<1	ND	<0.2	0.049	3.0	0.4	<0.02	0.45	0.005	<0.01		0

*[1] : EC applied EU DWD value.

*[2] : The filed measrement result of NO3 and NO2 is converted NO3-N and NO2-N for comparision with the detailed analysis.
NO3-N and NO2-N applied WHO Guideline Value.

1.4 SOCIO-ECONOMIC CONDITIONS

The current situation with regard to administration, society and economy of Myanmar is elaborated in the following sections.

(1) Administrative Divisions

Myanmar currently is divided into twenty one administrative subdivisions including state, region, union territory, self-administered zone, and self-administered division. Table 1.4.1 shows the current arrangement of administrative divisions.

Table1.4.1 Administrative Divisions of Myanmar

No.	Union Territory/ Region/ State	Self-administered (SA) Zone/ Division
1	Naypyidaw Union Territory	
2	Kachin State	
3	Kayah State	
4	Kayin State	
5	Chin State	
6	Sagaing Region	Naga SA Zone
7	Tanintharyi Region	
8	Bago Region	
9	Magway Region	
10	Mandalay Region	
11	Mon State	
12	Rakhine State	
13	Yangon Region	
14	Shan State	Kokang SA Zone
		Danu SA Zone
		Pa-O SA Zone
		Pa Laung SA Zone
		Wa SA Division
15	Ayeyarwady Region	

The constitution states that Naypyidaw shall be a Union Territory under the direct administration of the President. Day-to-day functions would be carried out on the President's behalf by the Naypyidaw Council led by a Chairperson. The Chairperson and members of the Naypyidaw Council are appointed by the President and shall include civilians and representatives of the Armed Forces.

Each state or region has a Regional Government or a State Government consisting of a Chief Minister, other Ministers and an Advocate General. Legislative authority would reside with the State Hluttaw or Regional Hluttaw made up of elected civilian members and representatives of the Armed Forces.

Self-Administered Zones and Self-Administered Divisions are administered by a Leading Body which consists of at least ten members and includes State or Regional Hlutttaw members elected from the Zones or Divisions and other members nominated by the Armed Forces. The Leading Body has both executive and legislative powers. A Chairperson is head of each Leading Body.

(2) Population and Tribes

Total population of Myanmar is 51,419,420 according to the result of 2014 Census data. It is confirmed that more than 20 million people have been increased since the last Census (1983). Demographic data of Union Territory, Regions and States including population, population density,

and household is summarized in Table 1.4.2.

Table 1.4.2 Demographic Data in Territory, Region and State

No.	Union Territory/ Region/ State	Population			Population Density (persons/ km^2)	Average No. of Household
		Male	Female	Total		
1	Naypyitaw Union Territory	565,155	595,087	1,160,242	164	4.1
2	Kachin State	878,384	811,057	1,689,441	19	5.1
3	Kayah State	143,213	143,414	286,627	24	4.8
4	Kayin State	775,268	798,811	1,574,079	52	4.7
5	Chin State	229,604	249,197	478,801	13	5.1
6	Sagaing Region	2,516,949	2,808,398	5,325,347	57	4.6
7	Tanintharyi Region	700,619	707,782	1,408,401	32	4.8
8	Bago Region	2,322,338	2,545,035	4,867,373	124	4.2
9	Magway Region	1,813,974	2,103,081	3,917,055	87	4.1
10	Mandalay Region	2,928,367	3,237,356	6,165,723	200	4.4
11	Mon State	987,392	1,067,001	2,054,393	167	4.6
12	Rakhine State	1,526,402	1,662,405	3,188,807	87	4.4
13	Yangon Region	3,516,403	3,844,300	7,360,703	716	4.4
14	Shan State	2,910,710	2,913,722	5,824,432	37	4.7
15	Ayeyarwady Region	3,009,808	3,175,021	6,184,829	177	4.1
	Total/ National Average	24,824,586	26,661,667	51,486,253	76	**76**

(Source: Population and Housing Census of Myanmar 2014)

There are eight major tribes in Myanmar, namely Kachin, Kayah, Kayin, Chin, Mon, Burma, Rakhine, and Shan, which are subdivided into 135 minor tribes. The biggest tribe in Myanmar is Burma who commonly inhabits in plains located in the center part of Myanmar. Other tribes mostly live in hilly and mountainous terrains surrounding plains with preserving their cultures and traditions.

(3) Economic Conditions

Referring statistics concerning about economic indicators from IMF and JETRO, GDP of Myanmar in the last three years shall be summarized in Table 1.4.3.

Table 1.4.3 Economic Indicators of Myanmar

Indicator	2011	2012	2013
GDP			
Nominal GDP (million USD)	52,000	54,000	56,400
Real GDP Growth Rate (%)	5.9	7.3	8.3
GDP per capita（USD）	832	876	869

Project referred and edited World Economic Outlook Database (IMF), Basic Economic Indicator (JETRO)

Referential documents indicate that GDP of Myanmar in 2013 is 56,400 million USD as well as that per capita is 869 USD, which could be grouped with Laos and Cambodia as small economic scale countries in Southeast Asian countries including Singapore and Brunei. This economic situation of Myanmar has been largely affected because of their political situation. However, the civilian government elected in a democratic approach has been altering various policies and regulations for economic activities. This attracted foreign investors to finance development programs and projects. Besides, development partners like international cooperation agencies, development banks, NGOs, etc. resumed their assistance to Myanmar. Eventually these positive changes hastened the speed of development in various sectors and boosted domestic demand.

According to statistical data of exported products, natural gas products contributed more than 40% of total amount of exports. Other major projects exported were crops (beans, rice, etc.), textiles and timbers (teak). Thailand, which buys products from Myanmar equivalent to approximately 50% of total export amount of Myanmar, is the biggest destination county for export and China is the second biggest with 25%.

1.5 VILLAGE SOCIO-ECONOMIC SURVEY IN TARGET VILLAGES

1.5.1 OBJECTIVES AND METHODOLOGIES

Socio-economic survey aims to understand characteristics, decision making mechanism, major economic activities, and economic conditions at household level as well as evaluate the sustainability of water supply services in target villages by assessing the current capacity of operation and maintenance of water supply facilities technically and administratively.

The survey consists of village survey and household sample survey. Structured questionnaire was applied for village survey while semi-structured questionnaire for household sample survey. The following sections elaborate the approach and process pf each survey.

(1) Village Survey

This survey intends to extract the information concerning about the general socio-economic conditions of villages and current status of existing water supply facilities from representatives of target villages with an attention of gender issues.

The Project coordinated survey teams to include female surveyors when survey teams conducted the interview survey along with a structured questionnaire. Besides, survey teams took into consideration during the interview to provide equal opportunities to both male and female to express their ideas and understanding about questions.

(2) Household Sample Survey

Representatives of sample households, which were selected randomly from classified financial strata (Better off, Middle, Worse off) in each target village, were interviewed by following items included in semi-structured questionnaire. Survey teams were composed with male and female surveyors. Thus, interviewers were timely changed according to the situation so that interviewees might not have any hesitation to express their responses. In total, 1,200 households were selected and interviewed.

1.5.2 SURVEY ITEMS OF SOCIO-ECONOMIC CONDITION

Survey items adapted in this survey were summarized in Table 1.5.1

Table 1.5.1 Survey Items

Survey Items	Survey Contents
Basic Information of the target village	Population, Number of households, Amount of household income (average, maximum, minimum), Major sources of incomes, seasonal variation of incomes, Existence of water management committee, Other existing organizations in the target village and Decision-making mechanism in the target village, Current condition of power supply to the village
Water use situation of the residents in the target villages	Present water sources in the dry season and the rainy season, amount of consumption of water in the dry season and the rainy season, uses of water, problems and requests about water supply, amount of water tariff etc.
Water use situation of	Water tariff, Present status of operation and maintenance of the water supply

Survey Items	Survey Contents
surrounding villages	facilities
Residents' willingness about water supply	Willingness to pay and save for water tariffs, willingness about operation and maintenance of water supply facilities
Situation of water related diseases	Generation of water related diseases such as diarrhea
Related matters of gender consideration	Difference in the role about the water according to sex, participation in decision-making in the target villages according to sex, burden of fetching water according to sex, needs of water according to sex

1.5.3 RESULTS OF SOCIO-ECONOMIC SURVEY

Results of village survey and household sample survey were individually explained in the following sections.

(1) Village Survey

The composition of key informants is summarized based on their responsibilities in Table 1.5.2. Members of health committee were not involved in this interview because they were basically stationed in the center of township. Besides, no one joined from village youth groups because this group is not commonly established in this area.

Table 1.5.2 Composition of Key Informants

No.	Key Informants	Sagaing	Mandalay	Magway	Total
1	Village administrative officer	40	40	40	120
2	Village elders	284	294	268	846
3	Village water committee	47	42	64	153
4	Teachers	17	14	21	52
5	Health committee	0	0	0	0
6	Village youth groups	0	0	0	0
7	Village women group	35	41	32	108
8	Representatives from other committees (agriculture, forestry, hygiene & sanitation)	40	40	40	120
Total		463	471	465	1,399

1) Population and Households in Target Villages

A table below shows population and number of households in target villages. In addition, the status of electrification is also included.

Table 1.5.3 Population and Households in Target Villages

Region	Township	Village	Project ID	H/H	Population			Electrification
					Male	Female	Total	
Magway	Magway	Thanbo	MG2-02	64	140	157	297	Yes
		Leikkan	MG2-08	228	510	624	1,134	No
		Ywarthitgyi	MG2-09	310	800	1,020	1,820	No
		Nyaungpinthar	MG2-03	267	650	800	1,450	No
		Thapyaysan (N)	MG2-06	72	105	145	250	No
		Shwekyaw	MG2-07	95	117	136	253	No
		Natkan	MG2-01	310	544	700	1,244	No
		Konegyi	MG2-04	254	534	653	1,187	No
		Sainggya	MG2-05	416	760	1,000	1,760	No

Region	Township	Village	Project ID	H/H	Population			Electrification
					Male	Female	Total	
	Taungdwingyi	Kangyigone	MG2-37	235	500	600	1,100	No
		Yayhtwetgyi	MG2-40	137	305	350	655	No
		Hlebwegyi	MG2-39	190	43	500	543	No
		Ko kkohla	MG2-36	220	447	457	904	No
		Htaukkyantgwin	MG2-38	270	759	780	1,539	No
	Yenangyaung	Lelkyinyoe	MG2-19	297	650	850	1,500	No
	Myothit	Ayaungmyinthar	MG2-22	197	560	700	1,260	No
		Laytinesin	MG2-20	597	1,046	1,200	2,246	No
		Tharmyar	MG2-21	571	1,551	1,660	3,211	No
		Ngwelay	MG2-23	340	540	370	910	No
		Indaw(N)	MG2-24	203	224	266	490	No
		Htanaungkwin	MG2-25	228	714	814	1,528	No
		Manowtgone	MG2-26	182	368	427	795	No
	NatMauk	Sellel	MG2-30	360	800	1,200	2,000	No
		Htonepouthchine	MG2-28	380	900	1,150	2,050	No
		Kyugyaung	MG2-35	90	250	300	550	No
		Kangyigone	MG2-27	65	150	200	350	Yes
		Wayonegone	MG2-33	150	330	397	727	No
		Podaukgone	MG2-31	152	350	470	820	No
		Nyaunggone	MG2-34	312	700	500	1,200	No
		Padaukngote	MG2-29	300	548	700	1,248	No
		Ywartharlay	MG2-32	81	180	230	410	No
	Chauk	Myaysoon	MG2-11	63	162	166	328	No
		Kanyaygyi	MG2-10	230	586	660	1,246	No
		Kyatesu	MG2-14	165	320	400	720	No
		Kyatkan	MG2-16	116	201	277	478	No
		Zeenwar	MG2-12	245	500	675	1,175	Yes
		Myaynialin	MG2-18	38	105	130	235	No
		Sudat	MG2-17	96	200	250	450	Yes
		Yenpyay	MG2-13	36	60	95	155	No
		Winkabar	MG2-15	580	1,100	1,500	2,600	No
Mandalay	MaHlaing	Khinthar	MA2-03	80	200	290	490	No
		Htantawgy	MA2-01	100	24	260	284	No
		Asone	MA2-02	145	295	340	635	No
	Myingyan	Nyaung Wun	MA2-08	86	192	240	432	No
		Chaysay	MA2-04	243	631	695	1,326	No
		Yonehto	MA2-07	147	281	422	703	Yes
		Kuywar	MA2-06	575	1,206	1,217	2,423	Yes
		Talgyi	MA2-05	160	353	408	761	No
	NgaZon	Kone Le	MA2-09	303	747	777	1,524	No
		Ywarside	MA2-12	30	107	124	231	No
		Kaungzin	MA2-11	144	411	453	864	No
		Phaung Ka Taw	MA2-10	199	650	525	1,175	No
	Natogyi	Kyaungkangyibin	MA2-14	77	201	234	435	No
		Kyauknan	MA2-13	236	510	605	1,115	Yes
		Nyaunggone	MA2-15	136	335	354	689	No
	Taungtha	Tharzi	MA2-19	183	466	522	988	No
		Kyauk Kar Taung Kone	MA2-18	67	110	140	250	Yes
		Chaungsone	MA2-17	80	380	413	793	No
		Tharyarmyaing	MA2-21	380	873	1,054	1,927	Yes
		Chaung Nar	MA2-16	104	223	294	517	No
		KanAye	MA2-20	94	120	180	300	No

Region	Township	Village	Project ID	H/H	Population			Electrification
					Male	Female	Total	
	Yamethin	Oakpo	MA2-22	210	700	800	1,500	No
		Kangyi	MA2-23	320	708	795	1,503	No
	Pyawbwe	Waryonesu	MA2-25	197	400	600	1,000	No
		Htanekan	MA2-24	230	500	700	1,200	No
	Naung U	Nyaungpinthar	MA2-33	23	50	63	113	No
		Mongywettaaw	MA2-31	82	100	200	300	No
		Saingkan	MA2-34	201	405	503	908	No
		Tawbyar	MA2-27	57	120	180	300	No
		PhoneKan	MA2-32	70	150	242	392	No
		Kanzauk	MA2-29	243	500	650	1,150	No
		Setsetyo	MA2-28	174	450	541	991	No
		Byugyi	MA2-35	320	937	1,050	1,987	No
		Talbindel	MA2-30	101	227	285	512	No
		Talkone	MA2-26	53	168	259	427	No
	KyaukPadaung	Tangakan	MA2-39	185	350	650	1,000	No
		Nakyatkhwal	MA2-40	1,067	1,920	4,210	6,130	Yes
		Thayattaw	MA2-38	145	250	50	300	No
		Leigyi	MA2-37	216	600	900	1,500	No
		Aleywar	MA2-36	226	489	600	1,089	Yes
Sagaing	Salingyi	Yonepinyoe	SA2-15	23	50	78	128	No
		Kine	SA2-17	72	130	150	280	No
		MinDaw	SA2-16	280	600	500	1,100	No
	MyinMu	ThaHtayKone	SA2-22	55	208	202	410	No
		HLayOoKan	SA2-19	63	287	298	585	No
		Magyitaw	SA2-23	39	71	90	161	No
		Kalapyan	SA2-18	78	180	203	383	No
		Magyikan	SA2-20	253	559	589	1,148	No
		Watkya	SA2-21	153	368	380	748	No
	Budalin	MaungHtanng	SA2-03	1,010	1,957	2,346	4,303	Yes
		Nyaungbinthar	SA2-02	53	104	119	223	Yes
		Mhonehtoo	SA2-05	50	103	101	204	No
		Kantawthar	SA2-04	110	200	250	450	No
		Yonedaw	SA2-01	96	200	250	450	Yes
		Wattuu I	SA2-06	220	420	440	860	No
	ChaungOo	Nat Yay Kan	SA2-08	171	370	530	900	No
		Thann Pin Kan	SA2-07	198	457	478	935	No
	Ayadaw	Zeepinlae	SA2-14	350	679	1,200	1,879	No
		Waryaung	SA2-11	920	1,823	2,177	4,000	No
		Yathar	SA2-13	318	374	392	766	No
		Oakkan	SA2-10	300	350	450	800	Yes
		WarTannKalay	SA2-12	100	400	600	1,000	No
		Sithar	SA2-09	85	142	270	412	No
	WetLet	Palae Thwe	SA2-37	63	120	130	250	No
		Shwenyaungtaw	SA2-39	70	120	150	270	No
		Sabeitaw	SA2-40	57	100	150	250	No
		Poukkan	SA2-38	267	600	900	1,500	No
	Kanbalu	Layytwinzin	SA2-32	150	345	369	714	No
		Nyaungkanthar	SA2-30	123	262	277	539	No
		Chaungchar	SA2-33	102	267	246	513	No
		Kyaunkone	SA2-26	253	529	642	1,171	Yes
		Khnowntar	SA2-29	104	429	575	1,004	No
		Inngoteto	SA2-27	280	614	664	1,278	No
		LwinGyi	SA2-25	60	244	255	499	Yes

Region	Township	Village	Project ID	H/H	Population			Electrification
					Male	Female	Total	
		Thindaw	SA2-24	60	406	411	817	Yes
		Myayhtoo	SA2-28	386	951	893	1,844	Yes
		Myaymon	SA2-31	415	1,166	1,361	2,527	No
	Dabayin	Minyogone	SA2-34	79	200	245	445	No
		Kyuntaw	SA2-36	100	200	220	420	No
		Shandaw	SA2-35	70	201	214	415	No
			Total	23,781	53,434	66,129	119,563	-

Total population and households in 120 target villages is counted to be 119,563 persons, and 23,781 respectively. The number of village covered with the national grid of electricity is just 19. The survey team further clarified village representatives without electricity whether they have any prospect to receive any assistance to electrify their villages. On their responses, it is understood that they did not get informed about any plan/program for connecting electricity line to villages from authorities. Table 1.5.4 shows the tendency of demography in each region.

Table 1.5.4 Demographical Tendency in Target Regions

Indicators	Magway (40 villages)	Mandalay (40 villages)	Sagaing (40 villages)	Average of 3 regions
Average Population	1,070	1,000	909	960
Average No. of H/H	229	185	181	198
Highest Population	3,211 (Tharmyar: MG2-21)	6,130 (Nakyatkhwal: MA2-40)	4,303 (Maunghtanng: SA2-03)	-
Smallest Population	155 (Yenpyay: MG2-13)	133 (Nyaungpinthar: MA2-33)	128 (Yonepinyoe: SA2-15)	-
Highest No. of H/H	597 (Laytinesin: MG2-20)	1,067 (Nakyatkhwal: MA2-40)	1,010 (Maunghtanng: SA2-03)	-
Smallest No. of H/H	36 (Yenpyay: MG2-13)	23 (Nyaungpinthar: MA2-40)	23 (Yonepinyoe: SA2-15)	-
Sex Ratio (Male : Female)	1: 1.22	1: 1.32	1: 1.18	1: 1.24

Among all 120 target villages, there are 39 villages where their population is less than 500 persons. Of these 39 villages, Yonepinyoe (SA2-15) has the smallest population of 128 persons. The scale of population is one of the most significant factors to ascertain the sustainable operation and maintenance of water supply facilities because higher population regulates fluctuation of revenue collected from users. Having such situation, it is advisable that the service level including the size of water supply facilities should be carefully determined by DRD when the the Project is implemented.

2) Major Industries in Target Villages (income sources)

The survey teams conducted the interview to key informants on the major industries as the main income sources for villages. As its results, it is revealed that agriculture, especially rice and peanut farming, is the most major industry in all 120 villages. Other industries such as livestock

and daily employment are also common subsequently. Very minor but small scale retail business and textile industry (weaving at home) are practiced at village level. The efficiency of income generation from agricultural farming is still limited because an irrigation system is still under development in target villages. Thus, the amount of income in harvesting and growing periods has substantial difference according to the explanation given from interviewees.

Numbers of responses on the major industries are summarized in each region as shown in Figure 1.5.1.

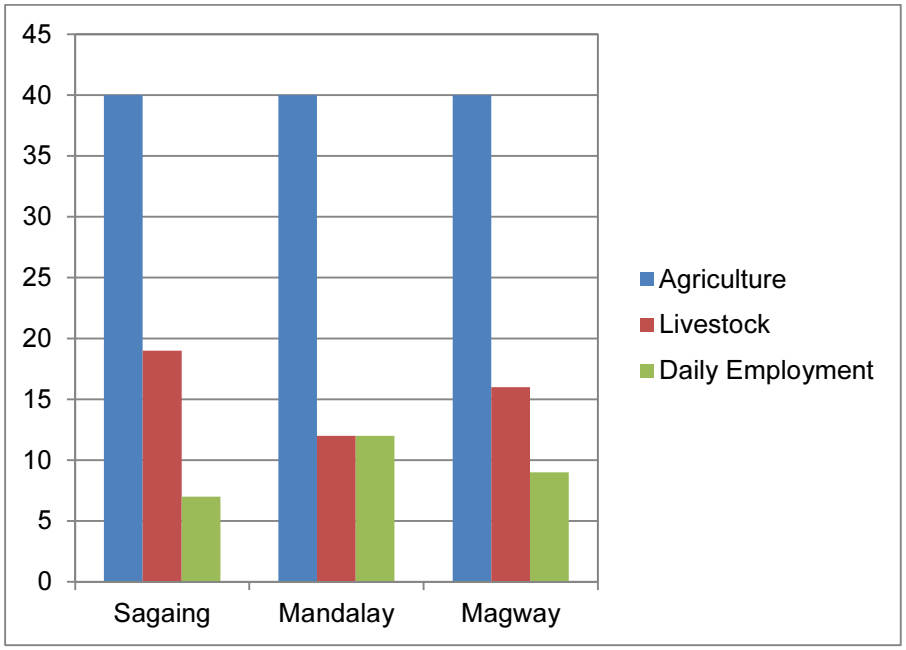


Figure 1.5.1 Major Industries in Target Villages

3) Situation of Existing Water Supply Facilities, Water Sources and O&M

The Project acknowledged that each target villages had at least one functional water supply facility existing within their community. Table 1.5.5 summarizes the number of existing water facilities and their functionality.

Table 1.5.5 No. of Existing Water Supply Facilities

	Sagaing	Mandalay	Magway	Total
Existing Water Supply Facilities	53	58	64	175
Functional	52	55	64	171
Not Functional	1	3	0	4
No. of villages fetching water in neighbouring villages	10	1	2	13

There are totally 175 existing water supply facilities in target villages, in which 171 facilities are functional at the time of a field survey. The deterioration of water sources in quantity and quality as well as poor management of operation and maintenance (shortage of fund, abandonment of repair) keeps 4 existing facilities malfunctioned as explained by key informants. The variety of existing functional water supply facilities are summarized in each region in Table 1.5.6.

Table 1.5.6 Types of Existing Functional Water Supply Facilities

Types of Facilities	Sagaing	Mandalay	Magway	Total
Tube Wells (TW)	18	26	23	67
Protected Dug Wells (PW)	16	14	10	40
Public Taps: Water KIOSK (PT)	1	0	4	5
Private Water Supply Facilities (PWS)	3	0	4	7
Ponds (P)	7	8	20	35
Unprotected Dug Wells (UW)	4	6	2	12
Unprotected Springs (US)	3	1	1	5
Total	52	55	64	171

Existing functional water supply facilities in target villages are mostly protected from the contamination of bacteria and fiscal matters but also it was confirmed that 17 unprotected water supply facilities are still utilized traditionally. Besides, it was observed that the distribution pipes were installed and connected to households in some villages. However their service coverage is partial in their communities.

Half of target villages have their village water committee (VWC) already established and some certain experience of operation and maintenance (O&M). Characteristics of existing VWCs are highlighted in the Table 1.5.7.

Table 1.5.7 Characteristics of Existing VWC

Characteristics	Sagaing	Mandalay	Magway	Total
Existing Village Water Committee (VWC)	17	22	21	60
No, of VWC with Female Members	3	5	2	10
No. of VWC with Water Fund	9	5	7	21
No. of VWC with Financial Record	9	5	7	21
No. VWC with Private Operators	14	21	19	54

In other villages where VWC has not yet established, village administrative officers have a responsibility to manage water supply services including operation and maintenance. The condition of existing water supply facilities, as mentioned earlier there are only 4 facilities malfunctioned, is generally good. It is, however, that the transparency of water service management to public is limitedly secured because the status of revenue and expenditure has been recorded only by 21 VWCs out of 60. Private operators are employed by VWCs in most of 60 villages with an onerous contact and generally performing as required.

4) Electrification

As it is explained in the previous section, 19 villages out of 120 target villages have got the access to public electricity supply from the national grid. On the other hand, small scale generators have often been employed either privately or publically for various purposes. Table 1.5.8 shows available small scale generators in target villages.

Table 1.5.8 Status of Electrification in Target Villages

Status	Sagaing	Mandalay	Magway	Total
Public Supply (Grid)	8	7	4	19
Generators owned by village/public institution	11	5	3	19
Generators owned by private	5	3	2	10
Small scale Solar Panel with car battery	14	14	25	53
No facility at all	2	12	7	21

It was observed that 19 villages possessed diesel generators with a capacity smaller than 20KVA and installed them at a village monastery or school. Furthermore, a system of solar cell generator with small battery has been promoted by regional governments and becoming quite popular in target villages.

(2) Household Sample Survey

The interview survey employing semi-structured questionnaire was conducted to 10 households each in target villages after representatives of target villages introduced the Project sample households with different income levels set by the Project. Total number of households in 120 target villages is 23,781. This survey involved 1,200 households in total, which is equivalent to 5% of total households. Criteria[1] utilized for classification in this survey are referred to the income level introduced by Myanmar central government for assessing the poverty reduction efficiency. The number of sample households cooperated in this survey is summarized in the table below.

Table 1.5.9 Number of Sample Households Categorized with Income Level in Target Villages

Region	Number of Sample Households Classified			Total in Region
	Better Off	Middle	Worse Off	
Sagaing	167 (42%)	144 (36%)	89 (22%)	400
Mandalay	152 (38%)	169 (42%)	79 (20%)	400
Magway	200 (50%)	133 (33%)	67 (17%)	400
Total in Income Level (% total)	519 (43%)	446 (37%)	235 (20%)	1,200

Remark: (@@%) shows percentage to total in region

According to the result, sample households belonging to a class of worse off do not own their own land. Thus, it was found that members of these households need to find out daily employment for earning the cost of living. Although those in middle class mostly own their own lands, the level of their income is still relatively low in comparison with the situation of other countries in Southeast Asia. Observing living conditions of better off class, it could be concluded that their properties such house, car, mobile phones, etc. are generally more expensive than those possessed by other classes. Besides, a size of their lands is much bigger than others. Therefore, it is assumed that the size of land has positive correlation to the level of income in the Project area where agriculture is the most major industry.

Village administrative officers are mandated to monitor the socio-economic conditions of villages by assessing the indicators set and given from Myanmar central government. Thus, the survey teams were able to collect the numbers of households in each income level from 120 target villages. Total number of households in 120 target villages is categorized with their income levels and summarized in Table 1.5.10.

[1] Better off: 300,000 >kyat/month, Middle: 100,000~300,000 kyat/month, Worse off: 100,000 <kyat/month

Table 1.5.10 Number of Households Categorized with Income Level in Regions

Region	Number of Households Classified			Total in Region
	Better Off	Middle	Worse Off	
Sagaing	2,554 (35%)	3,468 (48%)	1,208 (17%)	7,230
Mandalay	2,705 (37%)	3,713 (50%)	991 (13%)	7,409
Magway	3,289 (36%)	4,579 (50%)	1,274 (14%)	9,142
Total in Income Level (% total)	8,548 (36%)	11,760 (49%)	3,473 (15%)	23,781

Remark: (@@%) shows percentage to total in region

Comparing percentages of total numbers of households classified with their income levels in between target villages and regions, a percentage of middle class in target village is slightly lower than that in regions. The ratio of classes between target villages and regions, however, does not have much difference. Conclusively it is considered that the result of sample household survey could represent the reality of economic situation in regions.

1) Monthly Household Income and Expenditure to Water Supply Services

Data on income of sample household collected during the survey was statistically processed to understand regional features of economic status. The typical features of economic status in each region are summarized in Table 1.5.11.

Table 1.5.11 Regional Features of Average Monthly Income

H/H Income (kyat)	Sagaing	Mandalay	Magway	Total
Region Average	178,729	181,206	166,452	175,462
Highest Average	411,500	360,000	342,500	411,500
Lowest Average	86,000	91,500	73,500	73,500
Average Better Off	344,000	375,000	366,667	361,814
Average Middle	171,500	233,333	208,333	205,914
Average Worse Off	85,056	83,333	75,000	81,610

Average monthly income of 3 regions is 175,462 kyat. According to the result of a survey conducted in Myin Kun village of Magway region (JETRO, 2014), the average household income of Myin Kun village was 158,000 kyat/month.

The values of highest and lowest average household income in regions are classified depending on the income levels and displayed in Figure 1.5.2. It is clearly acknowledged that gaps between highest and lowest values are more than 5 times in any income level and region. As it is pointed out earlier, the major industry of these regions is agriculture and the irrigation system is still under development there. This might cause a seasonal variation of income in such a big manner.

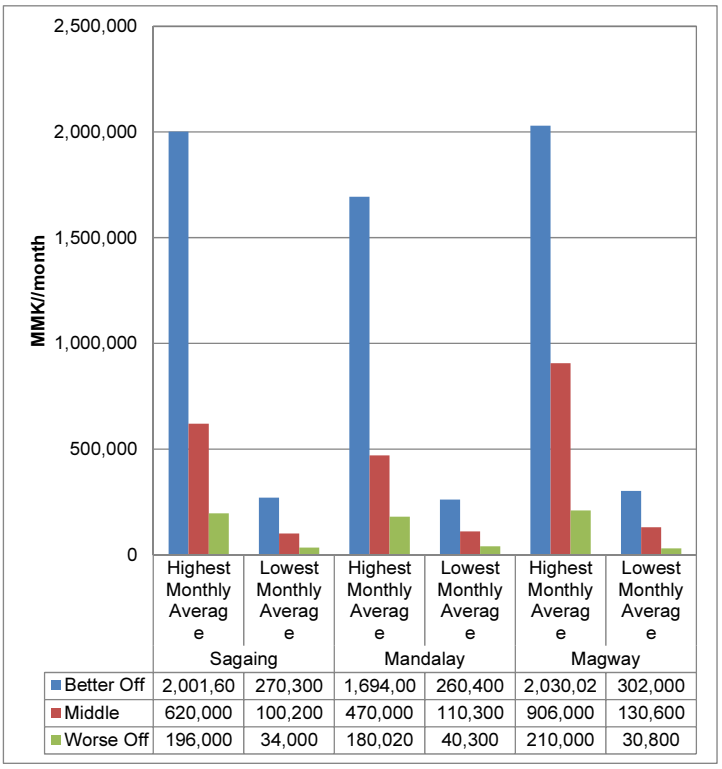


Figure 1.5.2 Highest and Lowest Average Household Income

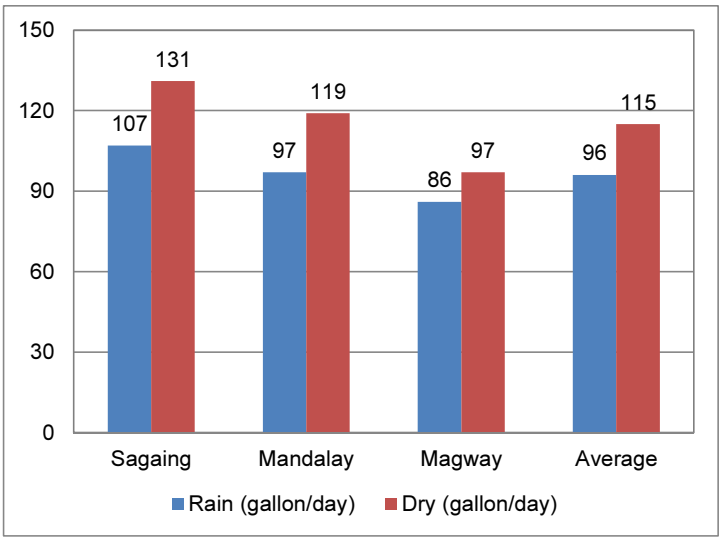
It is commonly known in Myanmar that majority of farmers practice agriculture on lands leased by land owners. Their income is considered to be lower relatively than that of farmers owning their own lands. The number and status of sample households, whose livelihoods are agriculture, is counted and summarized in Table 1.5.12.

Table 1.5.12 Status of Farmers in Regions

Status	Sagaing	Mandalay	Magway	Total (% total)
Landowners	233	285	321	839（97%）
Tenant Farmers	9	3	5	17（2%）
Landowners but only lending land	6	6	1	13（1%）

According to the result of the survey, 97% of farmers in target regions held their own lands, which is different from general understanding while tenant farmers are just 17 households (2 % in total).

Rainwater harvesting, in which rain drops are collected in a container through roof and gutter of a house, is commonly practiced to supplement collected rain water to drinking water in Southeast Asia during rainy season. Therefore, people there tend to change water sources by seasons. In order to understand the pattern of water usage from various water sources, survey teams examined the amount of water consumption from existing water sources as well as expenditure for water services in dry and rainy seasons. The result of this examination is displayed in the following figure and table.



Remark: 1 gallon = 4.5 L

Figure 1.5.3 Average Amount of Household Water Consumption in Dry and Rainy Seasons

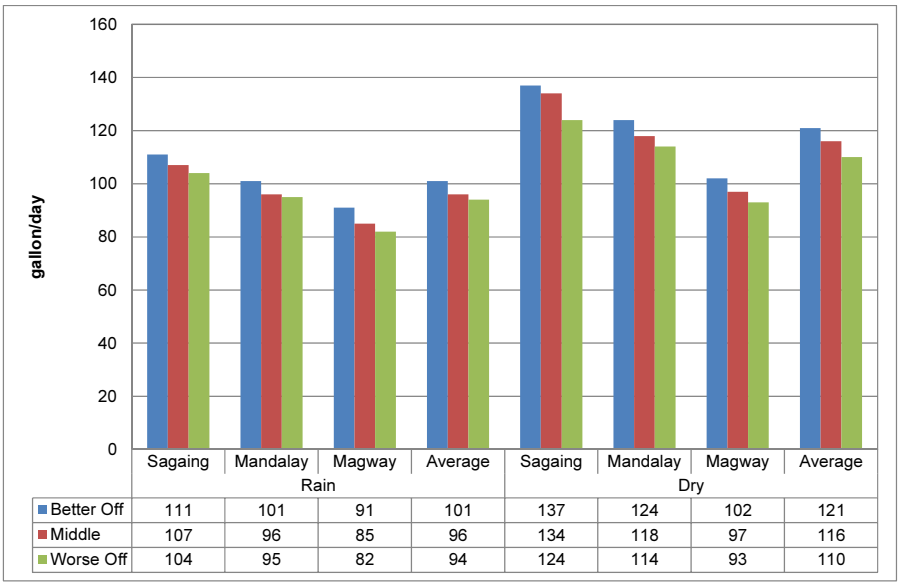
It is quite obvious in all regions that the amount of water consumption in a household increases in dry season. Average water consumption per day and person will be 19 gallon/day/person (85.5 liter) and 23 gallon/day/person (103.5 liter), supposed 5 members in one household.

The frequency of fetching water from different water sources is studied and sorted out according to the purpose of use including drinking, domestic, livestock and gardening. The result of this study (Table 1.5.13) figures out that in dry season fetching water from pond reduces while increase from tube wells (TW), protected wells (PW) and private water supply facilities (PWS) instead. This could be understood that the storage of pond water might reduce its volume causing the deterioration of water quality during a dry season hence village people shift fetching points from pond to other water sources, which have better water quality. No other significant change has been observed in the study.

Table 1.5.13 Situation of Fetching Water from Different Water Sources

Types of Water Source	No. of Response							
	Drinking		Domestic		Livestock		Gardening	
	Rain	Dry	Rain	Dry	Rain	Dry	Rain	Dry
Tube Wells (TW)	48	66	64	68	5	5	3	3
Protected Dug Wells (PW)	23	33	27	26	6	4	0	0
Public Tap: Water KIOSK (PT)	3	4	3	3	0	0	0	0
Private Water Supply Facilities (PWS)	1	3	7	6	1	1	1	0
Ponds (P)	38	25	6	6	2	1	0	0
Unprotected Dug Wells (UW)	11	10	10	11	4	5	1	0
Unprotected Spring (US)	5	2	4	3	1	1	0	0

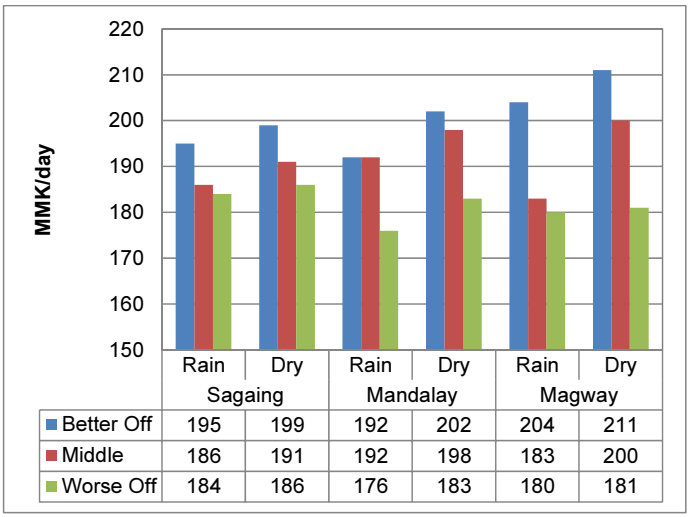
Comparing the amount of water consumption of households in different income levels, in all regions households categorized as better off tend to consume more water than those as worse off. The amount of difference in consumption is roughly 6 to 13 gallons per day, which is 27 to 59 liters per day. Figure 1.5.4 expresses the amount of water consumption of households in different income levels.



	Rain				Dry			
	Sagaing	Mandalay	Magway	Average	Sagaing	Mandalay	Magway	Average
Better Off	111	101	91	101	137	124	102	121
Middle	107	96	85	96	134	118	97	116
Worse Off	104	95	82	94	124	114	93	110

Figure 1.5.4 Water Consumption in Different Income Level

It is understood from the result of the survey that the expenditure for water services of better off households is generally 10 % higher than that of worse off households. In addition to this, the expenditure for water services in dry season in all income levels is 5 % higher than that in rainy season. The expenditure for water services in rainy and dry seasons is summarized in Figure 1.5.5.



	Sagaing		Mandalay		Magway	
	Rain	Dry	Rain	Dry	Rain	Dry
Better Off	195	199	192	202	204	211
Middle	186	191	192	198	183	200
Worse Off	184	186	176	183	180	181

Figure 1.5.5 Expenditure for Water Services in Different Income Level

Having such situations of consumption and expenditure for water, the survey team examined the perception among users on the expenditure for water services. The results of their responses are summarized in Figure 1.5.6.

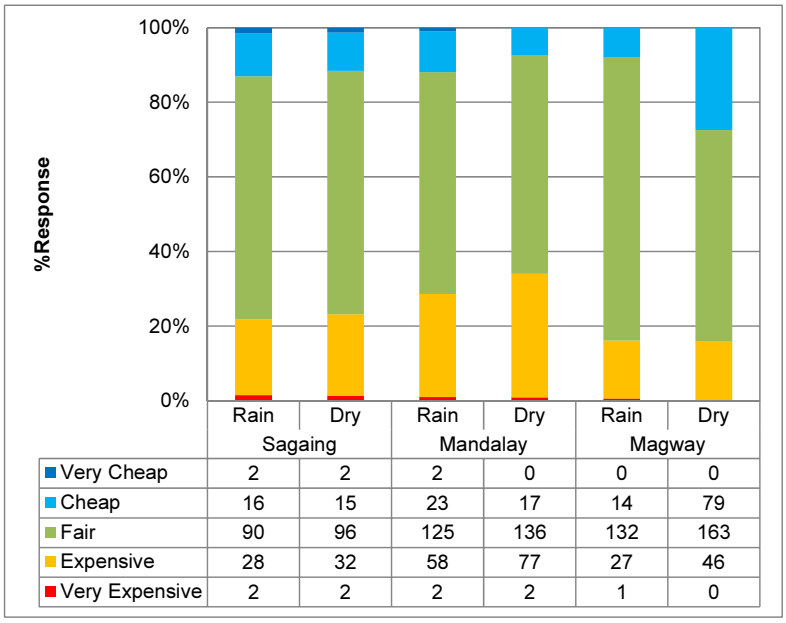


Figure 1.5.6 Perception on Expenditure for Water Services

More than 70% of respondents expressed that current expenditure for water services is appropriate, cheap, or very cheap. The result shows that people in sample households tend to perceive slightly more burden on the expenditure during a dry season. This tendency is clear among sample households categorized in worse off. In Table 1.5.14 below, breakdown of respondents (households) who answered "Expensive" and "Very Expensive" is summarized in each region according to their income level.

Table 1.5.14 Breakdown of Responses in Income Level

Income Level	Sagaing				Mandalay				Magway			
	Expensive		Very Expensive		Expensive		Very Expensive		Expensive		Very Expensive	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Better Off	2	2	0	0	5	18	0	0	3	3	0	0
Middle	6	7	1	1	15	18	0	0	6	13	0	0
Worse Off	20	23	1	1	38	51	2	2	18	30	1	0
Total	28	32	2	2	58	77	2	2	27	46	1	0

In order to comprehend real situation on expenditure for water services in target villages, the team computed, based on data collected during the survey, annual expenditure for water services in different income levels by presuming 7 months in dry season from October to May and 5 months in rainy season from May to October. The result of computation on annual expenditure for water services in different income levels is organized in Table 1.5.15.

Table 1.5.15 Annual Expenditure for Water Services in Different Income Level

Income Level	Sagaing			Mandalay			Magway		
	Rain	Dry	Total	Rain	Dry	Total	Rain	Dry	Total
Better Off	29,250	41,790	71,040	28,800	42,420	71,220	30,600	44,310	74,910
Middle	27,900	40,110	68,010	28,800	41,580	70,380	27,450	42,000	69,450
Worse Off	27,600	39,060	66,660	26,400	38,430	64,830	27,000	38,010	65,010

Average household annual income is calculated based on average monthly income shown in

Table 1.5.11 and the percentage of expenditure for water services in different income level is determined by comparing their average annual income. The result of calculation is shown in Table 1.5.16.

Table 1.5.16 Percentage of Expenditure for Water Services to Household Income

Region	Income Level	Average Household Income (Annual: MMK)	Expenditure for Water Services (Annual: MMK)	Percentage (%)
Sagain	Better Off	4,128,000	71,040	1.72
	Middle	2,058,000	68,010	3.30
	Worse Off	1,020,674	66,660	6.53
Mandalay	Better Off	4,500,000	71,220	1.58
	Middle	2,800,000	70,380	2.51
	Worse Off	1,000,000	64,830	6.48
Magway	Better Off	4,400,000	74,910	1.70
	Middle	2,500,000	69,450	2.78
	Worse Off	900,000	65,010	7.22

Assessing the result of computation shown in the table above, it is understood that computed in worse off all regions exceeds 5% of their annual household income.

2) Satisfaction on Water Supply Services and Willingness to Pay

In target regions, distribution network and house connection as a part of water supply facilities are not common. Therefore, people there have to travel from their home to water points and on return with water tanks filled with water. Figure 1.5.7 describes common means of water transportation in dry and rain seasons. From the interview to sample households, if the amount of water is just about 5 gallons (20 liters), people walk to water points for fetching water and come back with buckets by using a carrying pole. In case of fetching water more than 5 gallons, weight of buckets becomes too heavy to carry them back to home with a pole. In such a case, handcarts or oxcart would be used for carrying much bigger amount of water back to home. “Others” in Figure 1.5.7 includes buying water from venders and assistance of neighbors fetching water for elders. No significant change caused by seasons and income levels is observed.

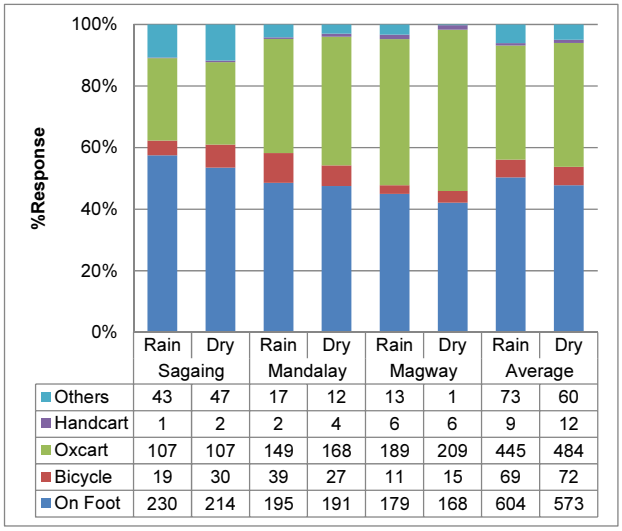


Figure 1.5.7 Means of Water Transportation in Dry and Rain Seasons

Time of fetching water is the sum of travelling between houses to water points and drawing

water at water points (waiting time inclusive). Average time of fetching water and frequency of fetching water is summarized for each region as shown in the Table 1.5.17.

Table 1.5.17 Average Time and Frequency of Fetching Water

Region	Average Time (Minutes)		Average Frequency (Times/day)	
	Rain	Dry	Rain	Dry
Sagaing	14	19	6	7
Mandalay	28	44	5	6
Magway	31	78	4	4

Total time of fetching water per day is calculated to multiple average time by average frequency in each region and season. The result shows that it becomes shortest in Sagaing region (84 minutes) when rain season while longest in Magway region (308 minutes) when dry season. Even though this house chore is shared among family members, it is simply easy to imagine how big this becomes burden certainly for their live Average time of fetching water during a dry season in Magway and Mandalay regions becomes much longer than that in a rain season. It could be assumed that people in these regions fetch water from the nearest water points from their houses during a rain season. However, in a dry season, the quality and quantity of water is deteriorated to be inappropriate for consumption and they are forced to travel much far to other water points where they can obtain clean and safe water. On the other hand, the frequency of fetching water is not changing largely between seasons. Average time of fetching water in each target village is tabulated in Table 1.5.18.

Table 1.5.18 Average Time of Fetching Water in Target Villages

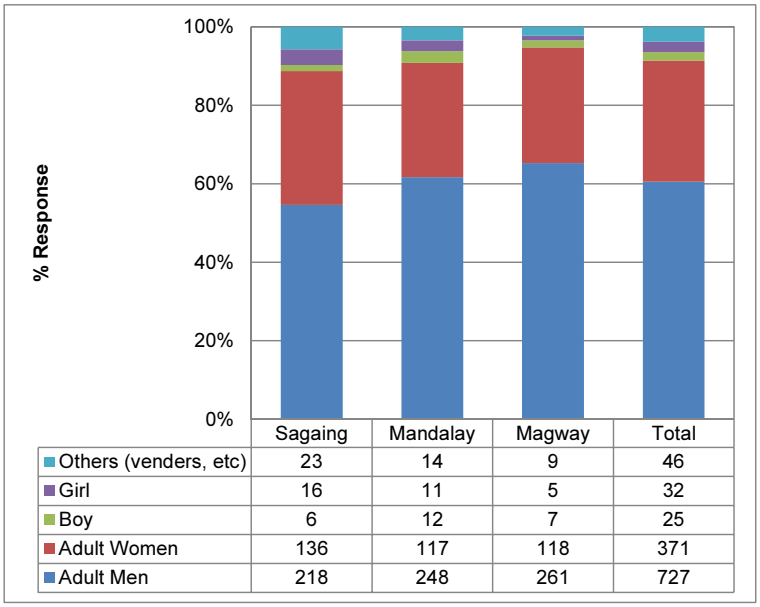
Region	Township	Village	Project ID	Average Time	
				Rain	Dry
Sagaing	Salingyi	Yonepinyoe	SA2-15	5	6
		Kine	SA2-17	28	44
		MinDaw	SA2-16	11	75
	MyinMu	ThaHtayKone	SA2-22	16	12
		HLayOoKan	SA2-19	17	13
		Magyitaw	SA2-23	6	6
		Kalapyan	SA2-18	10	10
		Magyikan	SA2-20	6	6
		Watkya	SA2-21	11	11
	Budalin	MaungHtanng	SA2-03	15	23
		Nyaungbinthar	SA2-02	8	8
		Mhonehtoo	SA2-05	7	8
		Kantawthar	SA2-04	7	7
		Yonedaw	SA2-01	3	4
		Wattuu I	SA2-06	11	10
	ChaungOo	Nat Yay Kan	SA2-08	39	33
		Thann Pin Kan	SA2-07	20	20
	Ayadaw	Zeepinlae	SA2-14	24	16
		Waryaung	SA2-11	10	22
		Yathar	SA2-13	9	7
		Oakkan	SA2-10	36	58
		WarTannKalay	SA2-12	18	42
		Sithar	SA2-09	26	32
	WetLet	Palae Thwe	SA2-37	17	19
		Shwenyaungtaw	SA2-39	6	5
		Sabeitaw	SA2-40	14	19
		Poukkan	SA2-38	19	47
	Kanbalu	Layytwinzin	SA2-32	12	17

Region	Township	Village	Project ID	Average Time	
				Rain	Dry
		Nyaungkanthar	SA2-30	8	10
		Chaungchar	SA2-33	6	4
		Kyaunkone	SA2-26	0	0
		Khnowntar	SA2-29	19	23
		Inngoteto	SA2-27	26	38
		LwinGyi	SA2-25	1	1
		Thindaw	SA2-24	0	0
		Myayhtoo	SA2-28	20	20
		Myaymon	SA2-31	9	10
	Dabayin	Minyogone	SA2-34	5	6
		Kyuntaw	SA2-36	48	44
		Shandaw	SA2-35	9	11
Mandalay	MaHlaing	Khinthar	MA2-03	29	31
		Htantawgy	MA2-01	18	23
		Asone	MA2-02	10	10
	Myingyan	Nyaung Wun	MA2-08	20	19
		Chaysay	MA2-04	26	30
		Yonehto	MA2-07	12	12
		Kuywar	MA2-06	5	5
		Talgyi	MA2-05	16	19
	NgaZon	Kone Le	MA2-09	5	14
		Ywarside	MA2-12	13	24
		Kaungzin	MA2-11	18	18
		Phaung Ka Taw	MA2-10	24	69
	Natogyi	Kyaungkangyibin	MA2-14	32	54
		Kyauknan	MA2-13	16	13
		Nyaunggone	MA2-15	13	16
	Taungtha	Tharzi	MA2-19	41	51
		Kyauk Kar Taung Kone	MA2-18	31	58
		Chaungsone	MA2-17	25	32
		Tharyarmyaing	MA2-21	30	34
		Chaung Nar	MA2-16	59	82
		KanAye	MA2-20	30	42
	Yamethin	Oakpo	MA2-22	19	26
		Kangyi	MA2-23	7	11
	Pyawbwe	Waryonesu	MA2-25	38	37
		Htanekan	MA2-24	24	53
	Naung U	Nyaungpinthar	MA2-33	56	99
		Mongywettaaw	MA2-31	62	146
		Saingkan	MA2-34	70	101
		Tawbyar	MA2-27	54	120
		PhoneKan	MA2-32	22	34
		Kanzauk	MA2-29	55	66
		Setsetyo	MA2-28	25	12
		Byugyi	MA2-35	33	95
		Talbindel	MA2-30	25	22
		Talkone	MA2-26	32	107
	KyaukPadaung	Tangakan	MA2-39	9	13
		Nakyatkhwal	MA2-40	29	86
		Thayattaw	MA2-38	55	50
		Leigyi	MA2-37	7	22
		Aleywar	MA2-36	19	19
a g w a	Magway	Thanbo	MG2-02	57	77

Region	Township	Village	Project ID	Average Time	
				Rain	Dry
		Leikkan	MG2-08	49	72
		Ywarthitgyi	MG2-09	36	47
		Nyaungpinthar	MG2-03	21	29
		Thapyaysan (N)	MG2-06	65	82
		Shwekyaw	MG2-07	31	55
		Natkan	MG2-01	41	56
		Konegyi	MG2-04	37	47
		Sainggya	MG2-05	83	88
	Taungdwingyi	Kangyigone	MG2-37	42	56
		Yayhtwetgyi	MG2-40	48	76
		Hlebwegyi	MG2-39	64	85
		Ko kkohla	MG2-36	10	10
		Htaukkyantgwin	MG2-38	17	19
	Yenangyaung	Lelkyinyoe	MG2-19	25	31
	Myothit	Ayaungmyinthar	MG2-22	38	36
		Laytinesin	MG2-20	14	26
		Tharmyar	MG2-21	44	49
		Ngwelay	MG2-23	38	39
		Indaw(N)	MG2-24	10	230
		Htanaungkwin	MG2-25	10	230
		Manowtgone	MG2-26	10	230
	NatMauk	Sellel	MG2-30	15	60
		Htonepouthchine	MG2-28	22	41
		Kyugyaung	MG2-35	24	66
		Kangyigone	MG2-27	16	62
		Wayonegone	MG2-33	57	81
		Podaukgone	MG2-31	10	230
		Nyaunggone	MG2-34	10	230
		Padaukngote	MG2-29	35	78
		Ywartharlay	MG2-32	45	39
	Chauk	Myaysoon	MG2-11	54	43
		Kanyaygyi	MG2-10	34	48
		Kyatesu	MG2-14	9	26
		Kyatkan	MG2-16	4	58
		Zeenwar	MG2-12	39	64
		Myaynialin	MG2-18	23	151
		Sudat	MG2-17	26	42
		Yenpyay	MG2-13	26	130
		Winkabar	MG2-15	7	9

The average time for fetching water varies from one village to others. Many villages are still spending more than a few hours for fetching water.

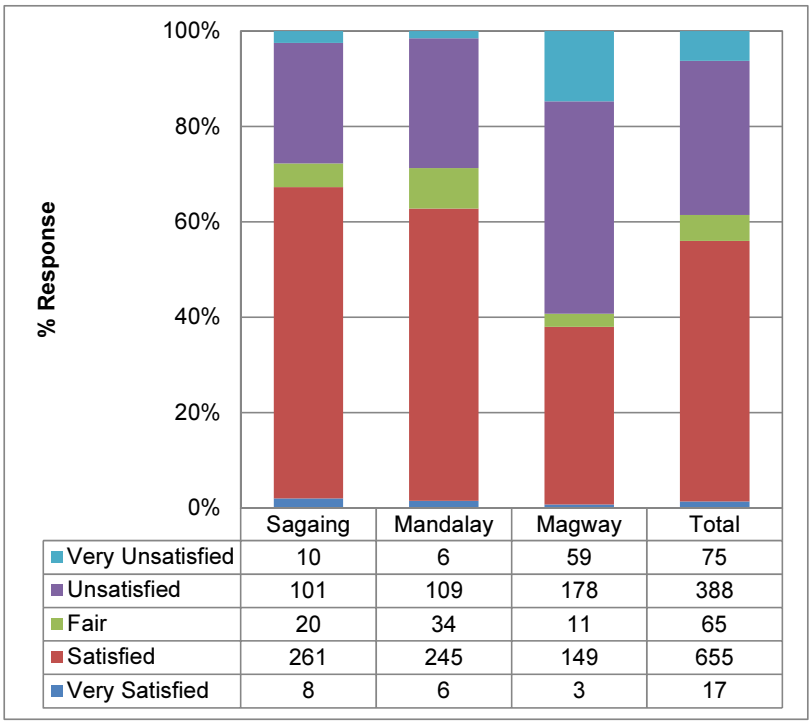
The survey teams questioned members of sample households who would go and fetch water every day. 60 % of total responses indicate that generally adult male are assigned to fetch water for daily use. On the other hand, adult female has 30 % in total. Remaining 10% consists of children and water venders. It is quite obvious that this situation is quite different from that in African countries where children and adult female have major responsibility to fetch water in their households. The result of interview is summarized in Figure 1.5.8.



	Sagaing	Mandalay	Magway	Total
Others (venders, etc)	23	14	9	46
Girl	16	11	5	32
Boy	6	12	7	25
Adult Women	136	117	118	371
Adult Men	218	248	261	727

Figure 1.5.8 Responsible Person for Fetching Water in Households

People as users have various opinions on the service level of existing water supply in their villages. In the interview survey, the teams provided 5 options (very satisfied, satisfied, fair, unsatisfied, very unsatisfied) expressing their satisfaction on the current water services. The result of interview is displayed in Figure 1.5.9.



	Sagaing	Mandalay	Magway	Total
Very Unsatisfied	10	6	59	75
Unsatisfied	101	109	178	388
Fair	20	34	11	65
Satisfied	261	245	149	655
Very Satisfied	8	6	3	17

Figure 1.5.9 Opinions on Current Water Services

Analysing comments gathered during the interview, it was found that there were mainly 4 factors affecting the level of satisfaction among users. They are 1): Water quality adequate for drinking, 2): Constant yield from water points, 3): Distance to water points, 4): Total time for fetching water. It was recognized that these factors might cast equally influences over the level of satisfaction among users. Rating % more than fair in Magway region is 20 % in comparison with the average rating more than fair (around 60%)

At present, people in target villages pay fees for water services from existing facilities. According to the result of the survey, it was revealed that the average amount of water fees in target village was 3.2 kyat/gallon as well as people in sample households perceived current level of water services valued in terms of money to be 3.2 kyat/gallon, which could be understood as the value of their willingness to pay. In Table 1.5.19, current average water fees and value of willingness to pay are summarized in each region.

Table 1.5.19 Current Average Water Fees and Willingness to Pay

Region	Current Water Service	
	Water Fees	Willingness to pay
Sagaing	2.8	3.1
Mandalay	3.5	3.3
Magway	3.2	3.1

Unit: kyat/gallon

In Sagaing region, average water fees in target villages are higher than the amount of their willingness to pay. This could be understood that the level of their satisfaction on the current water services (Ref.: Figure 1.5.9 Opinions on Current Water Services) stimulated their willingness

3) Priority on Development of Social Infrastructure

The interview survey aimed to collect the opinions on the priority on development of social infrastructure from sample households. The result of the interview survey is summarized in Table 1.5.20.

Table 1.5.20 Priority of Development of Social Infrastructure

Development Sector	Sagaing	Mandalay	Magway	Total (% total)
Water Supply	229	318	349	896（75%）
Health & Sanitation	55	19	13	87（7%）
Education (School)	23	10	14	47（4%）
Electricity	87	51	23	161（13%）
Nothing Particular	6	2	1	9（1%）

The development of water supply facilities are prioritized highest of all sample households in target regions. In the second place, the electrification of their communities is subsequently demanded, which might be greatly influenced by recent rapid economic growth of Myanmar. In extracting only opinions from female interviewees, the result will be slightly different from the overall result as shown in Table 1.5.21.

Table 1.5.21 Priority of Development of Social Infrastructure from Women's View

Development Sector	Sagaing	Mandalay	Magway	Total (% total)
Water Supply	39	47	36	122（41%）
Health & Sanitation	28	26	11	65（22%）
Education (School)	26	21	13	60（20%）
Electricity	24	14	8	46（15%）
Nothing Particular	2	3	1	6（2%）

Even from women's view, the development of water supply facilities is the most prioritized issue. However it is, the rates of other priorities such as health & sanitation and education are relatively higher than the overall result (Ref. Table1.5.18 Priority of Development of Social Infrastructure).

4) Women's Participation in Social Activities

The Project paid a special attention during the survey to the position of women in water related issues, who are generally responsible for house chores including cooking, washing, cleaning, and even health care for family. In order to understand their position and situation, special questions customized for women were prepared and employed during the interview survey mainly by female surveyors. Eventually their opinions concerning about water services were effectively collected. The result of the survey is elaborated in the following paragraphs.

Among 1,200 target households, opinions from women were collected from 299 households. On the other hand, the survey team could not collect opinions from 901 households, among which there was no woman in 130 households and women of 771 refused to answer questions because they were too shy as well as afraid to make any wrong answer. During the interview, female surveyors tried their best to encourage these women to give any response upon questions but totally failed. The summary of response in the interview is expressed in Table 1.5.22.

Table 1.5.22 Response from Women of Sample Households

Status		Sagaing	Mandalay	Magway	Total
Answered		119	111	69	299
Not Answered		281	289	331	901
Reason	*Absence*	*42*	36	*52*	*130*
	Refusal	*239*	253	*279*	*771*

(Refusal): because of shyness and hesitation

Although valid responses in this survey were around 25 % of all households, consideration on gender issues shall be discussed based on the results of each analysis elaborated in the following.

Table 1.5.23 indicates the information source accessible by women in the easiest manner. According to the result, it seems that women could obtain the information from nearer places, meaning that their husbands should be the nearest physically and the next is their neighbors. In many cases that women have less opportunity to go out and participate in social activities, their information source tends to be uniform like from their husband only. On the contrary, the result shows that women in target households obtain the information from many sources.

Table 1.5.23 Information Sources for Women

Sources	Sagaing	Mandalay	Magway	Total
Husband	35	31	22	88
Neighbours	32	27	24	83
Relatives	16	9	5	30
Friends	11	17	10	38
Administration	25	27	8	60
Total	119	111	69	299

It could be assumed that women in sample households could obtain the information easily from those whom they meet more often. Remarkably 60 respondents mentioned that they obtained the information directly from township and village administrative offices, which indicates that these women actively participated in social activities.

Furthermore, the survey teams examined how far women could travel alone from their villages and organized this result in Table 1.5.22.

Table 1.5.24 Possible Travel Distance for Woman Alone

Distance	Sagaing	Mandalay	Magway	Total
Within Village	13	11	8	32
Neighboring Village	41	39	23	103
Neighboring Ward	34	32	28	94
Center of Township	31	29	10	70
Total	119	111	69	299

10 % of all respondents acknowledged that they could not travel alone out of their home village. The most frequent answer women responded indicates that 103 women could travel alone up to neighboring village. Similarly, many 94 women expressed that they were allowed to travel alone to neighboring wards. The survey teams inquired women, who answered that they could travel alone only within home village, on the background of their answer. They explained that travelling alone out of home village was not a moral behavior according to their tradition.

Knowing a decision making mechanism in a household clearly helps us to understand how much women are allowed to participate in the process of decision making. In the countryside of African and Asian countries, it could be observed commonly that the position of women in households is relatively low so that only men can make decision in their home. Under such a circumstance, the opinions and demands of women will not be reflected on development plans for their communities. The survey team examined existing mechanisms of decision making in target villages through the interview to sample households. The result of the interview is summarized in Table 1.5.25.

Table 1.5.25 Decision Making Process in Household

Authority	Sagaing	Mandalay	Magway	Total
Only Husband/ Male	27	29	12	68
Only Wife/ Female	21	17	10	48
Couple/ Male & Female	71	65	47	183
Total	119	111	69	299

Interestingly 60 % of total responses indicate that any decision would be made by men and women in households together. In this result, it is understood that men only are not a major authority. 16 % of respondents answered unexpectedly that women only in their households had an authority of decision making.

1.5.4 DISCUSSION

(1) Positive Impact from Implementation of the Project

According to the results of the survey, people in target villages have already been receiving public water services from existing water supply facilities, which satisfy more than half of them. On the other hand, the Project recognized that approximately 30 % of people in target villages feel inconvenience on water quality, quantity and time for fetching water. Furthermore, it was acknowledged that 52 existing water supply facilities, out of total 171 facilities in target villages, extract water from unprotected water sources such as ponds (35 facilities), unprotected dug well (12 facilities), and unprotected spring (5 facilities). As indicated in Table 2.2.3, water from spring and unprotected dug well was not suitable for human consumption due to bacterial pollution.

After implementing the the Project, therefore, it is expected that some of these existing facilities may be abandoned because people in target villages will have new water supply facilities

which extract ground water with consumable quality and not utilize these existing facilities any more in future. Hence, the implementation of the the Project will improve the situation of water supply in target villages in terms of quantity and quality. Eventually this will contribute one of policy directions; "To improve socioeconomic life of rural populace and to narrow down the development gap between urban and rural areas" stipulated in "Current Situation of Rural Water Supply, Target Plan & Limitation" (DRD, August 2013).

(2) Required Arrangements during Implementation of the Project

Based on the current situation of functionality of existing water supply facilities; 171 facilities are functional out of total 175, it could be fair to admit that the operation and maintenance (O&M) of these facilities could be appropriate. However, the establishment of Village Water Committee (VWC) in target villages is not well accomplished. In fact only 60 VWCs (60 villages) are active for managing their water supply facilities. Besides, as it is reported earlier, some of important factors of O&M such as participation of women in VWC and record of financial management are not practiced by most of existing VWCs. This is considered a long term risk of O&M.

Based on the recognition described above, there would be a necessity of close assistance from DRD to target villages on the establishment of VWC during the implementation. For villages already VWCs exist, DRD needs to provide training on technical maintenance and repair as well as the management of finance and operation.

(3) Empowerment of Women in Social Activities

The result of the interview targeting women in target villages clearly describes that there is no situation and/or structure in their communities hindering and obstructing women to participate in social activities. Besides, it seems that the social status of women is almost equal to that of men in consideration with the way how women join a process of decision making for both household and public levels.

For example, according to the statistical year book 2011 (Ministry of Information, 2011), population of women in government officials occupies 52 % in total and 37 % of officials whose position is higher than section chief. Difference between women and men labor force participation rates of Myanmar is just 7 points while that in Japan 21 points according to the world development indicators 2014 (the World Bank, 2014). These facts imply that women's participation in social activities in Myanmar is not bad relatively in Asia.

In fact, when the survey teams visited target villages, we observed many men and women equally carrying water tanks by using oxcarts and poles. A lady interviewed directly by the Project explained that she would not hesitate to claim directly to VWC on the improvement of water supply services and even in village assemblies.

Considering the discussion above, there would be no chance that women in target villages may receive any negative impact or loss against their interest in water supply services when the the Project is implemented in future. However, it is quite recommendable that DRD should install a guideline for establishment of VWC including the obligation of women's participation, which could ensure the sustainable O&M of water supply facilities.

1.5.5 CONCLUSION

It is strongly expected that people in target villages will be able to access clean and safe water from newly constructed water supply facilities quantitatively enough to their demand after the the Project is fully implemented. This will also improve the time of fetching water because new facilities may be constructed within their living areas. This improvement in time will ease one of

burdens households in target villages bear in common. Besides, number of water sources providing portable water will increase so that villagers will optimize their expenditure for water services by selecting appropriate water sources depending on their purposes. This benefit will be shared equally by household in all income levels. Finally it is expected that the impact from the implementation will expand to improve the situation of hygiene and sanitation, furthermore their standard of living.

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 BASIC CONCEPT OF THE PROJECT

2.1.1 PROJECT PURPOSE

The GOM has been developing water sources based on "the Rural Water Supply 10-Year Plan (2000/2001-2010/2011)" and "the Rural Water Supply 5-years Plan (2011/2012-2016/2017)". Up to March 2014, at least one (1) water supply facility (deep well, pond, etc.) was provided in 14,630 villages out of 16,341 villages in the CDZ. On the other hand, it is an issue to supply water by deep wells to about half of the remaining 1,711 villages. Furthermore, development of new water sources is required in some villages where water supply facility already exists to supply sufficient water corresponding to the water demand in the villages.

The "Rural Water Supply Project in the Central Dry Zone (Phase 2)" is included in the second 5-Year Plan. The project aims to strengthen the capacity of DRD's rural water supply by providing the equipment necessary for construction of new deep wells, thereby contributing to improve the access of the people in the CDZ to safe and sustainable water sources.

2.1.2 GENERAL DESCRIPTION OF THE PROJECT

(1) Examination of the Request

The DRD of MLFRD holds jurisdiction of the rural water supply in Myanmar. The DRD initially requested the equipment and materials listed in Table 2.1.1 for the rural water supply project in the CDZ.

Table 2.1.1 Initial Request by the DRD

Item	Number
Truck mounted drilling rig (drilling capacity, more than 300m) and ancillary materials	2 sets
Air compressor	1 set
Cargo truck with crane	2 sets
Consumables for borehole construction (bentonite, CMC, etc.)	1 lot
Submersible pump (with generator and ancillary materials)	120 sets
Casing and screen	For 120 villages

Additional requests were made in the discussion between the DRD and the Study Team. They are:

- Changing the number of air compressor from one (1) to two (2)
- One (1) set of geophysical survey equipment
- Three (3) sets of well logging machines

In addition, the Study Team proposed some equipment to improve the rural water supply.

An air compressor is used by the DRD for installation of casing and screen, development of the well, pumping test by airlifting and rehabilitation of existing wells. In order for effective operation, the DRD requested to add one (1) air compressor. Accordingly, the request of the number of air compressors became two (2) sets instead of one (1) set.

Four (4) air compressors out of seven (7) possessed by the DRD are allocated to the CDZ project office. However, one (1) is already aged and the capacity of another came down due to leakage of oil. Therefore, two (2) air compressors are currently functioning. An air compressor is indispensable for development of wells after completion of drilling and normally allocated to each drilling rig. However, in case of the CDZ project office, two (2) air compressors are supporting six

(6) drilling rigs (five (5) for the CDZ and one (1) for Mandalay region). It is the intention of the DRD to improve this situation.

Only one (1) geophysical survey equipment is functioning. The DRD has carried out siting work for about 70 boreholes every year. The citing work in the CDZ is about 15 sites every year. Since the DRD has a plan to drill more than 200 boreholes during the 5-Year plan, it is required to decide the drilling sites. Therefore, the DRD planned to add one (1) geophysical survey equipment in order to strengthen the siting system.

The well logging machine was not included in the original request by the DRD. Well logging is indispensable to decide well structure (location and length of screen). Therefore, the Study Team proposed and agreed to include the well logging machine in the request.

The DRD will install submersible pumps in the wells after completion of the drilling to abstract groundwater. In such case, it is required to decide pumping yield and specification of submersible pumps properly based on the evaluation of target aquifers. Otherwise, it may cause negative impacts to groundwater such as depletion of water table, drying up of water , ground subsidence, etc. If unnecessarily huge capacity of submersible pump is installed in the well, the running cost will become very high.

The DRD is currently carrying out air-lifting instead of the pumping test by the submersible pump. Correct evaluation of aquifer cannot be done by such method. Therefore, it was agreed to include pumping test equipment in the request. The results of those discussions were reflected in the Minutes of Discussions signed between the DRD and JICA signed on 30 April 2015.

Accordingly, the equipment and materials listed in Table 2.1.2 are examined in the Study.

Table 2.1.2 Request Confirmed by Minutes

Item	Number	Note
Truck mounted drilling rig (drilling capacity, more than 300m) and ancillary materials	2 sets	No alteration
Air compressor	2 sets	Additional request
Cargo truck with crane	2 cars	No alteration
Geophysical survey equipment	1 set	Additional request
Well logging machine	3 sets	Additional request
Consumables for borehole construction (bentonite, CMC, etc.)	1 lot	No alteration
Submersible pump (with generator and ancillary materials)	120 sets	No alteration
Casing and screen	For 120 villages	No alteration
Pumping test equipment	1 lot	Proposed by the Team

The Study Team carried out the field survey after discussion with the DRD. Based on the result of the field survey, the Study Team had a series of discussions with the DRD on the equipment and materials listed in Table 1.2.2 and agreed on the contents of the request as shown in Table 1.2.3.

In the discussion with the CDZ Project Office, spare parts of the existing rigs were requested. However, such spare parts shall be purchased by the DRD's own budget, therefore, the request was not included in the list agreed (Table 2.1.3).

Detailed specification and number of those were examined in the study in Japan.

Table 2.1.3 Request Confirmed after Field Survey

Item	Specification	Number
Truck mounted drilling rig (drilling capacity, more than 300m) and ancillary materials	Drilling capacity: 250m	1 set
	Drilling capacity: 200m	1 set
Air compressor		2 sets
Cargo truck with crane	Pay load: more than 10 ton Lifting load: 5 ton	2 cars
Well logging machine	Measuring depth: 400m	1 set
	Measuring depth: 300m	1 set
Consumables for borehole construction (bentonite, CMC, etc.)		1 lot
Casing and screen		For 110 villages
Pumping test equipment		1 set

As the result of the discussion, the request was modified as shown in Table 2.1.3.

The request for two (2) drilling rigs with drilling capacity more than 300m was changed to one (1) drilling rig capable to drill up to 250m and one (1) drilling rig capable to drill up to 200m. The reasons for changing are as follows.

(1) In the 2nd 5-Year Plan, a total of 59 wells will be drilled by the DRD. However, such number of wells can be drilled by two (2) existing drilling rigs of the DRD (TOP 750HR and TOP 750). Therefore, new drilling rigs capable to drill more than 300m are not required.

(2) A DRD's drilling rig capable to drill up to 250m (TOP 500) declined drilling performance and it cannot be applied to drilling of wells with 250m depth. Therefore, one (1) drilling rig with drilling capacity of 250m is necessary for drilling of 44 wells with up to 250m depth in five (5) years.

(3) Although the DRD will allocate five (5) drilling rigs for the wells within 200m depth, it is not enough to drill 256 wells. Therefore, one drilling rig with drilling capacity is considered.

Regarding the well logging machine, the request was to provide three (3) sets, however, it was changed to two (2) sets. The reasons of the changing are as follows.

(1) Three (3) sets of well logging machines are necessary for the drilling works in the CDZ. Since the DRD has a plan to purchase one (1) set by its own budget, the remaining two (2) sets were requested.

(2) The maximum depth of planned wells in the Project is 400m, therefore, at least one (1) well logging machine shall be capable to measure up to 400m depth.

(3) It is not suitable to measure up to 300m depth by the well logging machine with 400m of cable, because it is too heavy to handle the measurement up to 300m depth.

As for the geophysical survey equipment, it was confirmed that the DRD would purchase one (1) set of geophysical survey equipment, therefore, the request was withdrawn.

Based on the results of the field work, a total of 10 villages were excluded from the target villages. Then, the remaining 110 villages were evaluated based on the results of a geophysical survey and socio-economic survey and 10 villages were excluded from the target villages. Finally, 100 villages remained as the target villages of the Project. The process of this evaluation is described in 1.2.2. The number of the target villages finally became 100 villages (34 villages in Sagaing, 31 villages in Mandalay and 35villages in Magway).

Therefore, the equipment and materials necessary for the Project is summarized in Table 2.1.4.

Table 2.1.4 Equipment and Materials to be considered in the Project

Item	Specification	Number
Truck mounted drilling rig (drilling capacity, more than 300m) and ancillary materials	Drilling capacity: 250m	1 set
	Drilling capacity: 200m	1 set
Air compressor		2 sets
Cargo truck with crane	Pay load: more than 10 ton Lifting load: 5 ton	2 cars
Well logging machine	Measuring depth: 400m	1 set
	Measuring depth: 300m	1 set
Consumables for borehole construction (bentonite, CMC, etc.)		For 100 villages
Casing and screen		For 100 villages
Pumping test equipment		1 set

(2) Target Area of the Study

The Central Dry Zone (CDZ) is distributed over the three (3) areas of Sagaing Region, Mandalay Region and Magway Region which are located in the middle north of Myanmar. The annual precipitation of the CDZ is small, about 100-880mm and is concentrated in the rainy season (May to October). The area is the hottest and driest area.

The Irrawaddy River is the only perennial river, therefore, the rural people are on the storage reservoir and/or dug well. However, these water sources are not clean. In addition, when these water sources are drawn down, the water quality deteriorates and dries up in the dry season. These water sources are unstable and unreliable, therefore, people have to get water from distant water sources in many villages. Therefore, deep well construction is necessary to get permanent water sources in CDZ.

120 villages (40 villages each in the Sagaing Region, Mandalay Region and Magway Region) are requested by the DRD as target villages for the Project. The Priority village selection process by DRD is shown below by the DRD.

(1) Conditions of water supply in the village are discussed in the Township (hereinafter refer to "T/S") Office at the village chief meeting at the end of the fiscal year, and select target villages by considering water availability and hardships.

(2) The T/S office reports the selected target villages to the DRD Regional Office.

(3) The DRD Regional Office reports the targeted villages selected by the T/S Offices to the DRD Head office.

The Study team carried out a village reconnaissance survey covering the requested 120 villages aiming at grasping the location, population and situation of existing water sources, topography, geology and the proposed location of the new deep wells in the villages. The results were used to decide the priority of the 120 villages as the 1st screening (Evaluation of Step 1).

Due to the site survey, the total of 23 villages out of 120 villages, namely five (5) villages in the Sagaing Region, eleven (11) villages in the Mandalay Region and seven (7) villages in the Magway Region, have been changed and, four (4) have been replaced.

The main reason for changing the target villages is that the DRD has already finished well construction for these three (3) years after preparation of the requested village list.

The flow chart of the process of narrowing down the target villages is shown in Figure 2.1.1. The evaluation of each step is described below.

As result of the evaluation, the number of the target village became 100, the list of the villages is shown in Table 2.1.7.

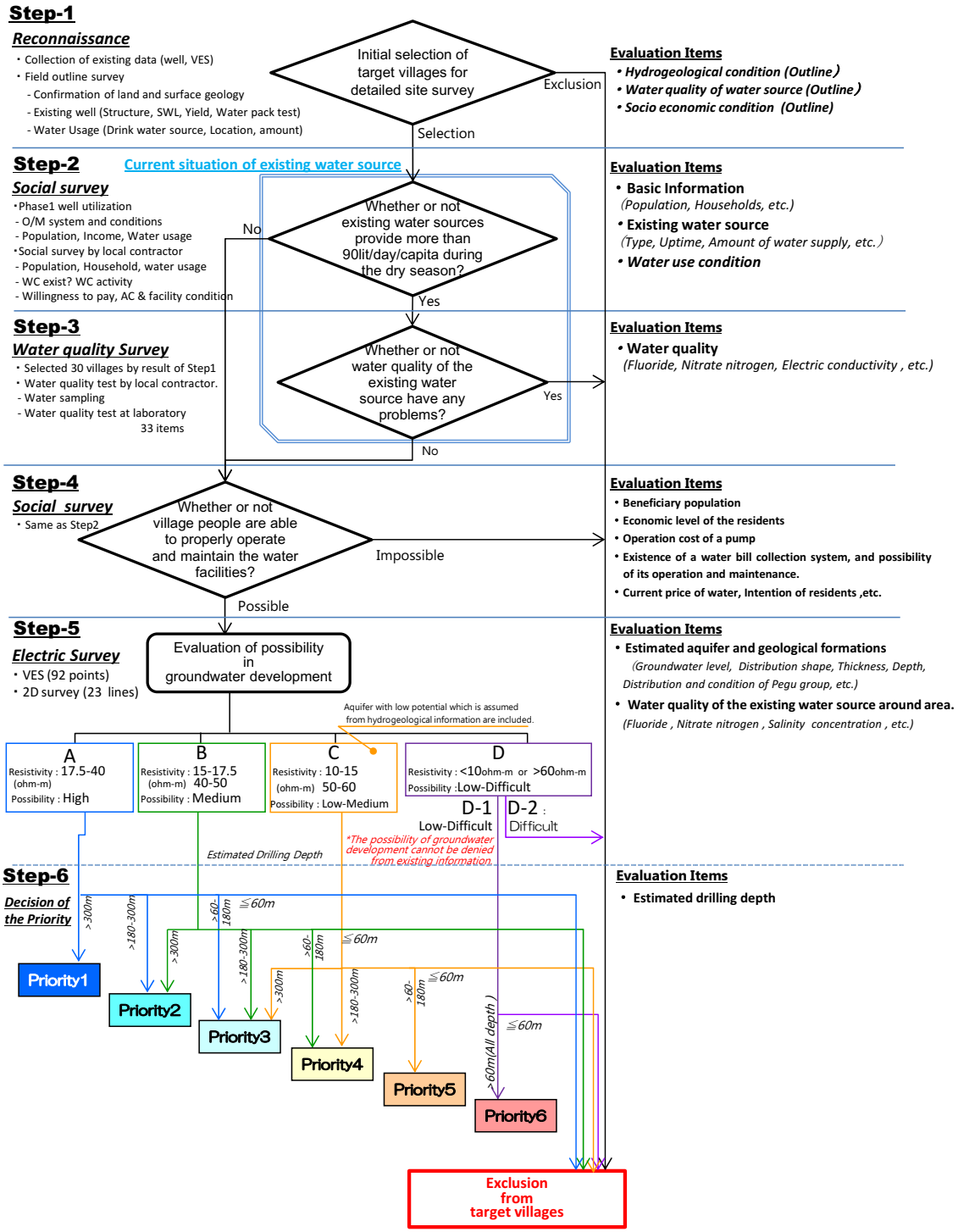


Figure 2.1.1 Narrow Down Flow Chart for Evaluation of Target Villages

1) Evaluation of Step 1

Villages were evaluated by hydrogeological conditions, water quality of water source and water usage conditions. The villages in which groundwater development is considered to be difficult or new water source construction is considered not necessary because water source development has been done after submission of the list of the target villages, were evaluated as [x]. As a result, 10 villages were excluded from the target villages. Meanwhile, the villages

considered as a promising villages are evaluated as [○] and the villages that need more information for consideration are evaluated as [△]. The remaining 110 villages were intended for the next step.

2) Evaluation of Step 2

Existing water sources and the water usage of target villages were evaluated by utilizing the results of the social condition survey. According to the results of the survey, every village did not have sufficient water for 20 gallon/capita/day targeted by the DRD. No village was excluded by the social condition survey. According to the results of the survey, every village uses water of 20 gallon/capita/day. However, every village uses many dug wells and shallow wells which are easy contaminated. Therefore, they did not have sufficient hygienic water for 20 gallon/capita/day targeted by the DRD, and evaluated that new water development is necessary.

3) Evaluation of Step 3

The evaluation of the appropriateness of the water source was carried out by the field water quality measurement.

Based on the result of the field water quality measurement, 30 villages which have a high value of Fluoride and Iron contents were selected as the target of the detailed water quality analysis in the laboratory. There is no village which has a substance exceeding drinking water standard like Fluoride and Arsenic that leads to serious health damage (refer to Appendix 5.3.1: Results of Field Water Quality Measurement).

4) Evaluation of Step 4

Sustainability of the operation and maintenance for a water supply facility to be constructed was evaluated from the view points of socio-economic activity, leadership structure and the socio-economic condition of households. According to the results of the socio-economic survey, over 50% villages have deep wells (majority is airlift system), and 98 % of existing water supply facilities are working. In addition, the proportion of O/M cost (water cost) against the average of family income is less than 5% in 80% of target villages. The priority of water development project is enormously high, therefore, it was considered that the water fee will be paid by priority. It is shown that people are maintaining water facilities by themselves as public facilities such as monastery and school, with or without the water management committee. Therefore, all villages were evaluated to have a high ability for the operation and maintenance of the water supply facility to be constructed including water tariff collection. Therefore, no village was excluded from the target of the Project. A summary of the socio-economic survey is shown as Appendix 5.7.

5) Evaluation of Step 5

Geophysical surveys (VES, 2D) were carried out for 110 villages selected in the Step 1 evaluation. Based on the results of the geophysical surveys, the possibility of groundwater development was evaluated.

Villages were evaluated A, B, C, D-1 and D-2 in descending order from the view point of possibility of groundwater development. Although Class D is a very difficult site to develop good groundwater, some villages have the undeniable possibility of groundwater development judging from electric conductivity (EC) of existing wells which shows the water seems to be drinkable, and such villages were classified as D-1. Finally 11 villages were evaluated as D-2 and were excluded from the target of the Project.

In this step, one (1) village (MA2-07 Yonehto) in Mandalay Region which was excluded in the first step was restored because the layer in which resistivity is 18.5 ohm-m (Evaluated in [A]

in Step 5) below 135m as a potential village for groundwater development after reanalyzing the data.

The result of the Step 5 is summarized in village evaluation shown in Appendix 5.4.

6) Evaluation of Step 6

The Project is procurement of the drilling equipment. Drilling of deep wells will be done by the DRD drilling teams, therefore, the villages with high possibility of groundwater development are given high priority. On the other hand, deeper well construction requires high drilling technique, therefore villages that need deeper well drilling are also given high priority.

Criteria, drilling depth, is divided into four (4) classes: "301 - 400m", "181 – 300m", "61 - 180m" and "60m or less". Wells of which depth is 60m or less are not categorized as deep wells according to the DRD standard, therefore they are out of the target of the Project. Using the classification determined in Step 5 and Step 6, the drilling priority was decided. Drilling priority is set higher as the sum of both scores is small.

In addition, villages categorized as D-1 in Step 5 have a very low possibility of groundwater development, and are classified "Priority 6" (Table 2.1.5).

Table 2.1.5 Priority Matrix

Electric Survey (Step 5) / Drilling Depth (Step 6)	Possibility of Successful Well Construction				
	A (1) High	B (2) Middle	C (3) Middle -low	D-1 Low - difficult	D-2 Difficult
More than 300m (1)	(2) Priority 1	(3) Priority 2	(4) Priority 3	Priority 6	Out of the Project
Less than 300m to More than180m (2)	(3) Priority 2	(4) Priority 3	(5) Priority 4		
Less than 180m to More than 60m (3)	(4) Priority 3	(5) Priority 4	(6) Priority 5		
Less than 60m	Out of the Project				

Note：Parenthetic number is the score

From the above results, the number of target villages of the Project was 100. The list of these 100 villages is shown in Table.2.1.6. A list of the requested 120 villages and the results of the evaluation are shown in Appendix 5.2.3. Reasons of exclusion of 10 village excluded in the Step 1 are shown in Table 2.1.7.

Table 2.1.6 List of Target Villages (100 Villages) (1/2)

Region	Township	ID	Villages	Population	Priority	Coordinate (WGS 84 UTM46N)	
						X	Y
Sagaing	Budalin	SA2-01	Yonedaw	369	5	721184	2468685
		SA2-02	Nyaungbinthar	223	3	720885	2486381
		SA2-03	Maunghtaung	5600	4	712894	2487822
		SA2-04	Kantawthar	420	5	704295	2487734
		SA2-05	Mhonehtoo	172	3	729874	2471014
		SA2-06	Watluu-I	768	5	700719	2482574
	Chaungoo	SA2-07	Thanbinkan	935	3	742454	2430400
		SA2-08	Natyaygan	809	3	743821	2426594
	Ayadaw	SA2-09	Sithar	420	3	742840	2472680
		SA2-10	Oakkan	800	4	747838	2482552
		SA2-11	Warryaung	4500	2	748170	2458383
		SA2-12	Warrtannkalay	750	5	750823	2470044
		SA2-14	Zeepinlel	1897	5	751516	2457534
	Salingyi	SA2-16	Minntaw	1071	4	712670	2428751
		SA2-17	Kine	305	6	711640	2437561

Region	Township	ID	Villages	Population	Priority	Coordinate (WGS 84 UTM46N)	
						X	Y
	Myinmu	SA2-18	Kalarpyan	385	2	749957	2422670
		SA2-19	Hlayookan	580	4	758107	2439343
		SA2-21	Watkya	748	4	745604	2447822
		SA2-22	Thahtaykone(Ywarma)	410	5	747673	2446221
	Kanbalu	SA2-24	Thindaw	817	3	773385	2613108
		SA2-25	Lwingyi	499	3	772013	2612839
		SA2-26	Koetaungboh (Kyunkone)	1171	4	773590	2620729
		SA2-27	Inngoteto	1278	5	768388	2598038
		SA2-28	Myayhtoo	1184	6	745839	2565464
		SA2-29	Khaowntar	1004	4	776585	2551429
		SA2-30	Nyuangkanthar	539	5	770771	2597741
		SA2-31	Myaymon	2527	3	785110	2544263
		SA2-32	Layytwinzin	714	4	800148	2549708
		SA2-33	Chaungchar	513	3	762397	2587371
	Dabayin	SA2-34	Minyogone	410	5	731866	2513234
		SA2-35	Shandaw	384	4	725913	2501505
		SA2-36	Kyuntaw (S)	434	5	728632	2505189
	Wetlet	SA2-37	PalaeThwe (Ywarthit)	298	3	798805	2492481
		SA2-38	Poukkan	1159	6	796554	2461964
Mandalay	Mahlaing	MA2-01	Htantawgyi	550	5	766932	2339178
		MA2-02	Asone	650	4	769110	2329262
		MA2-03	Khinthar(S)	480	4	782257	2317158
	Myingyan	MA2-04	Chaysay	1412	3	752986	2368995
		MA2-05	Talgyi	830	5	758871	2404696
		MA2-07	Yonehto	850	3	762363	2384258
	Ngazon	MA2-11	Kaungzin	864	4	765082	2403595
	Natogyi	MA2-14	Kyaungkangyibin	435	4	757284	2368820
		MA2-15	Nyaunggone	689	5	772284	2368730
	Taungtha	MA2-17	Chaungsone(La)	800	3	735423	2354667
		MA2-19	Tharzi	950	4	740022	2346931
		MA2-20	Kanaye	1150	4	740499	2349032
		MA2-21	Tharyarmyaing	2200	3	745680	2342452
	Yamethin	MA2-22	Oakpo	1660	4	826577	2270843
		MA2-23	Kangyi	1520	3	828701	2246082
	Pyawbwe	MA2-24	Htanekan	807	4	804392	2275367
		MA2-25	Waryonesu	797	1	804775	2275467
	Nyaungoo	MA2-26	Talkone	320	2	721219	2347331
		MA2-27	Tawbyar	360	3	726336	2345860
		MA2-28	Setsetyo	840	1	721783	2329618
		MA2-29	Kanzauk	565	2	709761	2328732
		MA2-30	Talbindel	523	2	719609	2332361
		MA2-31	Mongywettaw	365	2	724266	2337196
		MA2-32	Phoenekan	394	5	702946	2332978
		MA2-33	Nyaungbinthar	314	2	712986	2322241
		MA2-34	Saingkan(Tetide)	331	1	724241	2328758
		MA2-35	Byugyi	1804	1	724225	2325295
	Kyaukpadaung	MA2-36	Aleywar-2	1098	2	718698	2309611
		MA2-38	Lelgyi(Ma)	1279	3	734592	2325518
		MA2-39	Thayattaw	725	3	729386	2325074
		MA2-40	Nakyatkhwal	(4790)	2	719979	2312255
Magway	Magway	MG2-01	Natkan	1244	3	706558	2233838
		MG2-02	Thanbo(Ywarthit)	280	5	716115	2216165
		MG2-03	Nyaungbinthar	1535	2	737905	2244038
		MG2-04	Konegyi	1090	2	718609	2237658
		MG2-05	Sainggya	2300	3	725131	2213520
		MG2-06	Thapyaysan(N)	250	2	712474	2227465
		MG2-07	Shwekyaw	388	2	733927	2207547
		MG2-08	Leikkan	1115	3	726925	2239708
		MG2-09	Ywarthitgyi	1805	3	722085	2237683

Region	Township	ID	Villages	Population	Priority	Coordinate (WGS 84 UTM46N)	
						X	Y
	Chauk	MG2-10	Kanyaygyi	1239	3	702708	2281908
		MG2-11	Myaysoon (Ywarthit)	319	2	698121	2277376
		MG2-12	Zeebwar	1027	4	711611	2298972
		MG2-13	Yenpyay	280	3	691309	2301533
		MG2-14	Kyatesu(N)	740	3	685590	2292806
		MG2-15	Winkabar	2420	3	684440	2287269
		MG2-16	Kyatkan	478	3	685497	2292703
		MG2-17	Sudat	560	1	706642	2285676
		MG2-18	Myaynilain	253	3	698822	2287055
	Yenangyaung	MG2-19	Legyinyo	1637	2	724077	2266805
	Myothit	MG2-20	Laytinesin(S)	3299	2	732775	2236056
		MG2-21	Tharmyar	3700	2	736194	2241244
		MG2-22	Aungmyinthar	1150	5	733076	2231654
		MG2-23	Ngwelay	1237	4	738867	2222539
		MG2-24	Indaw(N)	530	5	742532	2229825
		MG2-26	Manawtgone	930	3	732003	2222326
	Natmauk	MG2-27	Kangyigone	360	2	742461	2259232
		MG2-28	Htonepoutchine	2018	4	730959	2255653
		MG2-33	Wayonegone	950	5	735749	2267902
		MG2-34	Nyaunggone	1814	3	732682	2256118
		MG2-35	Kyugyaung	550	3	744568	2259272
	Taungdwingyi	MG2-36	Kokkohla	860	6	765819	2218655
		MG2-37	Kangyigone	1099	4	762556	2192933
		MG2-38	Htaukkyantgwin	1052	1	772105	2184938
		MG2-39	Hlebwegyi	1988	2	747939	2200787
		MG2-40	Yayhtwetgyi	662	3	743110	2197239

Table 2.1.7 Reasons for Exclusion of 10 Villages

Region	T/S	Village	Reason
Sagaing	Myinmu	Makyeekan (SA2-20)	Water is distributed from a elevated tank to each household. The villager explained water is enough and no further water supply facility is necessary.。
Mandalay	Myingyan	Yonehto (MA2-07)	Groundwater quality in Pegu formation is generally bad. Water quality of a well (depth: 200m) drilled in 2014 shows EC 7,960 µS/cm. It is hydrogeologically thought difficult to get good quality of groundwater even if new well is drilled. The village is supplied enough water from springs located down stream of a dam.
	Ngazon	Konelel (MA2-09)	The village is located in the distribution area of Pegu formation. Both dug wells and tube wells are yielding high salinity of groundwater. A 128m of tube well was drilled by DDA. But it is not used due to bad quality of groundwater. It is thought difficult to get good quality of groundwater even if new well is drilled. Measured EC value: Dug Well: more than 6,000 µS/cm Tube Well (Depth: 61m): 6,360 µS/cm
		Phaungkadaw (MA2-10)	The village is located in the distribution area of Pegu formation. Three (3) tube wells were drilled. But water quality was bad. EC of a deep well (Depth: 200m) shows 6,470 µS/cm It is hydrogeologically thought difficult to get good quality of groundwater even if new well is drilled. The village is currently supplied by seven (7) dyg wells.

Region	T/S	Village	Reason
	Natogyi	Kyaungnan (MG2-13)	The village is located in the distribution area of Pegu formation. There is a deep well (Depth: 78m) of which EC is 11,8000 μS/cm. It is hydrogeologically thought difficult to get good quality of groundwater even if new well is drilled. Construction of a water supply facility is now going on in an adjacent village. The village is supplied the water from this facility even if quantity is not enough.
		Ywarsite (MA2-17)	The village is located in the distribution area of Pegu formation. There are two (2) deep wells of which depth are 97m and 213m. Both wells show high salinity. The well (213m depth) shows EC 11,680 μS/cm. Even if a new well is drilled more than 213m, it is difficult to get good quality of groundwater.
	Kyaupadang	Tangakan	In the village, Irawaddy formation distributes. But it is underlain by volcanic rock. According to the existing data, the village is located in a zone where Iron content is very high (Fe: 3-10mg/L). It is hydrogeologically thought difficult to get good quality of groundwater even if new well is drilled.
Magway	Myothit	Htanaungkwin (MG2-25)	The village is locates very close to the mountain where Pegu formation distributes. Therefore, Pegu formation distributes very shallow from the ground surface. Although about 30 wells were drilled in Pfgu formation, all the wells were dried up. It is hydrogeologically thought difficult to get good quality of groundwater even if new well is drilled.
	Natmauk	Padaukngote (Ywargyi) (MG2-29)	DRD drilled two (2) deep wells (Depth: 150m and 173m). However, both wells were dry. A well was drilled up to 183m by WRUD. The groundwater of the well shows EC 2,950 μS/cm and smell of iron. It is hydrogeologically thought difficult to get good quality of groundwater even if new well is drilled.
		Padaulkgone (MG2-31)	Groundwater of dug wells show high salinity. The rock formation which include stiffly consolidated nodules. It seems impossible to drill this rock by the rotary drilling machine.

2.2 OUTLINE DESIGN OF THE JAPANESE ASSISTANCE

2.2.1 DESIGN POLICY

(1) Basic Policy

The basic policy on the design in the Project is as described below. The appropriate scale and specifications are decided as the equipment procurement project for the DRD.

1) Among the requested equipment such as drilling rigs and related tools and materials, the well logging equipment and supporting vehicles, equipment of which the verification has been confirmed.

2) A set of pumping test equipment will be included in the procurement plan, because of the necessity for improvement of the future rural water supply project by the DRD.

3) Technical transfer (soft component) is planned on the method and analysis of the pumping test and well logging using the procured equipment.

(2) Policy against Natural Conditions

In Myanmar, recently, a possibility of groundwater contamination by arsenic and heavy metals has been pointed out in certain areas. Therefore, the target villages should be selected carefully after examination of the possibility of groundwater contamination. The villages with a high possibility to exploit good quality groundwater will be selected.

In the target area, there are many unpaved roads in the rural areas, which is almost the same condition as Phase 1. The condition of those roads worsens after rains, so the driving system is planned to be an all-wheel-drive or four-wheel-drive. The target area is less than 1,000 m in altitude, therefore high altitude specifications shall not be applied for the equipment.

(3) Policy against Socio-Economic Conditions

The study team confirmed that Myanmar had been shifting in well construction policy from one well for one village to the number of wells according to the demand by village population and there were some villages where the piped water supply system was constructed by their own expense. The well design constructed in the Project should secure extensibility in accordance with future demand and be able to carry out a pumping test that is important to decide well capacity in order to consider such an extension. Additionally, the equipment and materials should be planned for the villagers to operate and maintain without any difficulties.

(4) Policy for Procurement

Drilling rigs and related equipment are not manufactured locally. Though several local pipe manufacturers produce certain sizes of steel pipes, they cannot supply the appropriate class of steel pipes for the wells constructed by the Project. Such equipment is procured from proper manufacturers having suitable after-sales service system and superiority of specifications and performance for the planned well structures and drilling method.

There are agencies of Japanese or other country's manufacturers for submersible pumps, generators and air compressors, which have dealt with providing some products to the DRD. The products consistent with the existing equipment in the DRD should be selected to be able to use the existing handling tools.

Equipment for the Project will be procured in Myanmar, Japan or third countries for aspects of effective procurement processes, O&M and price.

(5) Policy of Operation and Maintenance

The equipment to be procured in the Project shall be properly and sustainably operated and maintained by the DRD. Therefore, equipment supported by local agents in Myanmar was selected so that spare parts and after-sale service will be readily available. In addition, taking into consideration sustainable operation and maintenance by the villagers, the equipment and materials for well construction which is supported by local agents in Myanmar were selected to ensure that spare parts supply and after-sale service are available as needed. In addition, an operation guidance plan and a soft component (technical assistance) plan will be carried out to operate and maintain properly for the DRD staff. Technical assistance aims at strengthening of the capacity of the DRD staff on the well logging and pumping test which are important to complete the well construction and to evaluate well capacity.

(6) Policy on Equipment Grade

Appropriate well structure is designed corresponding to their uses, drilling diameters and hydrogeological conditions. In order to achieve Phase 2 project successfully, suitable drilling rigs to drill a borehole with a depth according the hydrogeological conditions have been selected. Equipment for water supply such as submersible pumps and generators are also selected depending on the assumed depth and total dynamic head (hereinafter referred to as "TDH").

(7) Policy on Procurement Plan and Period

The new equipment shall be procured in the Project on the premise that Japanese companies will be selected through general competitive bidding based on the policy of Japanese Grant Aid. Regarding the schedule of the Project, the term of work was formulated considering the period of equipment manufacturing, transportation, training, equipment inspection and other procedures.

(8) Applied Standards

The standards to be applied are ISO, BS, API, DIN, ASTM, JCS, JEC, JEM and JIS.

2.2.2 BASIC PLAN (EQUIPMENT PLAN)

(1) Basic Plan

1) Equipment to be Supplied

The equipment to be supplied in the Project is as described below, which was agreed with the Myanmar side after discussion based on the result of our field survey.

- Two drilling rigs and accessories with a capacity of 200 m and 250 m deep borehole drilling
- Cargo trucks with crane
- Well logging machines to distinguish aquifers
- A set of equipment for pumping tests using a submersible pump
- Submersible pumps and generators to install boreholes
- Casing and screen pipes and consumable goods for well drilling
- Technical assistance (soft component) to improve the capacity of analysis of the pumping test and well logging

2) Target Areas

Target villages are 100 villages distributing in Sagaing, Mandalay and Magway Regions.

3) Project Term

The drilling rigs procured by this Project will start working in 2017 and the Project will end in 2022.

4) Screen Length and Drilling Depth

The screen length and drilling depth are determined for the target 100 villages of the Project using the resistivity of formations obtained by analyzing the geophysical survey results and the existing well data owned by the DRD. Detailed determination results are summarized in Appendix 5.4 Evaluation of Villages (Step5).

Criteria for determination of screen length and drilling depth are as follows.

(i) Screen Length

The screen length installed in the wells drilled by the DRD is 12m (6m x 2 pieces) and 18m (6m x 3 pieces). Same length is applied in the Project. Criteria for determination of screen length is shown in Table 2.2.1.

Difference of the screen length depends on the facies of aquifers which reflect the groundwater yield potential. For example, if the aquifer contains silty material, the groundwater potential will become relatively low. In such case, the screen length will be 18m to collect more groundwater than 12m length of screen.

Considering this condition, the screen length are selected 12m for the villages evaluated as high to moderate, 18m for the villages evaluated as low to moderate from view point of groundwater potential. Relation between resistivity and screen length is shown in Table 2.2.1.

Table 2.2.1 Relation between Resistivity and Screen Length

Estimated Screen Length	Groundwater Potential	Range of Resistivity	Number of well	Accumulated Ratio	Evaluation
18m	C	10.0 - 15.0	28	229%	Low resistivity suggests existence of silt to fine sand and low groundwater potential.
	C	16.5 - 56.2	9	39%	Groundwater potential is assumed low based on the data of existing well.
	B	15.0 - 17.5	8	47%	Groundwater potential is high but fine materials are highly contained.
12m	A	17.5 - 20.0	12	60%	Groundwater potential is evaluated high.
		20.0 – 30.0	21	82%	
	B	30.0 – 40.0	11	94%	
		40.0 – 50.0	6	100%	Porosity may be reduced due to consolidation.

(ii) Drilling Depth

Drilling depth and the screen length were determined following the flow shown in Figure 2.2.1. Reasoning of the determination of drilling depth is as follows.

i) In case there is an existing well(s) around the village and no problem on the water quantity and quality>

If the actual drilling depth is deeper or shallower than the proper depth, inadequate yield of groundwater or worsening of water quality are anticipate. Therefore, the drilling depth is determined as same as that of the existing wells/

ii) In case there is an existing well(s) around the village but yield of groundwater is low>

It is necessary to collect groundwater as much as possible from all the section of the aquifer if groundwater yield is extremely low. Therefore, the well is planned to drill up to the bottom of the aquifer judging from the result of geophysical survey.

iii) In case there is an existing well(s) around the village but it was confirmed that yield of groundwater is low or water quality is bad>

The target aquifer is selected upper or lower part of the formation from which the existing well is extracting groundwater. The drilling depth is determined considering the resistivity of the formation.

The drilling depth is determined by using the formula below.

(drilling depth) = (depth to the top of the aquifer) + (screen length (12m or 18m)) + (sand trap (6m)) + (allowance (10m))

iv) In case there is no existing well around the village>

The formula above is applied to determine the drilling depth.

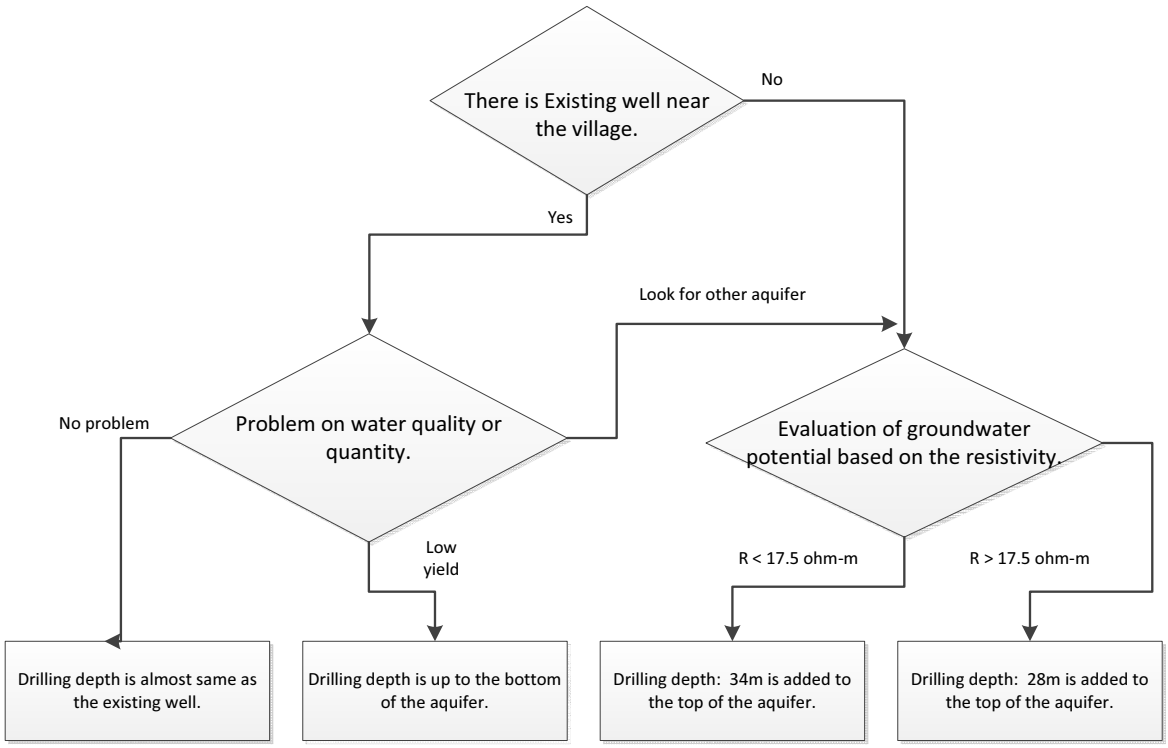


Figure 2.2.1 Flow for Determination of Drilling Depth and Screen Length

(2) Basic Equipment Plan

1) Truck Mounted Drilling Rig

(i) Borehole Depth and Drilling Method

The borehole depth to be drilled was estimated based on the result of the field survey and it is summarized in Table 2.2.2. The maximum drilling depth is 390 m and the average depth of the all boreholes is 201.3m.

Table 2.2.2 Borehole Depth (100 wells)

Drilling Depth (m)	Numbers (well)
301～400	10
251～300	13
201～250	15
151～200	31
101～150	26
60～100	5
Total	100

The DRD employs the Down-the-Hole hammer (DTH) drilling method in some parts of the mountainous area in Shan State where super hard rocks are distributed, but most of the other areas have been developed using the Mud Rotary drilling method which can be applied in a wide range of geological circumstances, namely unconsolidated formation to moderately hard formation. Using this method, a well is drilled by applying rotational force and pressure to the edge of the bit through the drill strings, and circulating fluid (water or mud) is carried by the water pump to cool the bit and remove the drilling sludge. Mud Rotary has been applied generally in the Central Dry Zone and has resulted in success without problems. In the Project,

Mud Rotary is employed since the field survey results show that the target area consists mostly of an unconsolidated to moderately consolidated layer where super-hard rock is not expected

(ii) Necessity of Procurement and Quantity

i) Second 5-Year Plan

The DRD is planning to drill 580 boreholes in the whole country except the CDZ, and 717 boreholes in the CDZ during the second 5-Year Plan. According to the DRD, half of the 717 boreholes, namely 358 boreholes, can be expected to be drilled by local contractors. Consequently, the remaining 359 boreholes, which consist of 138 in Sagaing, 90 in Mandalay and 131 in Magway, shall be drilled by the DRD in the CDZ.

Based on the results of the field survey, the depth of these 359 boreholes were assumed as shown in Table 2.2.3. For detail, refer to Annex 5.

Table 2.2.3 Distribution of the depth of the boreholes in the second 5-year plan

	Less than 200m	201 - 250m	251 - 300m	301 - 400m	Total
Sagaing	127	4	7	0	138
Mandalay	44	19	14	14	90
Magway	85	21	14	10	131
Total	256	44	35	24	359
Rig to be Applied	200m class Drilling Rig	250m class Drilling Rig	More than 250m class Drilling Rig		

ii) Applied Plan of Drilling Rigs

To complete the drilling of 359 boreholes, DRD will use their own five existing drilling rigs and two new drilling rigs, which have been requested for the Project by DRD, that is, a total of seven drilling rigs.

Existing Rigs	TOP300	3 sets	: appropriate for boreholes less than 200 m
	TOP750 (HR)	2sets	: appropriate for boreholes more than 250 m
New Rigs	250m-class rig	1set	: appropriate for boreholes 200 – 250 m
	200m-class rig	1set	: appropriate for boreholes less than 200 m

Table 2.3.4 indicates the number of boreholes to be drilled in the CDZ and the practical drilling number of boreholes by the DRD using the existing rigs for the Project (See Annex 5).

Table 2.2.4 Number of Boreholes to be Drilled and Practical Drilling Number of Boreholes

Drilling Depth	Applicable Rigs	Boreholes to be drilled	Practical drilling numbers of boreholes	Remaining undrilled boreholes
60-200m	TOP300 3 sets	256	88	168
201-250m	None of Rigs	44	0	44
251-400m	TOP750(HR) 2sets	59	59	0

If the DRD drills boreholes with a depth of less than 200 m using the existing three rigs, the drilling of 168 boreholes cannot be completed during the Project. A new drilling rig will be necessary to accomplish the drilling work of boreholes with a depth of less than 200 m.

A 250 m class drilling rig should be used for drilling of boreholes with a depth from 201 to 250 m. The DRD has a rig of TOP500 type which was originally suitable to drill up to 250 m. However, after repairing its hydraulic system, the rig can drill up to only about 150m. It means

that DRD does not have any suitable rig for drilling up to 250 m. An additional new rig is necessary for 201-250 m drilling.

Two (2) sets of TOP750 (HR) type rigs can be applied to drill to more than 250m. There are 59 boreholes to be drilled to more than 250 m. Since the two rigs can drill 59 boreholes during 5 years, the plan will be achieved in the term. An additional rig of the TOP750 type is not necessary.

Consequently, the required rigs to accomplish the drilling work in the the Project are a 200m-class rig which is used for boreholes with a depth of less than 200 m, and 250 m-class rig which is used for boreholes with a depth of 201-250m.

When a new rig of 250 m class is procured, it can drill 46 boreholes in five years. 44 boreholes are planned to be drilled in the Project, and the target will be accomplished. A new rig of 200 m class can also drill 46 boreholes in five years.

The Project includes 58 boreholes in which the drilling depth is expected to be less than 200 m. Normally, the DRD contracts out sub-contractors to drill these relatively shallow boreholes. Since hard rock occurs in the areas where these 58 boreholes are located, it is difficult to complete the drilling work by local contractors. Therefore, the DRD requested to include these boreholes in the Project, and it was acceptable.

A truck mounted rig with a drilling capacity up to 250 m and a truck mounted rig with a drilling capacity up to 200 m should be procured.

(iii) Specifications

i) Drilling Rig

Priority will be given to the maximum weight of the drill strings and casing pipes, which are technical components used to select the specifications of the drilling rig. The weight of drill strings and casing pipes is related to the capacity of pull-down and draw-works of the drilling rig. These are estimated from the casing program and drilling schedule, formulated from the prediction of hydrogeology which is based on the result of the geological survey.

Two (2) sets of Drilling rig are proposed to be procured in the Project as described above. One is for 250 m boreholes, and the other one is for 200 m boreholes.

The maximum weight of drill strings for a 250 m deep borehole is estimated to be approximately 9,000 to 10,000 kg. The 6 inch casing pipes weigh around 7,000 kg at 250 m (Table 2.2.5). Similarly, the maximum weight to drill 200 m deep is estimated around 6,000 to 7,000 kg and the casing pipes weigh around 5,600 kg.

Table 2.2.5 Weight of Drill Strings and Casing Pipes

Item	Length (m)	Weight/m (kg)	Total weight (kg)
Drill pipe (4-1/2")	252	26	6,552
Drill collar	12	160	1,920
Drill bit, sub, etc.			About 1,000
Casing pipe	250	27.7	6,925

Two (2) types of drilling rigs will be selected with a drilling capacity of 200 m and 250 m, and each depth shall be drilled with a 4-1/2 inch drill pipe. Both drilling rigs will have expansive work areas and, therefore, shall be truck mounted rigs (6×6 or 6×4). Table 2.2.6 and 2.2.7 show the outline specifications of the drilling rigs.

Table 2.2.6 Major Specifications of Rig with Drilling Capacity of 250m

Item	Specifications
Drilling capacity	The rig shall be capable to drill up to 250 m depth with minimum 4-1/2" outer diameter drill pipes (borehole diameter is 10-5/8").
Hold-back	At least 10,000 kg
Draw-works	At least 4,000 kg with single line
Mud pump	At least 1000 L/min discharge rate
Truck	6 x 4, left-hand drive

Table 2.2.7 Major Specifications of Rig with Drilling Capacity of 200m

Item	Specifications
Drilling capacity	The rig shall be capable to drill up to 200 m depth with minimum 4-1/2" outer diameter drill pipes (borehole diameter is 10-5/8").
Hold-back	At least 7,000 kg
Draw-works	At least 3,000 kg with single line
Mud pump	At least 700 L/min discharge rate
Truck	6 x 4, left-hand drive

ii) Drill strings

Drill Pipes

Well drilling generally uses 2-7/8, 3-1/2 and 4-1/2 inch outer diameter drill pipes. In the Project, considering the relation between the annular velocity for slime removal and the mountable mud pump on the truck, the drill pipes shall be at least 4-1/2 inch outer diameter, and for drilling efficiency, the length shall be 6m.

Drill collar and stabilizer

The DRD explained that drill collars provided by previous Japanese projects can be utilized for the drilling work in the Project. They will not be procured in the Project. Stabilizers are used to prevent a borehole from curving and drill strings from vibrating. Stabilizers sized 10-5/8 inches placed at every 100 m pitch, namely the total of 4 will be procured.

Tricone bit

According to the results of the hydrogeological study consisting of the field survey, the geophysical survey and the analysis of the existing data, the Project area is divided into three (3) areas depending on the distributed geological formation, namely unconsolidated surface soil and alluvium deposits, the Irrawaddy Formation which is unconsolidated to moderately consolidated, and the Pegu Formation which is consolidated. Table 2.2.8 shows the breakdown of the formation drilled in the Project, which is estimated to be a total length of 20,005 m drilling in the 100 villages.

Table 2.2.8 Geological Formation Length to be Drilled (100 boreholes)

Classification		Ratio (%)		Length to be drilled (m)	
Surface soil, Alluvium deposits	Sand and gravel, weathered rock	4.4%		883	
Irrawaddy Formation	Clay/silt soil	24.2	73.4	4,832	14,688
	Sandy soil	49.2		9,856	
Pegu Formation	Soft rock	7.5	22.2	1,490	4,434
	Medium/hard rock	14.7		2,944	
Total			100		20,005

The number of required bits was considered based on the consumption rate and types of bit adopted in Phase 1. Namely, the consumption rate of an open roller bearing type bit is set at 150

m which is DRD's past performance rate. The consumption rate of the insert bit with a sealed bearing or sealed journal bearing, which has several times the lifespan of an open roller bearing type, is set at 450 m per unit.

In order to drill the Irrawaddy and the Peg Formation, the bit type should be selected with a focus on insert-type bits with tooth application for soft to hard geological formations using sealed bearings or sealed journal bearings. The tooth-type insert bit was selected based on the code of International Association of Drilling Contractors (hereinafter referred to as "IADC") for sandy soil, unconsolidated layer, soft rock and medium-hard rock. The consumption rate was set at 450 m per unit as described above. A steel tooth type of tricone bit was adopted for the Alluvium deposits and clay-silt layer below the depth of 10 m, and its tooth type was selected from the IADC code for soft-medium geological formation. The bearing will be an open roller bearing, and to calculate the quantity, the consumption rate was set at 150 m per unit. A drag bit with tungsten carbide metal chip was adopted for drilling the surface soil layer, and its consumption rate was set at 150 m, the same as the steel tooth type.

Table 2.2.9 summarizes the number of tricone bits calculated from the predicted geological survey and casing program. Up to a depth of 10 m below the surface, 14-3/4" bits are used to drill, and after that, 10-5/8" bits are used to drill the borehole. 14-3/4" tricone bits are used to drill some part of the surface layer that is the Irrawaddy and the weathered Peg Formation.

The estimated drilling depth and total length was calculated on the basis of the field hydrogeological study, and naturally it will increase or decrease in the actual drilling. In addition, the remaining drilling sites for Phase 2 have difficulties compared with past sites, for example, a very hard rock layer (nodule) may be interbedded in the area. Therefore, it is possible that the assumed consumption rate will change widely. The number of drilling bits to be procured is calculated with a safety factor of 2 to complete the drilling work without any trouble.

Table 2.2.9 Number of Bits for Drilling

Geology	Surface soil, alluvium deposits, weathered rock		Clay / Silt	Sand	Soft / Medium hard rock
Bit size	14-3/4 inch		10-5/8 inch		
Bit type	Drag bit	IADC211	IADC211	IADC537	IADC617
Drill length (m)	587	413(1)	4,759(2)	9,856	4390
Bit Q'ty	8	6	64	44	20

(1) Irrawaddy: 369m, Pegu: 44m
(2) includes 296m of Alluvium

Sub Adapters

The screws for the drill pipe, drill collar, stabilizers and bits are based on American Petroleum Institute (hereinafter referred to as "API") standards, varying in type and size. Therefore, sub connectors are required to connect these drill strings and for protection and attrition of the screws of drill strings. A bit sub to connect the bit and the drill collar, and a crossover sub to connect the drill collar and drill pipe or bit stabilizer will be selected.

2) Air Compressor

(i) Necessity of Procurement and Quantity

An air compressor is used for cleaning and development on the installation of casing pipes, and air lift pumping. In addition, it is used for rehabilitation of the existing wells.

The DRD possesses seven air compressors and four of them are placed in the CDZ. Since one of the four is overage and another one has decreased ability because of oil leakage, the

remaining two can be operated normally. An air compressor is indispensable for cleaning and developing of boreholes after the completion of drilling, therefore usually it is provided with a drilling rig. In the CDZ project office, however, the working two air compressors have supported six drilling rigs, five for the CDZ and one for Mandalay. It means that one air compressor supports three rigs.

According to the conventional results in DRD, one rig can complete the drilling of about eight boreholes a year, and then 48 boreholes can be drilled by the DRD's six rigs. When the existing two air compressors support cleaning and development of these 48 boreholes, one carries out the work of 24 boreholes a year, that is, the work for a borehole is allotted about two weeks. While one week may be adequate for the work at site, at least an additional one week is necessary for moving between the sites and maintenance such as lubrication and cleaning of equipment after use. The two weeks for one borehole is the shortest possible time even in the case that a drilling work has progressed according to the schedule in using an air compressor most efficiently. In reality, the progress of a drilling work frequently cannot follow the original schedule due to various reasons. Consequently, it is very difficult for an air compressor to work efficiently as expected, and the progress of the well construction may be delayed. After the additional two rigs are supplied by the Project, the numbers of air compressors are not sufficient to complete the well construction efficiently. Actually, it is reasonable to deploy one air compressor for 13 to 17 boreholes drilling a year. The total number of borehole drilling will be 64 to 68 a year after procuring the additional two rigs by the Project, and then at least four air compressors are required to complete the well construction satisfactorily. Two new air compressors should be procured by the Project.

(ii) Specifications

The capacity of the existing air compressors owned by the DRD are an air delivery compressor ranging from 8.8 - 25.5 m3/min (310 – 900 cfm) and air pressure compressor ranging from 0.69 - 2.07 MPa (100 – 350 psi). The DRD has requested air compressors with 14.2 m^3/min (500 cfm) and 1.27 MPa (185 psi) class that is the most convenient class for their use. The expected pumping rate of 100 – 200 l/min requires less air delivery capacity, but the air pressure is reasonable for the water level in a well. Considering access to sites, the air compressors are not the trailer type but the skid type transported by truck. Table 2.2.10 shows the specifications of the equipment

Table 2.2.10 Outline Specifications of Air Compressor

Item	Specifications
Air delivery	At least 10 m^3/min (350 cfm)
Air pressure	At least 1.27 MPa (185 psi)
Type	Skid base

3) Cargo Truck with Crane

(i) Necessity of Procurement and Quantity

This vehicle is used to transport the materials and equipment to the site so that the drilling team can continue work without unnecessary interruption. The vehicle transports a variety of materials and equipment for deep well construction such as drill strings for well drilling (drill pipes and drill collars), the air compressor for air lifting, as well as riser pipes, casing pipes and screen pipes. The vehicle may also be used to install and pull up the pumps.

Currently, DRD owns six cargo trucks with crane, and four of them are positioned for the CDZ. All of them are working without any problem at present. After the additional two rigs are procured and the total seven rigs are working in the CDZ, the existing four cargo trucks will obviously be insufficient to transport materials and equipment for the seven sites dispersed in a

wide area. When a new rig is procured, normally a cargo truck is also provided for transportation. To operate the Project smoothly and supplement the current capacity for transportation of materials and equipment for well drilling, two (2) cargo trucks with cranes will be procured, one for each new drilling rig.

(ii) Specifications

The materials and equipment which are transported by the cargo truck with crane vary greatly, including drill strings (drill pipes, drill collars and so on), drilling agent (bentonite and CMC), equipment for air lift pumping (compressor, air pipes, water pipes and so on), permanently-installed pumps, generators, casing pipe and screen pipes. Table 2.2.11 shows the materials and equipment to be transported by truck for one well.

Table 2.2.11 Materials and Equipment Transported by Truck

Items	Quantity	Unit weight (kg)	Total weight (kg)
Drill Pipes (4-1/2" L=6m)	252 m	26 kg/m	6,552
Drill collars (6-3/4"O.D, L=6m)	12 m	160 kg/m	1,920
Drill bits, subs etc.,	1 set		Around 1,000
Casing pipes (6", L=5.5m)	250 m	27.7 kg/m	6,925
Bentonite	48 bags	25	1,200
Compressor	1 unit	1750	1,750
Riser pipes	200 m	5.44	1,088
Total			20,435

These materials and equipment are not transported at the same time, but it is effective to transport at least the drill strings (drill pipes and drill collars), casing pipes and accessories at one time. The total weight of the drill pipes and drill collars, which are the longest of all equipment, is around 9 tons. Also, the crane capacity shall be 5.5 tons considering the 4,500 kg compressor (Ingersoll-Rand, USA) which is the heaviest item at the DRD. The cargo length shall be more than 6 m, taking long-pipe transportation into account. In addition, the driving system shall be 6×4, considering the road conditions and traveling between sites. Table 2.2.12 shows the main specifications of the cargo truck with crane.

Table 2.2.12 Outline Specifications of Cargo Truck with Crane

Item	Specifications
Payload	At least 10 tons
Crane capacity	At least 5 tons
Cargo length	At least 6 m
Driving system	6 x 4, left-hand drive

4) Well Logging Machine

(i) Necessity of Procurement and Quantity

In the Project, the mud rotary drilling method is adopted. A driller is trying to judge a change of stratum with observation of a change of drilling fluid, namely its color, thickness and carried cuttings, during the drilling. Actually, it is very difficult to determine an aquifer because there are many factors to change the fluid and a time lag between changes in the depths and surface. Therefore, normally after drilling is completed up to the programmed depth, geophysical well logging is conducted. The logging measures the properties, such as resistivity, spontaneous potential and natural gamma, of the borehole continuously. Based on the logging results, the position or the depth of an aquifer can be decided.

The logging results of boreholes in the area can be used to obtain the information of geological conditions in the whole area by comparing each borehole result, which indicates the

extent and thickness of an aquifer. These results are very valuable data for a future groundwater management and development plan.

So far the DRD has been supplied with four logging machines (Geologger Mark II) by Japan. However, some of them have been broken or damaged, and then the DRD uses a fixed logging machine composed of usable parts of each damaged machine. Such usage is irregular, and there is a doubt about the accuracy of the logging data, even if a measurement result is obtained.

According to OYO which is the manufacturer of the machine, Geologger Mark II, they have already finished production and support of the Geologger Mark II and cannot repair it.

Consequently, DRD plans to purchase a new logging machine which has a 300 meter cable from this year's budget. Some of the boreholes, however, will be drilled up to about 400 m in Phase 2. A logging machine with 400 meter cable is needed to judge the position of an aquifer in the depths.

In addition, after a borehole drilling is completed, a logging should be conducted promptly to decide the casing program to case the borehole and to complete the well construction. Otherwise, the borehole is left in an uncased condition which is dangerous with possible collapsing of the borehole. Therefore, when seven drilling rigs are working in the CDZ, at least three logging machines should be necessary to deploy in each region, namely Sagaing, Mandalay and Magway, to carry out borehole logging soon after a drilling is completed.

A logging machine with a 300 meter cable for boreholes drilled up to 300 m, and a logging machine with a 400 meter cable for boreholes drilled up to 400 m, will be procured.

(ii) Specifications

Two (2) logging machines will be procured, one is with a 300 m cable and the other one is with a 400 m cable. Measuring items are resistivity, spontaneous potential and natural gamma which rays have been recorded by the DRD for a long time. Table 2.2.13 shows specifications of the logging machines.

Table 2.2.13 Outline Specifications of Logging Machines

Item	Measuring Items
A logging machine with 300 m cable	Resistivity, SP, Natural gamma
A logging machine with 400 m cable	Resistivity, SP, Natural gamma

5) Drilling Agent (Bentonite, CMC)

(i) Necessity of Procurement

The main function and requirements of the mud as drilling fluid used for mud rotary drilling method are described below.

Main function of the mud

- To wash the drill bit and remove cuttings from the bottom of the hole
- To deliver the cuttings to the surface, and keep cuttings suspended in the mud so it doesn't settle if circulation stops
- To control the pressure of gas, oil, water and underground fluids, and avoid blowouts
- To stabilize the borehole by making thin, strong and impervious mud walls
- To cool down and lubricate the bit and drill strings
- To transmit information about the inside of the borehole to the surface, which is used to evaluate the geological layer

Main requirements of the mud

- A good balance is maintained between the specific weight of the mud and pressure of the geological layer
- Rheological conditions (fluidity) shall be good
- Excellent in preventing sludge and corruption of the geological layer
- High resistance to contamination from salt, cement and so on
- Easily separate cuttings and gravel on the surface
- Low cost for making and conditioning the mud
- Biodegradable and nontoxic

In Phase 1, instead of mountain clay produced locally which had been used to make circulating fluid, bentonite and CMC were procured to make appropriate circulating fluid in consideration of the above functions and requirements. Since the previous mountain clay fluid could not coat the borehole sufficiently the wall of the borehole with a mud-type cake, collapse of the borehole and lost circulation had occurred frequently. It takes at least a couple of weeks to recover from lost circulation, and a delay of the drilling schedule is caused. Bentonite and CMC should be procured in the Project.

Locally produced preventive agents for lost circulation, such as sawdust, have been procured by the DRD. It is not necessary to procure them in the Project.

(ii) Specifications and Quantity

In order to supply stable mud, it is important to limit the use of quality bentonite as much as possible so the mud maintains all of its functions. In principle, a small amount of good quality bentonite is used. Also, both bentonite and CMC have no environmental impact at all. The mud fluid used for rotary drilling has generally an 8 % water-bentonite ratio and 0.1 % CMC mixed in, which controls fluid loss. The quantity was decided from the aggregate borehole volume with the drilling diameter and length. Since the expected underground geology includes unconsolidated gravel with a sand layer and a very porous fractured zone, there is a high possibility that lost circulation occurs even when a borehole is drilled carefully. Once lost circulation occurs, much mud water is lost. A safety factor of 2 is adopted so that drilling agents do not become in short supply even in such a case. Table 2.2.14 shows the quantity of bentonite and CMC.

Table 2.2.14 Quantity of Bentonite and CMC

	Drilling Depth (m)	Borehole volume (m^3)
14-3/4" (374.7mm) drilling	1,000	110.3
10-5/8" (269.9mm) drilling	19,005	1,087.3
Total Quantity of mud fluid		1,197.6
8 % bentonite	ton	191.6
0.1% CMC	kg	2,396.0

6) Submersible Pumps and Diesel Engine Generators

(i) Necessity of Procurement

A submersible motor pump is installed into a well to withdraw groundwater. The Project is planned to provide materials and equipment to complete the construction of wells in the selected villages which are expected to be able to obtain good quality groundwater by the result of our field study. In Myanmar, the Mono pump which is a single axis line shaft screw pump had been installed in a well conventionally in the past. The Phase 1 project, however, procured

submersible motor pumps which are generally used for a deep well at present, because of the difficulties of maintenance and repairing of the Mono pump. The Project also plans to procure submersible pumps which are now standard as pumping facilities for a deep well.

(ii) Specifications and Quantity

The pump head (TDH), is classified into six types based on the prediction of hydraulic water level by the result of the geophysical survey and data provided by the DRD. The six (6) types of TDH are 60 m, 100 m, 150 m, 200 m, 250 m and 300 m. The capacity of pumps is decided based on the request of the DRD for six inch cased tube wells. Table 2.3.14 shows TDH and capacity of the pumps to be procured. The details for each village are shown in Annex 4.

The power supply from a generator is appropriate to activate the pump, so one is procured for each pump generally. However, there are 15 villages supplied public electric power which is three phase electric power and able to be used for a submersible pump. In that case, a pump shall be connected to the public electric power, so a generator is not required for the 15 villages that are shown in Annex 4.

To prevent the motor from burnout when idle in case of low water level, a water level relay is planned so that the motor will stop automatically at such times. Table 2.2.15 shows the outline specifications and quantity of the submersible motor pump and the generator.

Table 2.2.15 Outline Specifications of Submersible Pump and Generator

Submersible motor pump and accessories	Generator	Pump set	Generator Quantity
Submersible motor pump for 6" well, 3 phase, 380~400V, 50Hz, riser pipes, water level relay with cable, check valve, control panel, 10m of cabtire cable, etc.,	Water cooled diesel engine generator	Total 100 sets(*)	Total 85
TDH 300m, Discharge rate, at least 7 m^3/h	37 kVA	6	6
TDH 250m, Discharge rate, at least 7 m^3/h	30 kVA	5	3
TDH 200m, Discharge rate, at least 8 m^3/h	30 kVA	18	16
TDH 150m, Discharge rate, at least 8 m^3/h	20 kVA	24	21
TDH 100m, Discharge rate, at least 10 m^3/h	20 kVA	40	33
TDH 60m, Discharge rate, at least 10 m^3/h	20 kVA	7	6

(*): A generator is not required for 15 villages supplied three phase electric power.

7) Casing Pipes, Screen Pipes and Bottom Plug

(i) Necessity of Procurement

Based on the casing program and the result of the predictions by the hydrogeological study, the required quantity of casing pipes and screen pipes will be procured to complete the construction of wells.

The wells will be constructed with 6" casing, though the DRD has mainly constructed wells with 4" casing. The 4" casing well can be constructed economically, but the 6" casing well has important merits for the future such as preparing for a future expansion of water demand and varied possibilities of measures to be taken with borehole troubles. As a result, the well will be used for a longer time.

After the above consideration, 6" casing pipes will be installed in the wells constructed in the Project. Regarding casing pipes, screen pipes and bottom plugs, an additional 15 % of the required quantity will be procured in consideration of potential well failure

(ii) Specifications and Quantity

Casing Pipes

Screen pipes are installed to prevent sandy particles, which comes from the unconsolidated fine sand, gravel layer and fractured zone, from entering into the well. Two types of screen slit sizes will be provided for use depending on the stratum conditions, namely 50 % of the total quantity to be procured is 0.5 mm slit and the other 50 % is 0.75 mm. The screen should have more than 10 % open area with a Johnson type screen. Material of the screen is stainless steel to prevent corrosion due to the water quality. Pipes will be connected with corrosion-proof couplings. Based on the results of the geophysical study and the experience of DRD, 51 wells are installed with two (2) units of 6 m screen pipe and 49 wells are installed with three (3) units of 6 m screen pipe. The total amount of screen pipes is 230 units by adding 5 % of the assumed damage rate.

For sand entering and accumulating in a well over time, a bottom plug to store sediment is installed into each well. Table 2.2.16 shows outline specifications of screen pipe and bottom plug.

Table 2.2.16 Outline Specifications of Casing Pipe

Code	Nominal size	Specifications	Quantity
Seamless steel pipe for high pressure piping works, equivalent to JIS G3454 STPG Sch40, with coupling joint	6 inches	Outer diameter: 165.2 mm, thickness: 7.1 mm, length: 5.5m/unit	3,756

Screen Pipes and Bottom Plugs

Screen pipes are installed to prevent sandy particles, which comes from the unconsolidated fine sand, gravel layer and fractured zone, from entering into the well. Two (2) types of screen slit sizes will be provided for use depending on the stratum condition, namely 50 % of the total quantity to be procured is 0.5 mm slit and the other 50 % is 0.75 mm. The screen should have more than 10 % open area with Johnson type screen. Material of the screen is stainless steel to prevent corrosion due to the water quality. Pipes will be connected with corrosion-proof couplings. Based on the result of geophysical study and the experience of the DRD, 51 wells are installed with two (2) units of 6 m screen pipe and 49 wells are installed with three (3) units of 6m screen pipe. The total amount of screen pipes is 230 units by adding 5 % of the assumed damage rate.

For sand entering and accumulating in a well over time, a bottom plug to store sediment is installed into each well. Table 2.2.17 shows outline specifications of screen pipe and bottom plug.

Table 2.2.17 Outline Specifications of Screen Pipe and Bottom Plug

Nominal size	Specifications	Slit size	Quantity
6 inches screen pipe	Johnson type slit screen, SUS, opening ratio: 10 % or more, length: 6 m, corrosion-proof coupling joint	0.5 mm	144
		0.75 mm	144
6 inches bottom plug	For sand sedimentation		115
Insulating coupling			230

Since the required amount of riser pipes depends on the actual water level (static water level and dynamic water level) after constructing a well, the estimated number may increase or decrease. 10 % of the original estimated quantity is added to the amount of riser pipes to be procured.

8) Pumping Test Equipment

(i) Necessity of Procurement

The current pumping test carried out by the DRD is an air lift pumping test after the construction of the well. The purpose of the test is to confirm that the pumping water level becomes stable with the target discharge rate, 100 to 120 L/min.

The original pumping test, which is also known as an aquifer test, is conducted to determine the hydraulic characteristics of the aquifer such as an hydraulic conductivity, transmissivity and storage coefficient, and also to determine a reasonable pumping rate of the well. The hydraulic characteristics obtained by the pumping tests of wells in the area show the regional pattern of groundwater flow and storage. These data will be indispensable information to estimate the further development potential of groundwater in the area and to formulate a groundwater management plan which is certainly required for the near future.

Recently, the DRD has intended to construct a number of wells to meet the water demand of the village population, though only one (1) well was required to be constructed for one (1) village before. This is also one of the reasons that the appropriate pumping test is necessary to obtain the accurate capacity of the wells constructed by the DRD.

The water level in the well with the elapsed time from the pumping started with a fixed pumping rate should be recorded precisely and continuously for the appropriate pumping test. However, the current air lift pumping test cannot keep a stable condition of water level and discharge rate of the well, thus it is impossible to obtain data which can be analyzed.

The Project team proposed to carry out a pumping test with a submersible pump instead of the current air lift pumping test after the completion of well construction, and the DRD agreed with this.

To conduct the proposed pumping test, the DRD has already some of equipment except submersible pumps, riser pipes and generators. Therefore, submersible pumps, riser pipes and generators should be procured.

(ii) Specifications and Quantity

Two (2) types of submersible pump are procured to evaluate properly the capacity of an aquifer. One is prepared for a well with a deeper water level and another is for a well with a relatively shallow water level. A generator that is applicable to these two types of pump will be procured.

Considering the distribution of the estimated groundwater level in the area, two pumps with the capacity of 10 m^3/h with TDH 250 m and the capacity of 14 m^3/h with TDH 100 m are very practical on a wide basis. Table 2.2.18 summarizes outline specifications of the pumping test equipment.

Table 2.2.18 Outline Specifications of the Pumping Test Equipment

Items	Specification	Quantity
Submersible pump	TDH: 250 m, 10 m^3/h with accessories (including 300 m cable)	2
Submersible pump	TDH: 100 m, 14 m^3/h with accessories (including 150 m cable)	2
Riser pipes	2" JIS SG3454STPG Sch40 or equivalent	60 units
Diesel engine generator	37 kVA	1
Water level indicator	300m	1
Water level measuring pipes	PVC 1" x 4 m	83 units

(3) List of Equipment to be procured in the Project

The list of equipment to be procured in the Project is shown in Table 2.2.19.

Table 2.2.19 List of Equipment to be Procured in the Project

No.	Equipment	Contents	Quantity	
1	Drilling Equipment			
1-1	Truck-mounted Drilling Rig and Tools (250 m depth drilling)			
1-1-1	Truck-mounted Drilling Rig (250m depth drilling)			
	Truck-mounted Drilling Rig (250m depth drilling)	with spare parts	1	set
1-1-2	Standard operating accessories (250m depth drilling)	Accessories for 250m drilling rig	1	set
1-1-3	Drilling Tools (250m depth drilling)	Drill pipes, bit subs	1	set
	Drill pipe	4-1/2″ O.D. flush type with 3-1/2 IF, 6m long	42	units
	Bit sub	4-1/2″ IF box to 6-5/8 REG box	3	units
	Wear sub	3-1/2 IF box to pin	2	units
	Cross over sub	3-1/2 IF box to 4-1/2 IF pin	2	units
1-1-4	Casing and Fishing Tools (250m depth drilling)	Casing band, fishing tools, etc.	1	set
1-1-5	Miscellaneous tools of drilling works (250m depth drilling)	Tools	1	set
1-2	Truck-mounted Drilling Rig and Tools (200 m depth drilling)			
1-2-1	Truck-mounted Drilling Rig (200m depth drilling)			
	Truck-mounted Drilling Rig (200m depth drilling)	with spare parts	1	set
1-2-2	Standard operating accessories (200m depth drilling)	Accessories for 200m drilling rig	1	set
1-2-3	Drilling Tools (200m depth drilling)	Drill pipes, bit subs	1	set
	Drill pipe, 4-1/2" O.D. flush type with 3-1/2 IF, 6 m long	4-1/2″ O.D. flush type with 3-1/2 IF, 6m long	34	units
	Bit sub	4-1/2″ IF box to 6-5/8 REG box	3	units
	Wear sub	3-1/2 IF box to pin	2	units
	Cross over sub	3-1/2 IF box to 4-1/2 IF pin	2	units
1-2-4	Casing and Fishing Tools (200m depth drilling)	Casing band, fishing tools, etc.	1	set
1-2-5	Miscellaneous tools of drilling works (200m depth drilling)	Tools	1	set
1-3	Air-Lift/Pumping Test Unit			
1-3-1	Air compressor	350 cfm, 1.27MPa class	2	units
1-3-2	Air lift equipment	Air pipes and accessories	1	set
1-3-3	Pumping test equipment	submersible pumps, riser pipes, generator	1	set
	Submersible motor pump	TDH:250m, 10m3/h	2	sets
	Submersible motor pump	TDH:100m, 14m3/h	2	sets
	Riser pipe (5.5m)	2″ JIS G3454 STPG38 Sch40 (or) ASTM A53 Grade A, Sch40, thread	60	units
	Portable water level indicator	300m, φ13mm, sensor	1	unit
	Pipe for water level indicator	PVC, thread, φ1″ x 4m	83	units
2	Supporting Vehicle			
2-1	Truck-Mounted 5 tons Crane Truck			
2-1-1	Truck-Mounted 5 tons Crane Truck	Loading capacity 10 tons	2	units
	Spare parts	Spare parts for vehicle	2	sets
3	Geophysical Logging Equipment			
3-1	Logging Equipment (with analysis software)			
3-1-1	Logging Equipment (with analysis software)	with 300 m cable, with 400 m cable	2	units
4	Equipment and Materials for Well Construction			
4-1	Submersible motor pump and diesel engine generator		Pump	Generator
4-1-1~3	Submersible motor pump (TDH: 300m, 7m3/h) and Disel engine generator	Submersible pump, riser pipe, generator	6	(6)
4-1-4~6	Submersible motor pump (TDH: 250m, 7m3/h) and Disel engine generator	Submersible pump, riser pipe, generator	5	(3)
4-1-7~9	Submersible motor pump (TDH: 200m, 8m3/h) and Disel engine generator	Submersible pump, riser pipe, generator	18	(16)
4-1-10~13	Submersible motor pump (TDH: 150m, 8m3/h) and Disel engine generator	Submersible pump, riser pipe, generator	24	(21)
4-1-14~15	Submersible motor pump (TDH: 100m, 10m3/h) and Disel engine generator	Submersible pump, riser pipe, generator	40	(33)
4-1-16~18	Submersible motor pump (TDH: 60m, 10m3/h) and Disel engine generator	Submersible pump, riser pipe, generator	7	(6)
4-2	Casing pipe and Screen pipe			
4-2-1	Casing pipe	6″STPG, Sch40, thickness 7.1mm, O.D. 165.2mm、L=5.5m	3,756	units
4-2-2	6" Screen pipe	6″, Johnson type, 0.5mm slit, L=6m	144	units
	6" Screen pipe	6″, Johnson type, 0.75mm slit,L= 6m	144	units
4-2-3	Insulating coupling	6″	230	units
4-2-4	Bottom Plug	6″, L=5.5m	115	units
5	Drilling Materials for Well Drilling			
5-1	Material for mud water			
5-1-1	Bentonite		191.6	tons
5-1-2	CMC		2,396	kg
5-2	Drilling bit / Bit stabilizer			
5-2-1	Drilling Bit (Drag Bit)	6-5/8″ REG pin joint	1	set
5-2-2	Drilling Bit (Tricone Bit)	6-5/8″ REG pin joint	1	set
5-2-3	Bit Stabilizer	Stabilizer	1	set

2.2.3 OUTLINE DESIGN DRAWING (WELL STRUCTURE)

The conceptual drawing of the well to be constructed by the Project is shown in Figure 2.2.2.

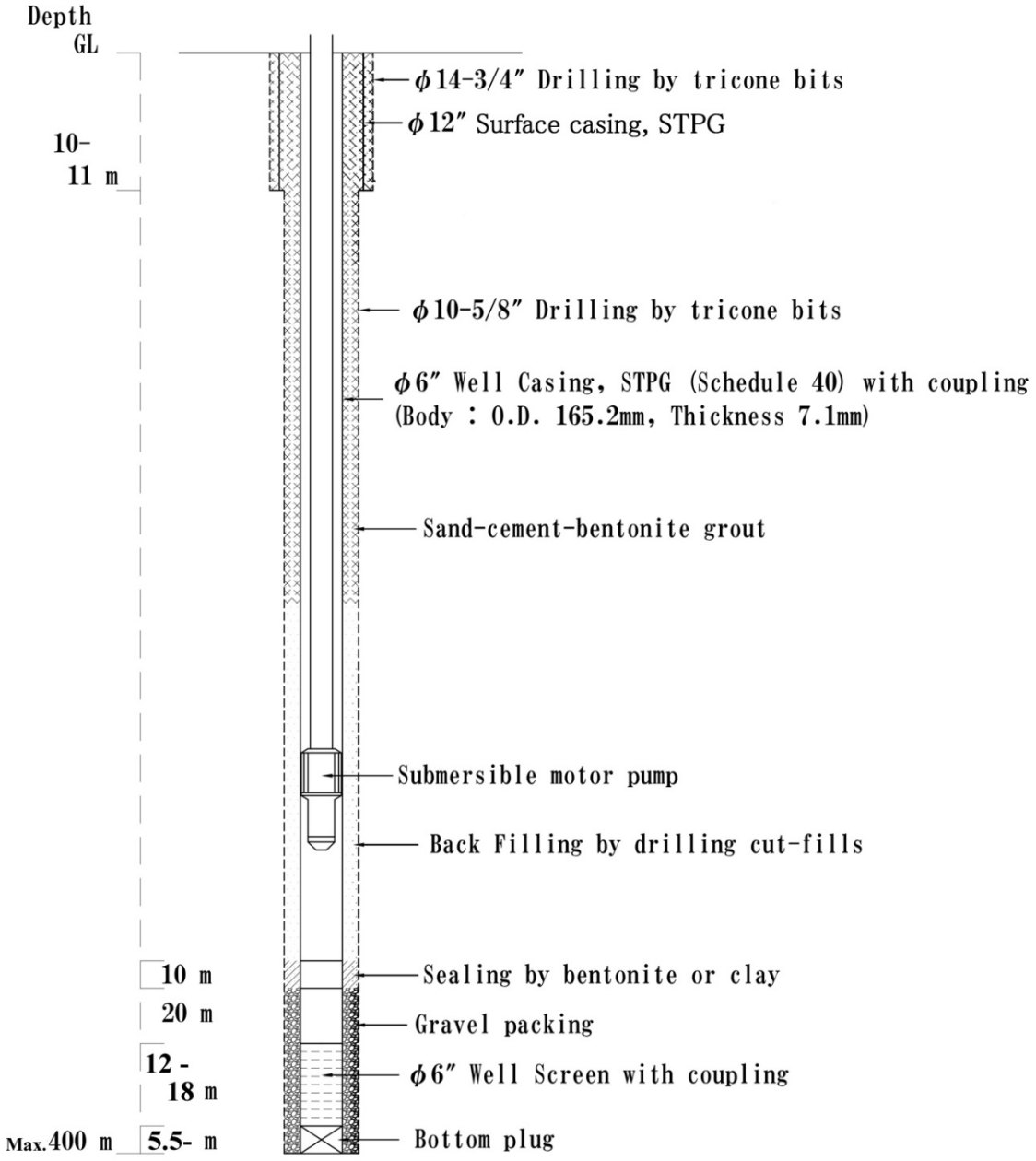


Figure 2.2.2 Well Structure

2.2.4 IMPLEMENTATION PLAN

(1) Implementation Policy

Equipment for the Project will be procured in Bangladesh, Japan or third countries for aspects of effective procurement processes, O&M and price. In the procurement processes, availability of consumables, spare parts and the O&M structure should be considered. In addition, equipment to be procured should be adapted to conditions of the usage environment.

(2) Implementation Conditions

1) Preparation of the Myanmar Side

The consignee of the equipment is the DRD, implementation agency of the Project.

The Myanmar side should make sure smooth implementation for import of equipment such as custom clearance and registration of vehicles since dispatched engineers from the supplier conduct commissioning such as unpacking, checking and initial operation training of equipment before delivery to the DRD.

The Myanmar side also should take note of effective procedures for import permission, tax exemption and custom clearance..

2) Transportation of Equipment

The supplier should confirm transportation conditions and make sure of prompt custom clearance and delivery. Moreover, they should take care of the safety aspect during transportation

(3) Scope of Works

Procurement allocations of major equipment are shown in Table 2.2.20.

Table 2.2.20 Procurement Allocations of Major Equipment

Equipment		Procurement Condition in Myanmar	Country of Origin	Country of Procurement
1.	Drilling Equipment and other related equipment			
1-1 1-2	Drilling rigs and standard drilling accessories	Drilling rigs are not manufactured in Myanmar. Therefore, they will be procured in Japan considering aftercare.	Japan	Japan
1-3	Equipment for Air Lifting and Pumping Test			
	1) Air compressor	They are not manufactured in Myanmar. Therefore, they will be procured in Japan considering aftercare.	Japan	Japan
	2) Equipment for Air Lifting	The equipment needs closer coordination with drilling equipment. Therefore, they will be procured in Japan same as drilling equipment.	Japan	Japan
	3) Pumping test equipment	Since pumping test equipment is installed in the well and pull out from the well in every drilling site, durability is important. The Japanese products have high durability. In addition, pumping test equipment needs closer coordination with drilling equipment and tools of the drilling rigs. Therefore, they will be procured in Japan	Japan	Japan
2.	Supporting vehicles (Cargo truck with crane)	They are not manufactured in Myanmar. There are agencies of Japanese company in Yangon. Parts are almost same as those of the drilling rigs. Considering the aftercare, the Japanese product is procured.	Japan	Japan
3.	Well Logging equipment	They are not manufactured in Myanmar. There is an agent of the Japanese manufacturer in	Max. measuring depth (300m): Japan or Third	Japan

Equipment		Procurement Condition in Myanmar	Country of Origin	Country of Procurement
		Yangon. The measuring depth of the Japanese one is maximum 300m. The measuring depth up to 400m is manufactured in the third countries.	country Max. measuring depth (400m): Third country:	
4.	Equipment and Materials for Well Construction			
	1) Submersible motor pump and diesel engine generator	There are agencies of Japanese, German and Danish companies for submersible pump. Steel riser pipes are not procured in Myanmar. There are agents of Japanese and Italian manufacturers for generator. Those agents have experience of delivery of well logging machines. Therefore, they should be Japanese or third country's made considering aftercare.	Japan or Third country	Myanmar
	2) Casing and screen pipes	They are not manufactured in Myanmar. Casing pipes made in Thailand and screen pipes made in Australia can be procured in Myanmar. Screen pipes are required strength and quality of connection. Therefore, screen pipes are procured in Japan. Since insulating couplings are not procured in Myanmar, they will be procured in Japan.	Casing pipe/Bottom plug: Third country Screen/Insulating coupling: Japan	Casing pipe/Bottom plug: Myanmar Screen/ Insulating coupling: Japan
5.	Consumables for Well Drilling			
	1) Material for mud water	Bentonite is manufactured in Myanmar, but CMC is not manufactured. Products of the third country's made are not available. Bentonite is procured in Myanmar and CMC is procured in Japan.	Bentonite: Myanmar or Third country CMC: Japan	Bentonite: Myanmar CMC: Japan
	2) Drilling bit / Bit stabilizer	They are not manufactured in Myanmar. Therefore, they will be procured in Japan considering aftercare.	Japan	Japan

(4) Procurement Supervision

The consultants and the equipment suppliers should supervise the following procedures in order to efficiently implement bid, design, procurement, manufacture, transportation and delivery.

1) Supervision by the consultant

- Confirmation and collation of shop-drawings submitted by the supplier
- Discussion with the DRD about acceptance of equipment before shipment
- Inspection of manufactured equipment (by witnessing inspection or review of reports)
- Inspection of equipment before packing (by review of inspection reports)
- Meeting with inspectors for Witnessing inspection of equipment quality before shipment

- Supervision of carrying-in and unpacking
- Supervision of initial handling training
- Supervision of pre-delivery inspection
- Witness of delivery of equipment
- Confirmation of completion of equipment operation instructions

2) Supervision by the supplier

- Preparation, confirmation and collation of shop-drawings
- Management of equipment manufacturing
- Inspection of manufactured equipment
- Inspection of equipment before packing
- Witness of pre-shipment inspection
- Carrying-in and unpacking
- Adjustment and test operation of the equipment
- Initial handling training
- Pre-delivery inspection
- Delivery of equipment to DRD

(5) Quality Control Plan

The following inspection will be implemented for quality control by the supplier and the consultant.

1) Confirmation and collation of shop-drawings

Inspectors of the suppliers and the consultant shall review and modify shop-drawings prepared by the supplier in order to assure the quality of functional specifications.

The process will take 0.5 month for the inspectors of the supplier and 0.4 month for the consultant's inspectors.

2) Product Inspection

Consultants will carry out the factory inspection of manufactured equipment based on approved shop drawings. The inspection will be implemented by witness inspection of the factory or review of inspection reports submitted by manufacturers. The consultants will inspect drilling rigs, drilling tools, generators and compressors by witness inspection of the factory.

The process will take 0.4 month for the inspectors of the suppliers and the consultant respectively.

3) Inspection before shipment

Number and quantity of procured equipment will be inspected before packing.

The necessary period for this inspection will take 0.23 month for the inspectors of the supplier and the consultant respectively.

4) Equipment collation check before loading

A third party organization will conduct pre-shipment inspection for equipment to be procured in Japan and in third countries.

Inspectors of the supplier shall witness this inspection for equipment to be procured in Japan.

This process needs 0.1 month for the inspector of the suppliers.

5) Delivery Inspection in Myanmar

After adjustment and test operation, procurement supervisors of the supplier will inspect

equipment with the DRD staff, the procurement engineers of the consultant and residential procurement engineers of the consultants. It will be conducted for 0.5 month.

After the delivery inspection, the equipment will be delivered to the DRD.

(6) Procurement Plan

Truck mounted drilling rigs and equipment, supporting vehicles, well logging equipment and drilling materials will be procured in the Project. Each item needs expertise, therefore a contractor of the Project is reasonable to be a trading company that has the experience of procurement of similar equipment and materials.

Trucks will be transported by a conventional ship from Yokohama Port to Yangon Port by sea. Afterwards, they will be transported to the DRD storehouse in Yangon and be handed over to DRD. Other equipment will be transported by a container ship by the same route with trucks.

The conventional ship has monthly operation and the container ship has almost daily service between Yokohama Port and Yangon Port.

(7) Operational Guidance Plan

Drilling instructors of the supplier shall have technical training about major machinery such as two (2) drilling rigs, supporting vehicles, generators and compressors to DRD's staff after carrying in, unpacking, test operation and adjustment. Meanwhile, the equipment maintenance instructors shall give guidance about equipment maintenance to the DRD's staff.

In addition, initial operation training of logging equipment and a pumping test will be carried out by the manufacturer's instructors in the same period.

(8) Soft Component (Technical Assistance) Plan

Technical assistance is carried out aiming at strengthening of the staff of the DRD on the well logging and pumping test.

1) Background of the soft component plan

It is necessary for the DRD to decide the well structure such as section of the screen and casing immediately after the completion of drilling by carrying out well logging to grasp the distribution depth and thickness of aquifer (s). Although the DRD had received technical instruction on the well logging and pumping test technique in the past technical assistance project by JICA, the DRD has few experiences of a series of techniques to decide well structure by obtaining reliable data and proper analysis of the data because no logging machine out of four (4) is functioning. Therefore, technical assistance is planned to strengthen the capability of well logging plan, logging technique, data analysis and decision of well structure by using the new logging machine to be supplied in the Project.

In addition, it is important to evaluate the potential of aquifers and wells by pumping test by submersible pump to be carried out just after the completion of development of the well. DRD has currently been carrying out the brief pumping test by airlifting. The test is continued till the groundwater become clear after development work for cleaning of the well.

DRD has the intention to realize more high level of rural water supply in the CDZ. For this purpose, it is indispensable to grasp the accurate capacity of the aquifer. Such information will be obtained by the accurate pumping test composed of (1) step draw down test, (2) constant discharge test and (3) recovery test by submersible pump. The pumping test kit to be supplied in the Project shall be utilized in the pumping test. The soft component is carried out to strengthen such capacity of the staff of the DRD.

2) Objective of soft component

The objective of the soft component is that the staff of DRD obtain the technique for construction of proper deep wells based on the result of well logging, to formulate the proper pumping plan of groundwater and to effectively develop the rural water supply in the CDZ.

3) Expected output of soft component

(i) Well logging

It is expected to create the following output by soft component on well logging.

Output (1) : Staff of the DRD will acquire the technique for planning and implementation of well logging.

Output (2) : Staff of the DRD will acquire the technique on examination of obtained data.

Output (3) : Staff of the DRD will acquire the technique to decide the proper well structure by using the analysis result of well logging.

(ii) Pumping test

It is expected to create the following output by soft component on pumping test.

Output (1) : Staff of the DRD will acquire the technique on formulation of the proper pumping test plan.

Output (2) : Staff of the DRD will acquire the technique on the pumping test by submersible pump.

Output (3) : Staff of the DRD will acquire the technique on the data analysis of logging data and to evaluate the aquifer.

Output (4) : Staff of the DRD will acquire the technique on the formulation of proper pumping plan based on the evaluation of the aquifer.

4) Means of verification for output

Means of verification to assess the output described in above Item (3) are shown in Table 2.2.21 and Table 2.2.22.

Table 2.2.21 Means of Verification to Assess the Output (Well Logging)

Output	Items for Verification to Assess the Output	Means of Verification
Output (1) : Staff of the DRD will acquire the technique on formulation of the proper pumping test plan	Capable to handle the equipment properly.	<Field test at the site> To confirm the handling activity of the equipment by the DRD's staff.
	Capable to install the equipment at the site properly.	
	Capable to set the ascent and lowering velocity of probe properly.	
	Capable to show the obtained data on the display	
	Capable to obtain the proper data.	
	Capable to explain the points to consider in handling and operating the equipment.	
Output (2) : Staff of the DRD will acquire the	Capable to classify the data based on the variation character of the obtained data properly.	<Paper test> To confirm the process from analysis of the data

Output	Items for Verification to Assess the Output	Means of Verification
technique on the pumping test by submersible pump	Capable to correlate the data with deological description, changing in drilling speed, etc. ,and to modify the geological column properly and explain the result.	to decision of well structure by the DRD's staff
Output (3) : Staff of the DRD will acquire the technique on the data analysis of logging data and to evaluate the aquifer	Capable to decide well structure (casing program, section of gravel and sealing) properly based on the geological column, drilling record, logging result, etc. and explain.	

Table 2.2.22 Means of Verification to Assess the Output (Pumping Test)

Output	Items for Verification to Assess the Output	Means of Verification
Output (1) : Staff of the DRD will acquire the technique on formulation of the proper pumping test plan	Capable to select the pumping test unit (submersible pump, number of riser pipe, etc.	<Paper test> To confirm the pumping test plan prepared by the DRD's staff.
	Capable to formulate the pumping test plan	
	Capable to explain the pumping test plan to other DRD staff.	
Output (2) : Staff of the DRD will acquire the technique on the pumping test by submersible pump	Capable to transport and install the pumping test unit properly.	<Field test> To confirm the manner of handling of the equipment and explanation by the DRD's staff.
	Capable to handle the pumping test unit properly (handle with care, not step on the cables)	
	Capable to explain the points to consider in handling and execution of the pumping test.	
	Capable to make step draw down test plan based on the result of the preparatory test.	<Field test> To confirm the actual pumping test by the DRD's staff at the site.
	Capable to make constant discharge test plan based on the result of the step draw down test.	
	Capable to continue pumping by setting the yield as planned.	
	Capable to record the test data and test condition.	
	Capable to measure water quality during the pumping test.	
	Capable to organize demobilization from the site.	
Output (3) : Staff of the DRD will acquire the technique on the data analysis of pumping test data and to evaluate the aquifer	Capable toinput the test data as the digital data	<Paper test> To confirm the analysisi result of the DRD's staff.
	Capable to prepare a graph which show the water table lowering in the step draw down test and the constant revovery test.	
	Capable to prepare a Q-S diagram of step draw down test.	
	Capable to calculate specific capacity	
	Capable to calculate aquifer loss and well loss.	
	Capable to get coefficient of permeability by analysing the data of constant discharge test and recovery test.	

Output	Items for Verification to Assess the Output	Means of Verification
	Capable to get critical yield and optimum yield and explain the procedure and the result.	
Output (4) : Staff of the DRD will acquire the technique on the formulation of proper pumping plan based on the evaluation of the aquifer	Capable to select the specification of pumping unit considering the capacity and characteristic of aquifer, cost of pumping unit and water demand of the village based on the analysis result of th epumping test.	<Paper test> To confirm the selection of the equipment for the pumping test and the pumping test report prepared by the DRD's staff.
	Capable to prepare the pumping test report.	

5) Activities and input in soft component program

(i) Technical instruction of well logging

Required activities on the well logging technique for attaining the objective and output of the soft component are as follows.

i) Mobilization (from Japan to the site in Myanmar) and preparation work

- Explanation and discussion of the overall plan of the technical assistance on well logging

ii) Activity related to obtaining of planning and implementation of well logging

- Explanation of summary and principles of well logging
- Instruction of handling of well logging equipment
- Instruction of technique to obtain the proper data

iii) Activity related to obtaining of technique to analyze the logging data

- Instruction to classify the aquifer based on the well logging result
- Instruction to modify the geological column (depth of boundaries of strata and geological facies) based on the logging data

iv) Activity related to obtaining of technique to decide the well structure based on the result of well logging

- Instruction to decide the target aquifer to abstract groundwater based on the result of well logging
- Instruction to decide the section of screen to be installed against the target aquifer
- Instruction to decide the well structure including depth of sealing, section of screen and section of gravel packing

v) Summarization of the technical assistance and demobilization (from the site in Myanmar to Japan)

- Confirmation and discussion on the result of technical assistance

(ii) Technical instruction of pumping test

Required activities on the well logging technique for attaining the objective and output of the pumping test are as follows.

i) Mobilization (from Japan to the site in Myanmar) and preparation work

- Explanation and discussion of the overall plan of the technical assistance on pumping test

ii) Activity related to obtaining of technique for planning of the pumping test

- Explanation of summary and principles of well logging
- Instruction of planning of the pumping test correlated to the target and purpose of pumping (selection of the pump, riser pipe, etc.)

iii) Activity related to obtaining of technique for implementation of the pumping test by using the submersible pump

- Instruction at the site to install and handle the submersible pump, generator, riser pipe, flow meter, etc.
- Instruction of technique on pumping and measurement of water level during the tests
- Instruction of technique to decide the number of step and pumping rates of step draw down test based on the result of the preparatory test
- Instruction of technique to plan the pumping rate and duration of the constant discharge test based on the result of the step draw down test
- Instruction of procedure from the constant discharge test to the recovery test
- Instruction of evaluation of the test data (whether the data are proper or not)

iv) Activity related to obtaining of technique for evaluation of aquifer by analyzing the test data

- Instruction to input obtained data as the digital data
- Instruction to draw different graphs for analyzing the test data
- Instruction of analysis of test data to calculate aquifer constants and others

v) Activity related to obtaining of technique for planning of production of water based on the evaluation of aquifer

- Instruction to decide the production rate of water and to select the specification of pumping unit considering the evaluation of aquifer
- Instruction to prepare the report on the pumping test

vi) Summarization of the technical assistance and demobilization (from the site in Myanmar to Japan)

- Confirmation and discussion on the results of technical assistance

Details of activities described above are summarized in Table 2.2.23 and 2.2.24. Duration of period in the tables is net, excluding holidays and the date for trips.

Table 2.2.23 Detail of Soft Component for Well Logging

Activities	Purpose	Target	Implementation Method	Period	Resource 【Responsibility 】	Output/Report
Stage 1: Mobilization (from Japan to Myanmar)/Preparation Work						
1-1) Mobilization (from Japan to Myanmar)				1 day	1 Japanese consultant 1 Local interpreter	
1-2) Explanation of the whole plan of the soft component	Before commencement of the soft component, An engineer will explain and discuss with the DRD Headquarters and the CDZ Project Office on the purpose and contents of the soft component in order to get agreement.	Staff of the DRD Headquarters and the CDZ Project Office	Contents of the soft component plan are explained and discussed. The meeting will be held in Naypyitaw with the DRD Headquarters and at Nyaungoo with the CDZ Project Office.	3 days	1 Japanese consultant 1 Local interpreter	Soft component plan
Stage 2: Instruction of technique of well logging						
2-1) Explanation of Summary and Principle of Well Logging	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will comprehend the significance, principle and implementation method of well logging.	3 persons from the DRD Headquarters and 12 persons from the CDZ Project Office (15 persons in total).	Contents of the soft component plan are explained and discussed in lectures.	0.5 day	1 Japanese consultant 1 Local interpreter	-
2-2) Instruction of handle the well logging machine	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to handle the logging machine.		Soft component plan and the operating manual of the equipment are used for instruction.	0.5 day		-
2-3) Instruction of technique to carry out the well logging	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to carry out the well logging.		The logging data are obtained by using the procured logging machine at the sites,	7 days		Logging data
Stage 3: Instruction of technique to analyze the logging data						
3-1) Instruction to classify the aquifer based on the well logging result	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to classify the logging data and to classify the aquifers by correlating with the geological column.。	3 persons from the DRD Headquarters and 12 persons from the CDZ Project Office (15 persons in total).	A lecture will be held.	6 days	1 Japanese consultant 1 Local interpreter	Modified geological column (including classification of aquifers)
3-2) Instruction to modify the geological column (depth of boundaries of strata and geological facies) based on the logging data	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to modify the facies and boundaries of strata described in the geological column.					

Activities	Purpose	Target	Implementation Method	Period	Resource 【Responsibility 】	Output/Report
Stage 4: Instruction to decide the well structure						
4-1) Instruction to decide the target aquifer to abstract groundwater based on the result of well logging	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to decide the target aquifer to abstract groundwater by analyzing the logging data.	3 persons from the DRD Headquarters and 12 persons from the CDZ Project Office (15 persons in total).	A lecture will be held.	7 days	1 Japanese consultant 1 Local interpreter	Well structure
4-2) Instruction to decide the section of screen to be installed against the target aquifer	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to decide the section of screen to be installed against the target aquifer					
4-3) Instruction to decide the well structure	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to decide the well structure including depth of sealing, section of screen and section of gravel packing.					
Stage 5: Summarization of soft component/Demobilization (from Myanmar to Japan)						
5-1) Discussion with DRD on the activities and results of soft component	Confirmation of the activities and results of soft component will be done between the DRD and the Japanese consultant	Staff of the DRD Headquarters and the CDZ Project Office		3 days	1 Japanese consultant 1 Local interpreter	Manual for well logging Completion report of soft component
5-2) Demobilization (from Myanmar to Japan)				2 days	1 Japanese consultant	
			Total	**30 days**	Japanese Consultant : 30 days Local Interpreter : 27 days	

Table 2.2.24 Detail of Soft Component for the Pumping Test

Activities	Purpose	Target	Implementation Method	Period	Resource 【Responsibility 】	Output/Report
Stage 1: Preparation work						
1-1) Mobilization (from Japan to Myanmar)				1 day	1 Japanese consultant	
1-2) Explanation of Summary and Principle of the pumping test	Before commencement of the soft component, An engineer will explain and discuss with the DRD Headquarters and the CDZ Project Office on the purpose and contents of the soft component in order to get agreement.	Staff of the DRD Headquarters and the CDZ Project Office	Contents of the soft component plan are explained and discussed. The meeting will be held in Naypyitaw with the DRD Headquarters and at Nyaungoo with the CDZ Project Office.	3 days	1 Japanese consultant 1 Local interpreter	Soft component plan
Stage 2: Instruction to plan the pumping test						
2-1) Explanation of summary and principles of the	Staff of the Myanmar side (the DRD	3 persons from the	Contents of the soft	1 day	1 Japanese consultant	

Activities	Purpose	Target	Implementation Method	Period	Resource 【Responsibility 】	Output/Report
pumping test	Headquarters and the CDZ Project Office) will comprehend the significance, principle and implementation method of the pumping test.	DRD Headquarters and 12 persons from the CDZ Project Office (15 persons in total)	component plan are explained and discussed.		1 Local interpreter	
2-2) Instruction of planning of the pumping test	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will be instructed on the planning of the pumping test correlated to the target and purpose of pumping			1 day		Pumping test plan
Stage 3: Instruction to implement the pumping test						
3-1) Instruction to install and handle the submersible pump, generator, riser pipe, flow meter, etc.	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to handle and install the pumping test unit at the site.	3 persons from the DRD Headquarters and 12 persons from the CDZ Project Office (15 persons in total)	Installation method and handling of the pumping test unit are explained in lectures.	8 days (including trips)	1 Japanese consultant 1 Local interpreter	—
3-2) Instruction of technique on pumping and measurement of water level during the tests	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to manage the pumping rate and measure the water level.		Management of pumping rate and water level measurement method are explained at the site.			—
3-3) Instruction of technique to decide the number of step and pumping rates of step draw down test based on the result of the preparatory test	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to decide the number of step and pumping rates of step draw down test based on the result of the preparatory test		Instruction is made on the technique to decide the number of step and pumping rates of step draw down test based on the result of the preparatory test at the site.			Instruction document for the step draw down test
3-4) Instruction of technique to plan the pumping rate and duration of the constant discharge test based on the result of the step draw down test	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to plan the pumping rate and duration of the constant discharge test based on the result of the step draw down test		Instruction is made on the technique to plan the pumping rate and duration of the constant discharge test based on the result of the step draw down test at the site.			Instruction document for the constant discharge test
3-5) Instruction of the procedure from the constant discharge test to the recovery test	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will comprehend the procedure from the constant discharge test to the recovery test		Instruction is made on the procedure from the constant discharge test to the recovery test.			—
3-6) Instruction of evaluation of the test data	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to evaluate the test data.		Instruction is made on the technique to evaluate the test data			Pumping test data
Stage 4: Instruction to evaluate the aquifer by analyzing the test data						
4-1) Instruction to draw different graphs for analyzing the test data	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will	3 persons from the DRD Headquarters	A lecture will be held.	1 day	1 Japanese consultant 1 Local interpreter	Different graphs

Activities	Purpose	Target	Implementation Method	Period	Resource 【Responsibility 】	Output/Report
	obtain the technique to draw different graphs for analyzing the test data.	and 12 persons from the CDZ Project Office (15 persons in total)				
4-2) Instruction of analysis of test data to calculate aquifer constants and others, and evaluate aquifers	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to analyze test data to calculate aquifer constants and others, and evaluate aquifers		A lecture will be held.	3 days		Aquifer constants, evaluation result of aquifer
Stage 5: Instruction to plan the water production plan						
5-1) Instruction to decide the production rate of water and to select the specification of pumping	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to prepare the production plan of groundwater from the pumping test results.	3 persons from the DRD Headquarters and 12 persons from the CDZ Project Office	A lecture will be held.	2 days	1 Japanese consultant 1 Local interpreter	Groundwater production plan
5-2) Instruction to prepare the report on the pumping test	Staff of the Myanmar side (the DRD Headquarters and the CDZ Project Office) will obtain the technique to prepare the pumping test report.		A lecture will be held.	2 days		Pumping test manual Implementation report on the pumping test
Stage 6: Summarization of soft component/Demobilization (from Myanmar to Japan)						
6-1) Discussion with DRD on the activities and results of soft component	Confirmation of the activities and results of soft component will be done between the DRD and the Japanese consultant	Staff of the DRD Headquarters and the CDZ Project Office		3 days	1 Japanese consultant 1 Local interpreter	
6-2) Demobilization (from Myanmar to Japan)					1 Japanese consultant	
			Total	**30 days**	Japanese Consultant : 30 days Local Interpreter : 27 days	

6) Procurement plan of the implementation resource of the soft component

The personnel to be assigned to implement the soft component are as follows.

1) Two (2) Japanese consultants (1 for well logging and 1 for pumping test)

Japanese consultants formulate the soft component plan and supervise the whole process of the soft component. They are responsible for report and discussion with the DRD and relevant organization of the Japanese side, and for transferring technique to the staff of the DRD.

2) Two (2) interpreters (locally hired) (1 for well logging and 1 for pumping test)

Local interpreters between English and Burmese are employed for the smooth implementation of the soft component since it is difficult to communicate with DRD' staff by English.

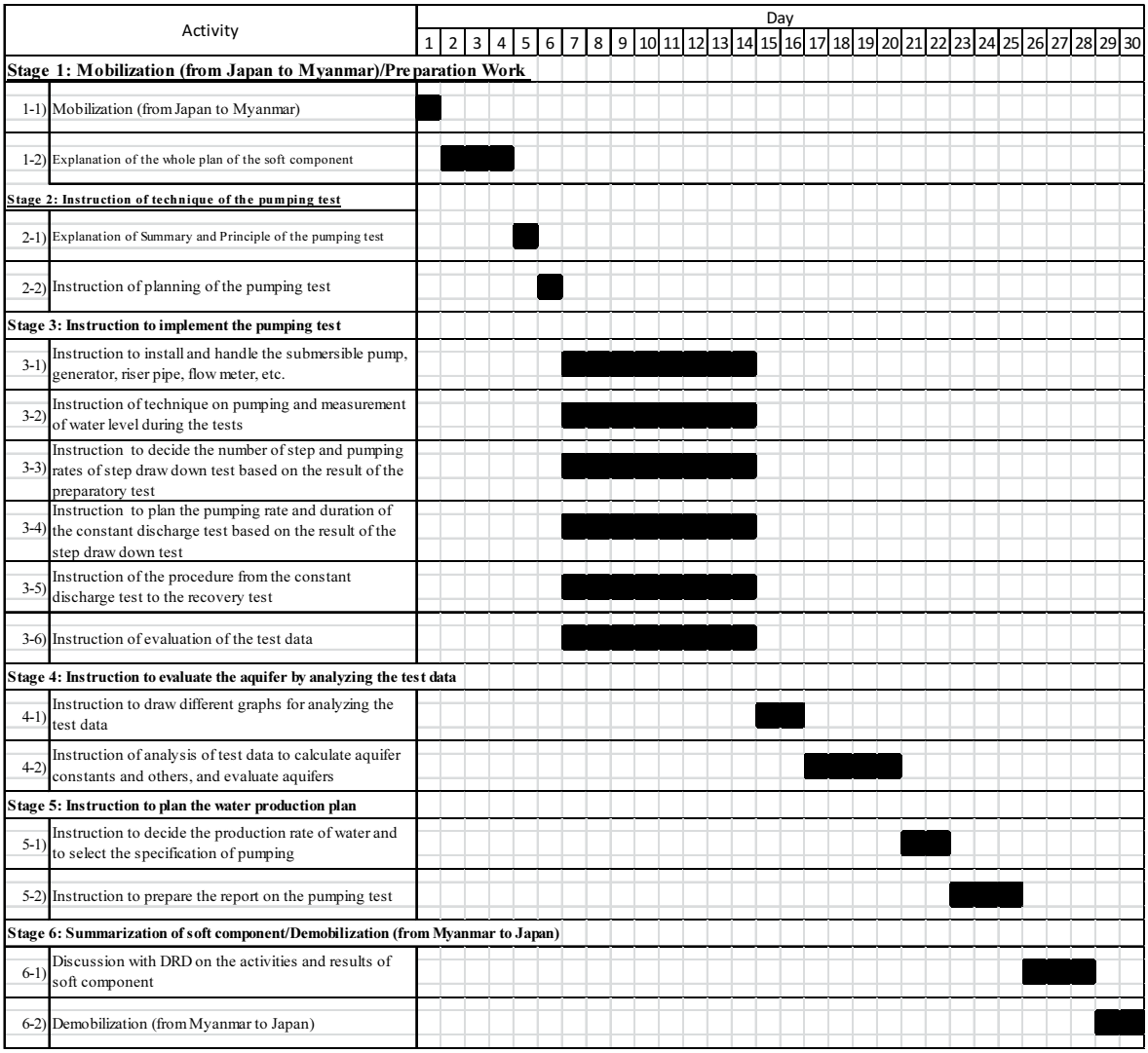
7) Implementation schedule of the soft component

Since the soft component program is carried out by using the logging machine and the pumping test unit to be procured in the Project, it is planned to implement succeeding to the initial operation training of those equipment. The implementation schedule is shown in Table 2.2.25 and Table 2.2.26.

Table 2.2.25 Implementation Schedule of the Soft Component on Well Logging

Activity		Day (1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30)
Stage 1: Mobilization (from Japan to Myanmar)/Preparation Work		
1-1)	Mobilization (from Japan to Myanmar)	
1-2)	Explanation of the whole plan of the soft component	
Stage 2: Instruction of technique of well logging		
2-1)	Explanation of Summary and Principle of Well Logging	
2-2)	Instruction of handle the well logging machine	
2-3)	Instruction of technique to carry out the well logging	
Stage 3: Instruction of technique to analyze the logging data		
3-1)	Instruction to classify the aquifer based on the well logging result	
3-2)	Instruction to modify the geological columnbased on the logging data	
Stage 4: Instruction to decide the well structure		
4-1)	Instruction to decide the target aquifer to abstract groundwater based on the result of well logging	
4-2)	Instruction to decide the section of screen to be installed against the target aquifer	
4-3)	Instruction to decide the well structure	
Stage 5: Summarization of soft component/Demobilization (from Myanmar to Japan)		
5-1)	Discussion with DRD on the activities and results of soft component	
5-2)	Demobilization (from Myanmar to Japan)	

Table 2.2.26 Implementation Schedule of the Soft Component on the Pumping Test



8) Output of the soft component

Output of the soft component on well logging and the pumping test are as follows.

(i) Soft component on well logging

- Soft component plan for well logging
- Logging data
- Geological column revised
- Well structure
- Manual for well logging (English and Burmese)
- Completion report of the soft component

(ii)Soft component on the pumping test

- Soft component plan for the pumping test
- Implementation plan for the pumping test
- Instruction document for step drawdown test
- Instruction document for constant discharge test

- Pumping test data
- Different graphs
- Aquifer constants, evaluation result of the aquifer
- Groundwater production plan
- Manual for the pumping test (English and Burmese)
- Completion report for the soft component

9) Implementation cost for the soft component

Implementation cost to be borne by the Japanese side for the soft component on well logging and the pumping test are expected to be 63 million MMK (1 MMK = 0.112 JPN).

10) Matters to be borne by the Myanmar side

For implementation of the soft component, the DRD is responsible for dispatching the staff to the program. The number of attendance to the program is expected to be 15 persons in total: Three (3) persons from the DRD Headquarters and four (4) persons each from three (3) regions (Sagaing, Mandalay and Magway Regions).

The DRD will bear the travel expense and allowance of the attendance, it is expected to be 3.5 million MMK.

(9) Implementation Schedule of the Project

1) Manufacturing period of the equipment

Drilling rigs and trucks with crane take the longest time for manufacturing compared to other equipment to be procured under the Project. According to the interview to the manufacturers, it takes one (1) month for prepare shop drawings and nine (9) months for assembling. Therefore, the period for design and manufacturing of rigs is estimated to be 10 months under the Project. Other equipment will take five (5) months for assembling. In order to deliver as soon as possible, delivery of the equipment is divided into two (2) times.

- The first shipment: Equipment to be assembled in five (5) months

  (Air compressor, Well logging machine, Consumables for borehole construction, Casing and screen, and Pumping test equipment)

- The second shipment: Equipment to be assembled in 10 months

  (Drilling rigs and Cargo truck with crane)

2) Delivery period and necessary procedures

After manufacturing of the equipment at the factory, each procedure for delivery of the equipment from the factory to Yangon will take the following period.

Dispatching from the factory - Shipment	1.0 month
Marine transportation – Custom clearance – Inland transportation (Yangon Port – DRD's Yard in Yangon)	2.0 months
Total	3.0 months

The total period for the first and second delivery from dispatching the factories to delivery to DRD's Yangon Yard is 3.0 months/time each.

3) Work Period for Installation of Equipment

The installation processes consists of three (3) works: Carrying in/Unpacking, Adjustment / preliminary operation and Instruction for preliminary operation. Each work will take the following periods. The total period for this process is 1.50 months.

Equipment of the first shipment	1.40 months
Equipment of the second shipment	0.73 months

4) Period for Inspection and Check

The inspection period is not included in the implementation schedule since it is conducted in the same period as the inspection for preliminary operation.

5) Estimation of period for Procurement

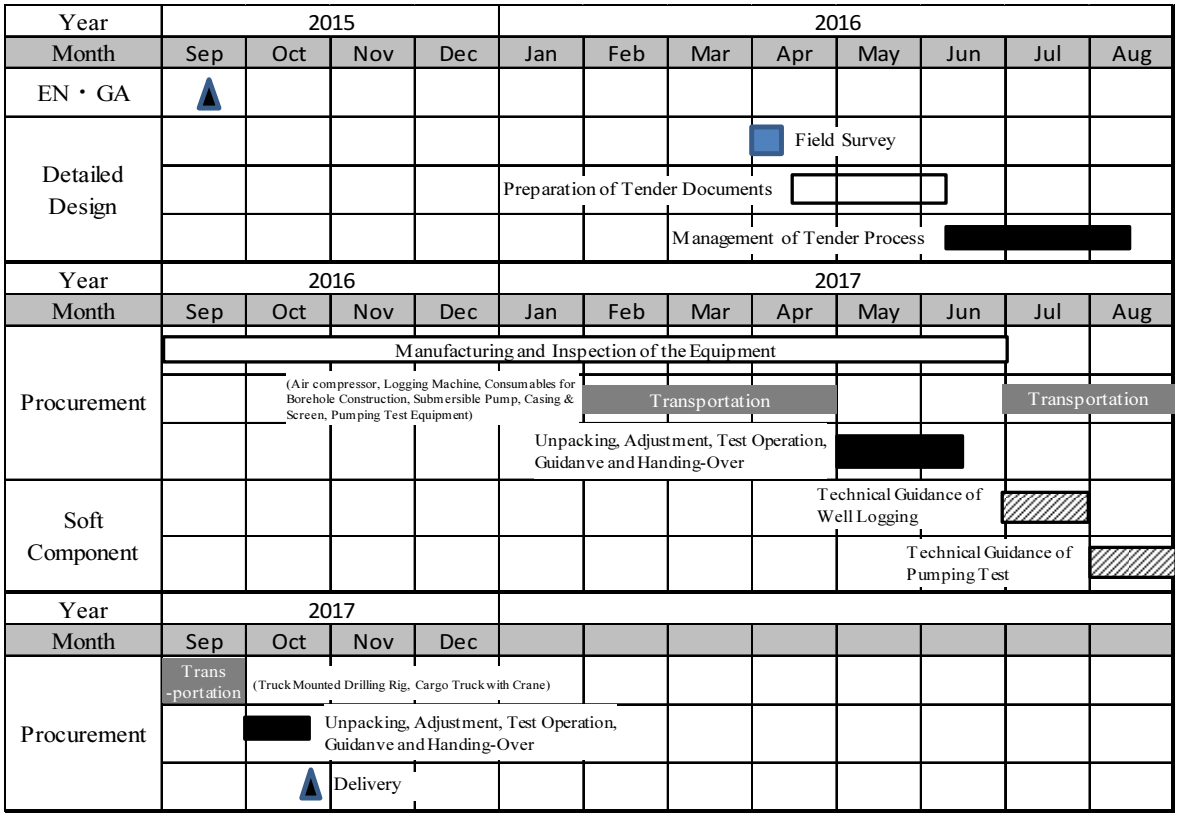
According to the above 1) to 4), the procurement period is calculated as follows.

Table 2.2.27 Procurement Schedule

Item	First Procurement	Second Procurement
Manufacturing period	5.00 months	10.00 months
Procedures / transportation period	3.00 months	3.00 months
Installation etc.	1.40 months	0.73 months
Total	9.40 months	13.73 months

The whole schedule of the Project will be 25.00 months as shown in Table 2.2.27.

Table 2.2.28 Implementation Schedule



2.3 OBLIGATION OF THE GOVERNMENT OF MYANMAR

2.3.1 GENERAL ISSUES

In implementation of the Project, the obligation of the Myanmar side is as follows.

- To bear the following commissions to a bank of Japanese for the banking services based upon the Banking Arrangement (B/A)
  1) Advising commission of Authorization to Pay (A/P)
  2) Payment commission
- To ensure prompt unloading and customs clearance at the port of disembarkation in Myanmar and to assist internal transportation of the products
  1) Tax exemption and custom clearance of the products at the port of disembarkation
  2) Internal transportation from the port of disembarkation to the Project site
- To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into Myanmar and stay therein for the performance of their work
- To exempt Japanese nationals from customs, duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract
- To maintain and use properly and effectively the equipment provided under the Grant Aid
- To bear all the expenses, other than those to be borne by the Grant Aid, necessary for the transportation and installation of the equipment
- To give due environmental and social consideration in the implementation of the Project
- To facilitate the data and information necessary for the detailed design study for the Project
- To get approval necessary for the implementation of the Project

2.3.2 SPECIFIC ISSUES IN THE PROJECT

- Drilling of deep wells by procured equipment
- Construction of distribution tank and control house for pumping
- Provision of staff necessary for operation and maintenance of the procured equipment
- Bearing the cost of travel expense and transportation cost of the staff who attend the soft component program
- Submitting reports JICA once a year about the progress of deep well construction, usage of the procured equipment and monitoring result of water quality

2.3.3 THE COST TO BE BORNE BY THE DRD

The cost to be borne by the DRD is that for the undertaking described in 3.2 above. Summary of these is shown in Table 2.3.1.

Table 2.3.1 Costs to be Borne by the Myanmar Side

Item	Cost ($x10^3$ MMK)
A. Cost for the First Year	
1) B/A and A/P	11,446
2) Deep Well Drilling	162,500
3) Construction of Water Supply Facility	268,300
4) Maintenance of the procured equipment	25,075
5) Travel allowance and expense for attending the soft component	3,500
6) Water Quality Analysis	356
Total for the First Year ①	471,177
B. Cost after the First Year	
1) Deep Well Drilling	162,500
2) Construction of Water Supply Facility	268,300
3) Maintenance of the procured equipment	25,075
4) Water Quality Analysis	356
Total for each Year after the First Year ②	456,231
Total after the First Year ③＝②× 4	1,824,924
Grand Total for 5 Years ①＋③	2,296,101

2.4 PROJECT OPERATION PLAN

2.4.1 ORGANIZATION OF IMPLEMENTATION AGENCY

The implementation agency of rural water supply in Myanmar is the Ministry of Livestock, Fishery and Rural Development (MLFRD). The MLFRD is composed of "Directorate of Livestock and Fisheries", "Livestock Breeding and Veterinary Department", "Department of Fisheries", "Department of Rural Development" and "University of Veterinary Science". If the Project is implemented as a Japan's Grant Aid Project, the DRD in the MLFRD is responsible for the management of the Project. The DRD controls all the rural water supply projects. Figure 2.4.1 shows the organization of the MLFRD and the DRD.

In the DRD, the highest position is Director General and he is followed by tow (2) Deputy Director Generals cum Chief Engineers, one is for planning and the other is for implementation. Four (4) Deputy Chief Engineers who are head of Divisions are posted under the Deputy Director cum Chief Engineer. The Rural Water Supply and Sanitation Division is responsible to implement the rural water supply projects. The DRD has seven (7) Regional Offices and seven (7) State Offices, and Township Office in each township.

The DRD has 5,566 staff in total: 350 persons in the headquarters and 5,216 persons in the region and state levels (As of June, 2015). Among them, 50 persons belong to the Headquarters of the Rural Water Supply and Sanitation Division.

The CDZ Project Office of the DRD will take responsible for actual implementation of the Project: deep well drilling, construction of water supply facilities, and operation and maintenance of the equipment and materials. The office is headed by a project manager. Under the Project manager, four (4) sections are allocated: They are Drilling Ground Water Survey Section, Rehabilitation Section, Maintenance & Monitoring Section and Maintenance Workshop. Eight (8) staff are allocated to the Maintenance Workshop which is responsible for maintenance of the equipment. Five (5) drilling crews are organized in the office and two (2) more crews will be organized if the Project is implemented.

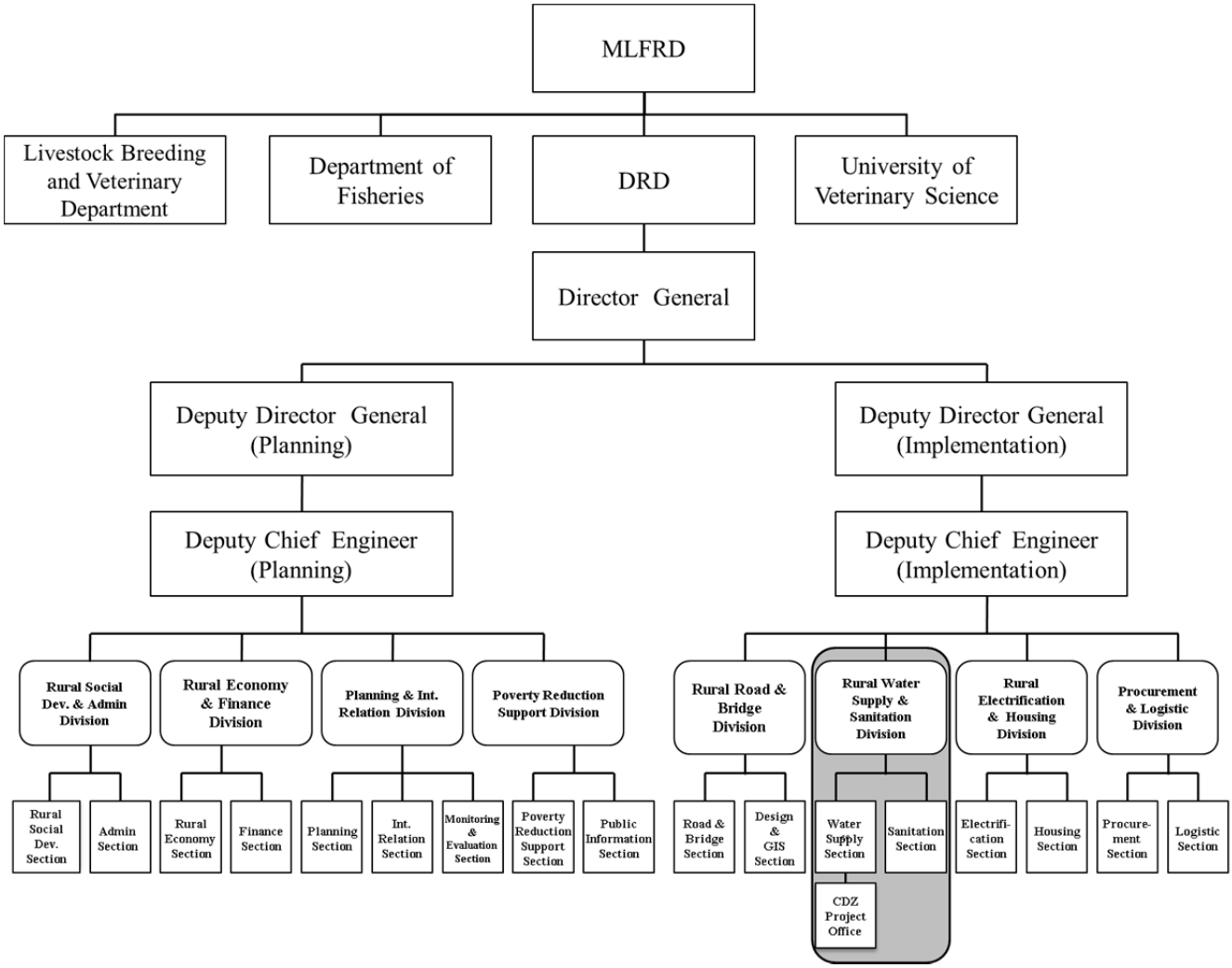


Figure 2.4.1 Organization Chart of the DRD

2.4.2 OPERATION AND MAINTENANCE OF THE PROCURED EQUIPMENT

The operation and maintenance fee for equipment to be procured for the Project will be covered by DRD's budget. However, the submersible pump and the generator installed into the well of each village will be operated and maintained by the residents of the village in principle.

The actual maintenance work for the newly procured equipment will be conducted in the Nyaungoo workshop of DRD. The workshop has effectively maintained the CDZ's five (5) rigs including three (3) rigs which were provided by Japan in 1980s to use with good condition. In the workshop, the staff of the drilling teams has carried out inspection, maintenance and replacement of parts of equipment, and the maintenance staff has carried out repairing of equipment. When the new drilling rigs will be procured, new drilling teams will be assembled. The maintenance of new rigs will be planned to be conducted by the drilling teams and the maintenance staff in the workshop as usual.

An estimate of new operation and maintenance cost for equipment to be procured by the Project is detailed in "2.5.2 Operation and Maintenance Cost". It is thought that no further operation and maintenance cost will be incurred, because the Project cost is small, the DRD has experience using the main equipment, and specification of the equipment is common and technically straightforward.

It was confirmed that operation and maintenance had been carried out without any problems

by the residents of the village where a new well was constructed by Phase 1 project. In the target villages in the Project, similar to Phase 1, the O & M guidance with training using handling manuals for a pump and a generator provided by the DRD is required for the residents.

2.4.3 WATER QUALITY ANALYSIS AND MONITORING

(1) Current System of Water Quality Analysis and Monitoring

1) Structure of Water Quality Analysis and Monitoring

The National Drinking Water Quality Standards (NDWQS) were established at the initiative of the Ministry of Health (MOH) in September 2014 and approved by the Myanmar government in June 2015. This Standard is applied for all of the drinking water in Myanmar with exception of commercial drinking water. Public information and sharing has been promoted with the relevant agency on public health and drinking water.

16 priority parameters are mentioned as water quality standards of drinking water in NDWQS. The method of the American Public Health Association (APHA) has been adopted as the standards method for a number parameter. On the other hand, considering the view of technical considerations and resources in Myanmar, another simple analytical method also has been accepted. 16 priority parameters and standard values are shown in Table 2.4.1.

Table 2.4.1 Priority Parameter in NDWQS

No	Parameter	NDWQS Standard Value	WHO Guideline	the Water Works Law in Japan	Possible to Analysis in DRD
1	Total Coliforms	3 MPN/100mL*1	Must not be detectable in any 100mL sample	Bacteria :100 colonies are detectable in 1 mL sample	×
2	Fecal Coliforms	0 MPN/100mL*1		E. Coli : Must not be detectable in sample	×
3	Taste	Acceptable / No objectionable Taste			○
4	Odor	Acceptable / No objectionable Odor			○
5	Color	15 TCU	15 TCU	5 Degree (W)	×
6	Turbidity	5 NTU	5 NTU*2	2 Degree (W)	○
7	Arsnic (As)	0.05 mg/L	0.01 mg/L (P)	0.01mg/L (H)	○
8	Lead (Pb)	0.01 mg/L	0.01 mg/L (P)	0.01mg/L (H)	×
9	Nitrate (NO_3)	50 mg/L	50 mg/L 11 mg/L as Nitrate-Nitrogen	10 mg/L as Nitrate-Nitrogen (H)	Δ
10	Manganese (Mn)	0.4 mg/L	0.4 mg/L (P)	0.05 mg/L (W)	○
11	Choloride (Cl)	250 mg/L	250 mg/L (C)	200 mg/L (W)	Δ
12	Hardness	500 mg/L as CaCO3	- (C)	500 mg/L (W)	○
13	Iron (Fe)	1.0 mg/L	0.3 mg/L (C)	0.3 mg/L	○
14	pH	6.5 - 8.5	-	5.8 – 8.6	○
15	Sulphate (SO_4)	250 mg/L	500 mg/L (C)	-	○
16	Total Dissolved Soild (TDS)	1,000 mg/L	1,000 mg/L (C)	500 mg/L (W)*3	○

*1 : the standard value of "Un-piped water supplies" which the target of the Project in the four kinds of water source type

*2 : Guideline value of small water supplies where resources are very limeted and where there is or no treatment

*3 : Standard value of "Total Solid"

Legend

○ : DRD can measure by owned equipment

△ : DRD can measure by owned equipment, but that does not corespond to NDWQS value

× : DRD can not measure by owned equipment (It is required to request to the analysis to MOH)

Remark

P : Provisional guideline value because of uncertainties in the health database.

C : Concentrations of the substance at or below the health-based guideline value may affect the appearance, taste or odour of the water, leading to consumer complaints.
H : Human health among water quality standard parameter
W : Water service shouold have the property among water quality standard parameter

Water quality monitoring frequency is defined on each analysis parameter and type of water source. Parameters for drinking water quality typically fall under three (3) categories such as Microbiological, Physical and Chemical. And also water source has four (4) types such as Treated-piped water, Water in distributed system, Un-piped water supplies and Emergency water supplies. Deep wells which are the target of the Project corresponds to "Un-piped water supplies". Analytical parameters and frequency show as follows

- Microbiological Quality Once initially
- Physical Quality Two times per year
- Chemical Quality Two times per year

2) Organization System of Water Quality Analysis

Water quality analysis for the rural water supply sector, the DRD which is the implementation agency of well drilling and construction will be continuously responsible. Currently, the Division of Rural Supply and Sanitation in the DRD Headquarters is responsible for water quality analysis. 18 parameters shown in Table 2.4.2 are measured using a simplified analytical instrument and spectrophotometer (SHIMAZU UVmini-1240). Parameters from No.1 to No.10 in the table have established a system that can be constantly measured in the DRD laboratory. On the other hand, from No.11 to No.18 request the MOH for analysis due to the lack of instruments and reagents. Procurement of reagents depended on support from UNICEF until 2014/2015, but the DRD has put in reagent purchase costs in the 2015 budget. This application has a higher possibility of obtaining approval, therefore, reagents will be procured by the DRD's own budget from 2016/2017 fiscal year.

Table 2.4.2 Possible Analysis Parameter in DRD

No	Parameter	Detectable Range	Remark
1	pH	0.00 – 14.00	Simplified pH meter
2	Electrical Conductivity (EC)	0-20,000 uS/cm	Simplified EC meter
3	Turbidity	0.0-100.0 NTU	Simplified Turbidity meter
4	Arsenic (AS)	0.005-0.5mg/L	Simplified colormeric method
5	TDS	0-20,000mg/L	Simplified TDS meter
6	Hardness	5.0-500.0 mg/L	Spectrophotometer (SHIMAZU UVmini-1240)
7	Fluoride (F)	0.2-1.2 mg/L	
8	Niterate (NO_3)	0.2-10.0 mg/L	
9	Iron (Fe)	0.1-10.0 mg/L	
10	Chloride (Cl)	2.0-200.0 mg/L	
11	Aluminium (Al)	0.05-0.40 mg/L	- To be mesaured by spectrophotometer. - To be requested the analysis to the MOH when the reagent is insufficient. - Reagents are expected to be available by purchasing the DRD's own budget from 2016/2017 fiscal year.
12	Calcium (Ca)	0.5-15.0 mg/L	
13	Chromium (Cr)	0.02-1.0 mg/L	
14	Copper (Cu)	0.1-5.0 mg/L	
15	Magnesium (Mg)	1.2-24.0 mg/L	
16	Manganese (Mn)	0.5-15.0 mg/L	
17	Sulphate (SO_4)	5.0-300.0 mg/L	
18	Zinc (Zn)	0.1-2.0 mg/L	

Five (5) staff who have knowledge of the chemical are assigned for water quality analysis in the DRD headquarters. One of them started to work for water quality analysis from 2012, but other four (4) staff were assigned from January 2015. Training of the handling of the analytical

instrument has been carried out by staff, so that another staff also is available to analyze it. The number of analyzed samples is around 100 to 200 (107 samples in 2012/2013, 166 samples in 2013/2014 and 187 samples in 2014/2015). The data reduction in Excel has been promoted including the past results data.

The laboratory of the DRD is located in the separated part of the office space by the partition, the instrument and systems do not satisfy the standard method of the NDWQS. At the present, the DRD does not have any plan to upgrade these facilities, water quality analysis will be continuously done corporation with the MOH. The MOH also agree to keep the current systems.

And procurement of a dedicated sampling bottle is difficult and expensive in Myanmar, therefore, a bottle of commercial drinking water (capacity is around 1L) is used for water sampling. The NDWQS recommends the applicable water sampling method such as immobilization of dissolved substances by nitrate acid or sulphuric acid, prewashing and low temperature transportation. The DRD headquarters is following this recommendation, and informs T/S staff who is in charge of sampling through the seminars and workshops. However, it is assumed that it is practically difficult to perform these methods.

3) Organization System of Water Quality Monitoring

The DRD conducts water quality analysis once when construction of the well is completed. After that well is handed over and managed by the VWC, water quality monitoring is not conducted continuously. If villagers feel discomfort from the well water, the VWC will ask the T/S office staff to check and analyze the water quality. But the requests from the Township office do not mention specific analysis parameters, and the DRD laboratory has responded to the items which are available to analyze by its own instruments. Also the laboratory of the DRD headquarters cannot comprehend all of sample information such as sampling location, sampling conditions, depth of well, etc. so that a unified sampling format does not exist.

4) Implementation system of Water Quality Analysis and Monitoring

The system related to water quality analysis standards and monitoring of drinking water was established by the NDWQS. However the MOH has difficulty to immediately apply this standard for all of the water supply facilities in Myanmar due to the lack of technique and resources. It is difficult for the DRD to carry out analysis and monitoring along the standard method in the present condition, because the DRD should manage a lot of water supply facilities in all of the country. Therefore, the implementation plan and operation system of the DRD should be discussed and coordinated with relevant organizations.

The current analysis method at the DRD laboratory is different from the standard method of NDWQS. There is an accuracy issue to be analyzed by spectrophotometer and simplified measurement instrument. On the other hand as described above 1), NDWQS also approved the result of the other simplified analytical method. In case of the DRD and the MOH, these organizations already have a good relationship, so that immediate upgrade of instruments is not required for the near term. However, parts of the specified new parameter are not available to be analyzed or included out of the measurement range by the DRD owned instruments. It will be desirable to add the request items by discussion with the MOH. The MOH has analytical instrument according to the standard method (such as Atomic Absorption Spectrophotometer, Gas Chromatography and etc.) and also has sufficient equipment for carrying out the detailed analysis.

It was confirmed that information sharing with the DRD headquarters and Township office has not been closely related to results of water quality analysis. The DRD and Township office are warning residents to stop using well water in case it contains some harmful substance such as

Arsenic, heavy metal, etc. But provision of information to residents is often not enough when the human health effects risk is considered to be relatively small. For such occasions, Township staff empirically knows the characteristics of the water quality in the area of responsibility, but that is not based on hydrogeological rationale and result of analysis. According to the NDWQS, process of sampling, data management, frequency and monitoring will be officially announced as the standard method. It is necessary to systematically organize and share the results of analysis which is based on the unified format of specific information of samples. Therefore, the Project proposes continuous water quality monitoring. Details are shown in next section.

(2) Proposed Water Quality Monitoring of Groundwater

The priority 16 parameters are mentioned as water quality monitoring parameters for water supply facilities in the NDWQS (ref. Table 2.4.1). As described in 2.4.3 (1), the enforcement policy and the scope of application have not been formulated and coordinated by each relevant organization which is in charge of water supply. And it is unrealistic and difficult in the current system of the DRD to conduct monitoring for all of water supply facilities that are in their jurisdiction.

Therefore, the Project proposes the pilot implementation of continuous water quality monitoring along with NDWQS regarding new well drilling. Analytical parameters are not only the 16 parameters shown in NDWQS, including parameters that the DRD has carried out in the analysis up to now. The parameters which cannot be analyzed by DRD are assumed to be carried out by consignment to the MOH as in the past. In addition, the person in charge of the MOH replied that has no objection to continuously cooperate with DRD. Analysis results of each water resource should be summarized in the data sheet, and should be entered into the simple database using Microsoft Excel. These data will contribute to future water quality management.

The necessary contents for the water quality monitoring are shown in Table 2.4.3. And an updated data sheet is shown in Figure 2.4.2.

Table 2.4.3 Necessary Items for Water Quality Monitoring

Items	Contents	
Well Information	・ Well ID ・ Region / State ・ Name of Township ・ Name of Village ・ Latitude and Longitude (if not available, smapling location should be mentioned) ・ Type of Water Source (such as Deep well, Shallow well, Pond, Channel and etc.) ・ Depth of Well ・ Yield ・ Person of Sampling, Sampling Date ・ Laboratory Code, Anaysis Date	
Analysis Parameter	【General Conditions】 10 Parameters	Genaral Coliforms, Faecal Coliforms, pH, Electrical Conductivity (EC), Taste, Odor, Color, Turbidity, Hardness, TDS
	【Metal】 9 Parameters	Aluminium, Calcium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Zinc
	【Non Metal】 5 Parameters	Arsenic, Chloride, Flouride, Nitrate, Sulphate
Frequency	・ Once at the completion of the drilling of well ・ Once a year in the selected wells in the following cases based on the result of water quality analysis at the completion of the drilling of well ➢ water quality of a well meets the standard and/or the WHO Guidelines (ver. 4) but it is very close to the standard or Guidelines ➢ there is an existing deep well, of which water quality does not meet the standard or Guidelines, close to the well drilled in the Project.	

Items	Contents
	➢ there is any facility which may cause groundwater pollution (factories, mines, etc.) in the adjacent area of the target village.
Scope of Application	・ New well drilled by the Project

※Underline is required parameters except priority parameter including consignment to MOH or analyzed by DRD up to now.

Ministry of Livestock, Fisheries and Rural Development

Department of Rural Development

Water Chemical Analysis Report

Sheet No		Sample ID	
Person of Sampling		Sampling Date	
Lab. Code		Analysis Date	
Regiion/Sate		Latitude	
Township		Longitude	
Village		Depth	
Sources		Yield (gph)	

No	Chemical Prameters	Result	Chemically Potable Range
1	pH		6.5 - 8.5
2	Electrical Conductivity		0 - 1,500 uS/cm
3	Total Coliforms		0 - 3 MPN/100ml
4	Faecal Coliforms		0 MPN/100ml
5	Taste		Acceptable / No objectionable Taste
6	Odor		Acceptable / No objectionable Odor
7	Color		0 - 15 TCU (True Color Unit)
8	Turbidity		0 - 5 NTU (Nephelometric Turbidity Unit)
9	Hardness		0 - 500 mg/l as $CaCO_3$
10	Total Dissolved Solid (TDS)		0 - 1,000 mg/l
11	Aluminium (Al)		0 - 0.2 mg/l
12	Calcium (Ca)		0 - 200 mg/l
13	Chromium (Cr)		0 - 0.05 mg/l
14	Copper (Cu)		0 - 2.0 mg/l
15	Iron (Fe)		0 - 1.0 mg/l
16	Lead (Pb)		0 - 0.01 mg/l
17	Magnesium (Mg)		0 - 150 mg/l
18	Manganese (Mn)		0 - 0.4 mg/l
19	Zinc (Zn)		0 - 3.0 mg/l
20	Arsenic (As)		0 - 0.05 mg/l
21	Chloride (Cl)		0 - 250 mg/l
22	Fluoride (F)		0 - 1.5 mg/l
23	Nitrate (as N)		0 - 50 mg/l
24	Sulphate (SO4)		0 - 250 mg/l

Remark -

Chemist

Gary Area in Figure is consigned to analyse to MOH until now or requirement in hereafter.

Figure 2.4.2 Proposed Data Sheet for Water Quality Analysis

(3) Measures when Water Quality Parameter Exceeds the Standard

The DRD will construct water supply facilities by using existing and newly procured equipment when the Project is implemented. It is agreed between the DRD and JICA in the Minutes concluded on 30 April 2015 to report to the JICA Myanmar office about the following issues as the Progress Monitoring Report periodically.

As for water quality, the following issues were agreed in the Technical Notes signed on 2 July 2015, the Record of Discussions attached to the Grant Agreement for the Project concluded on 16 September 2015 and the Minutes of discussions signed on 20 October 2015.

1) The DRD will analyze the water quality at the completion of the drilling of deep wells and the results shall be included in the Progress Monitoring Report to be submitted to the JICA Myanmar office every year. Necessary cost for this issue is borne by the DRD.
2) In the following cases, the DRD will monitor water quality once a year.
   a) Water quality of a well meets the standard and/or WHO Guidelines (ver. 4) but it is very close to the standard or Guidelines
   b) There is an existing deep well, of which water quality does not meet the standard or Guidelines, close to the well drilled in the Phase 2 project.
   c) There is any facility which may cause groundwater pollution (factories, mines, etc.) in the adjacent area of the target village.
3) If the water quality does not satisfy the standard, such water shall be used only for purposes other than drinking. In such case DRD shall properly inform and instruct the community people not to drink the water of such well to avoid occurrence of health hazards. If the community people use the water for drinking, DRD will take necessary measures such as refilling the well.

2.4.4 RECOMMENDATION FOR DESIGNING OF WATER SUPPLY FACILITY

(1) Construction of Elevated Water Supply Tank

Fetching water by bull carts is common in the CDZ. However, water supply to the bull carts is limited to the time when the pump is working. Therefore, the bull carts will make long que around the water supply facility. It is considered that it is waste of the time and the water supply efficiency is low.

In order to solve this problem, it is proposed to construct the elevated water supply tank about 2 to 3m high from the ground level. It makes possible to supply water to plural bull carts at once even when the pump is not working and contributes to improve the efficiency of water supply. In addition, such elevated tank is capable to supply water by pipes to the houses in the village. Therefore, it is recommended to introduce the elevated tank as shown in Figure 2.4.3 when the DRD designs the water supply facilities in the Project.

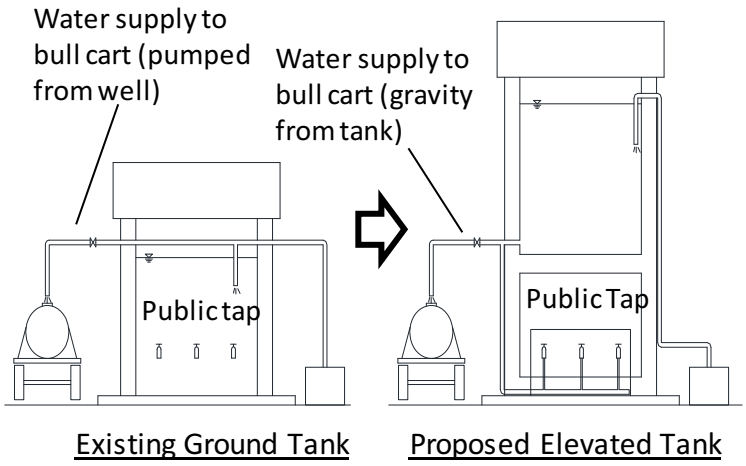


Figure 2.4.3 Proposal of the Elevated Water Supply Tank

(2) Sealing of the Top of the Water Supply Tank

It was confirmed in the study that the water supply tank in the villages visited had mostly no sealing on the top of the tank, therefore, dust or unsanitary materials would be easily enter the tank. Furthermore, mosquito could be generated and it would cause diseases such as malaria and dengue fever. Such situation can be easily improved by sealing the top of the water supply tank. Therefore, it is recommended to design the sealing to cover the water supply tank in the Project.

2.4.5 OPERATION AND MAINTENANCE OF WATER SUPPLY FACILITIES TO BE CONSTRUCTED

(1) Current Situation of O&M of Water Supply Facilities Constructed in the CDZ Phase 1 Project

In order to understand the current situation of O&M, the Study Team visited target villages of the CDZ Phase 1 project in Sagaing, Mandalay, and Magway regions.

Preliminary before the field survey was conducted, Japanese experts interviewed officials of DRD about the condition of water supply facilities constructed in the CDZ Phase 1 project. According to their explanation, all of them were basically in good conditions without technical failures because these facilities had just a short operation period. Therefore, the focuses of this field survey were concentrated and assessed the status of i): the establishment of village water committees, ii): Assistance from administrative authorities on O&M, iii): Current situation of O&M of water supply facilities. Table 2.4.4 shows villages of the Phase 1 project, where the survey was conducted.

Table 2.4.4 List of Villages of the CDZ Phase 1 Project Targeted in This Survey

Region	Township	Village	Commencement of Operation	Population Served
Sagaing	Yinmabin	Pho Win Taung	Dec, 2014	1,000
	Pale	Min Tain Pin	June, 2015	6,000
Mandalay	Nyaungoo	Magyizauk	Oct, 2013	889
		Kudaw	May, 2013	2,687
		Myanegyi	Jan, 2013	898
Magway	Chauk	Htanzu	Feb, 2014	550
		Yaylar	Feb, 2014	1040
		Zeechobin	June, 2014	775

Remark: Data given from the DRD was edited by the Project

1) Establishment of VWC

The CDZ Project office of the DRD explained to the Project that VWCs have already been established in all target villages in the Phase 1 project. In fact, it was confirmed that people in 8 villages listed above (Table 2.4.4 List of Villages of the CDZ Phase 1 project targeted in this Survey) had a series of discussion among villages and came to establish their VWCs during the construction of facilities. The common composition of these 8 VWCs includes chairperson, treasurer and other members. The number of VWC members surveyed is summarized in Table 2.4.5.

Table 2.4.5 No. of VWCs in the Phase 1 Villages

Region	Township	Village	Number		
			Male	Female	Total
Sagaing	Yinmabin	Pho Win Taung	10	0	10
	Pale	Min Tain Pin	10	0	10
Mandalay	Nyaungoo	Magyizauk	12	3	15
		Kudaw	15	0	15
		Myanegyi	7	0	7
Magway	Chauk	Htanzu	15	0	15
		Yaylar	25	0	25
		Zeechobin	5	0	5

It is only Magyzauk village in Mandalay that women participate in VWC. According the interview to members of VWC, the reason of absence of female members in VWCs is mostly due to the requirement of physical strength for operation of pumps and technical maintenance. From the women's point of view, this arrangement is quite supportive because women were busy for house chores so that, they think, men are suitable to be members of VWC. Besides, women interviewed in this survey also mentioned that they could express their demand requests directly to village assemblies and VWCs if necessary.

In the survey, Japanese experts recognized that all VWCs did not have their user rules stipulating a composition, tenure, responsibility/obligation, etc. It seems that these issues were discussed and agreed in a village assembly when a VWC was officially established. However, these issues agreed among users have been documented in writing. Obviously shown in Table 2.4.5, the number of VWCs varies from one to another. It is simply because of absence of a guideline to assist the establishment of VWCs. On the other hand, the operation of water supply facilities was contracted to private technicians as an operator in all villages.

2) Official Assistance on O&M from Administrative Authorities

According to the result of the interview, it was realized that DRD in target regions have provided technical training to VWCs supported in the CDZ Phase 1 project in order to strengthen VWCs to implement O&M of water supply facilities in a sustainable way. At the same time, they provided technical assistance to VWCs for identifying a problem, estimating cost of repair & maintenance and even bridging VWCs to service providers.

With regard to the financial management of O&M, principally VWCs need to disburse the cost of O&M from their water funds. However, in case of high costs more than the amount of their water fund, VWCs commonly request users (villages) to contribute the share for maintenance or repair. VWCs interviewed explained that they did not encounter such a situation because their facilities were rather new. However, they also mentioned that communities as whole had various experiences to sustain the public institution or facility such monasteries and schools, therefore they believed that they could handle both technical and financial matters when

their facilities had a problem. Even though they have some experiences, there would be an occasion when the cost of repair or maintenance exceeds more than their financial capacity. In such an occasion, VWCs will consider a request to DRD or township offices to provide the financial assistance to VWCs.

3) Status of O&M of Water Supply Facilities

For assessing the status of O&M in the target villages of the CDZ Phase 1 project, the indicators shown in Table 2.4.6 were employed by referring other projects related to O&M of water supply facilities.

Table 2.4.6 Assessment Indicators for O&M

Area		Indicators	Focal Points
Status of Functionality	a)	Condition of Generator	Is electricity produced without any problem in a generator?
	b)	Condition of Submersible Pump	Is a yield of pumping obtained as planned?
	c)	Condition of Storage Tank and Water KIOSK	Is there any leakage or breakage in a system?
Status of O&M by VWC	d)	Establishment of VWC	Is VWC established after making agreement or consensus among villagers?
	e)	Record of Operation	Is the operation of a generator and pump recorded regularly?
	f)	Record of Financial Management	Is the revenue from fee collection and the expenditure for any payment recorded regularly?

The result of assessment on the status of O&M is summarized in Table 2.4.7. In addition to the result, important findings supplementing the assessment are also noted.

Table 2.4.7 Result of Assessment on O&M

Region	Village	Commencement of Operation	Status of Operation*		Status of O&M by VWC*		Important Findings
Sagain	Pho Win Taung	Dec, 2014	a)	Good	d)	Good	Pipeline was installed with own cost from villagers and connected to all households already.
			b)	Good	e)	Good	
			c)	Good	f)	Good	
	Min Tain Pin	June, 2015	a)	Good	d)	Good	Elevated water tank was under construction with own cost. Pipes for distribution were purchased.
			b)	Good	e)	Good	
			c)	Good	f)	Good	
Mandalay	Magyizauk	Oct, 2013	a)	Good	d)	Good	Storage tank was newly constructed with assistance from NGO and household connection covers now 75% of entire population.
			b)	Good	e)	Good	
			c)	Good	f)	Good	
	Kudaw	May, 2013	a)	Good	d)	Good	Bigger capacity water tank was constructed with assistance from NGO
			b)	Good	e)	Good	
			c)	Good	f)	Good	
	Myaenegyi	Jan, 2013	a)	Good	d)	Good	Nothing particular.
			b)	Good	e)	Good	
			c)	Good	f)	Good	
Magway	Htanzu	Feb, 2014	a)	Good	d)	Good	VWC constructed net fence around generator house and well with own cost.
			b)	Good	e)	Good	
			c)	Good	f)	Good	
	Yaylar	Feb, 2014	a)	Good	d)	Good	With own cost pipeline was installed to primary school and monetary for free service.
			b)	Good	e)	Good	
			c)	Good	f)	Good	

Region	Village	Commencement of Operation	Status of Operation*		Status of O&M by VWC*		Important Findings
	Zeechobin	June, 2014	a)	Good	d)	Good	Nothing particular.
			b)	Good	e)	Good	
			c)	Good	f)	Good	

*: Assessment indicators in Table 2.4.6 is applied

According to explanation given from each regional office of DRD, all the target villages in the CDZ Phase 1 project have got their VWC established during the construction period and these VWCs are active enough to provide water supply services regularly to users. In fact, Japanese experts visited 8 facilities and recognized indicators of O&M including functionality and O&M showed very positive. Even though the period after the commencement of operation in these villages is still short, the observation, in which Japanese experts directly appreciated to see the cleanliness around generator houses as well as other facilities, convinced strongly Japanese experts to accept that these VWCs could have strong sense of ownership upon facilities constructed in the CDZ Phase 1 project.

It was confirmed that private operators employed in surveyed 8 facilities kept records of operation of a generator and submersible pump regularly. Besides, treasurers in VWCs kept revenue from fee collection and donation from users and expenditure for diesel, salary, etc. For these record keeping exercises, DRD has not provided any training or seminar in the past as revealed from the interview. Nevertheless, all surveyed VWCs practiced record keeping properly. However, the communication between VWCs and DRD is minimal with regard to the progress of O&M, which might be caused because VWCs are not obliged to send their report to DRD due to the absence of a guideline for O&M.

Some surveyed VWCs opted for the house connection by installing a pipeline and elevated water tank. The expansion of facilities was basically planned by referring the design of water supply facilities in the vicinity of their villages and also realized by VWCs together with volunteers from villages but independently without support from DRD or township offices. Considering such their dedication and capacity, Japanese experts came to be certain of the provision of sustainable water supply services from water supply facilities constructed in the CDZ Phase 1 project.

Materials and human resources necessary for O&M of facilities could be available from hardware shops and car garages existing in villages. Therefore, VWCs are able to take a quick action when maintenance and repair of facilities needs to be done. However, in case of serious damages in facilities, VWCs have to communicate any workshop providing professional services in big cities like Mandalay or Yangon.

(2) Policy and Regulation on O&M for Rural Water Supply

Based on analysis on the existing official documentations for rural water supply, it could be fair to conclude that there is no policy and regulation on O&M of water supply facilities in rural water sector. Besides, the number of new water supply facilities to be constructed in rural parts of Myanmar is clearly indicated in National Comprehensive Development Plan (from 2011 to 2030; 20-Year Plan) but the component of O&M for existing water supply facilities is totally missing in this plan. In addition to this, as it is described several times in the previous sections, a guideline for establishing VWCs and regulation on O&M by VWC are not in place yet.

The Study Team interviewed representatives of UNICEF and acknowledged that the lack of policy and regulation on O&M in rural water sector was widely recognized among governmental institutions like DRD and Ministry of Health, and other stakeholders of this sector through Water,

Sanitation and Hygiene Sector Situation Analysis (2014), which was conducted jointly by World Bank, UNICEF, JICA, and other development partners. At the time of this survey, the development of Rural Water Strategy would be assigned to a consultant to be employed with the support of UNICEF. The Study Team obtained and examined TOR for this consultancy work as well as TOR for a taskforce to manage the consultancy work. Unfortunately the Study Team could not capture the entire picture on the direction of O&M in rural sector from these documents.

(3) Current Organizational Arrangement and Situation of O&M in CDZ

The status of water supply facilities constructed in the CDZ Phase 1 project was described in the previous section. In addition to it, the status of water supply facilities constructed with a financial assistance directly from DRD was also examined and confirmed as good as that in the CDZ Phase 1 project. Based on close observation and interview to stakeholders of rural water supply in target regions, current organizational arrangement is assessed empirically and summarized in Table 2.4.8.

Table 2.4.8 Outline of Current Situation of Water Facilities funded by DRD

1: Kadin Village /Yamethin Municipality/ Mandalay Region		
<Basic Information>		
i:	Household	240
ii:	Population	Approx. 2800
iii:	Electrification	Public line is available (booster pump is supplied with electricity from it)
iv:	Type of Water Facility	Shallow tube well and water storage tank were constructed by February 2015 and O&M started since March 2015.
<Situation of O&M>		
v:	VWC has been formed with a membership of 5 men (no woman). The reason why no woman participates is mostly because physical strength is required for general works including pump operation and maintenance of facilities as well as water services are provided to users in morning and evening when women need to do house chores. Villagers collected totally 1,800,000 MMK (each household contributed 45,000 MMK) for installing distribution pipelines. At present 240 households in this village and 40 in a neighbouring village came to have a private connection from pipelines. Tariff for water service is charged with 600 MMK/220 gallons (equivalent to 1000 L). Chairperson of VWC explained that the amount of tariff was calculated by estimating possible items of expenditure. At the time of the survey, VWC had no water fund available from collecting water tariff. However, VWC considered that amount of unpaid contribution from users, which values 450,000 MMK, shall be available water fund. Since the commencement of O&M, VWC receives often technical assistance from DRD and does not have any case of breakage and damage in water facilities.	
 Water Pump with Diesel Engine		 Water Storage Tank
2: Zee Taw Village / Raw Bwe Municipality / Mandalay Region		
<Basic Information>		
i:	Household	200
ii:	Population	Approx. 1100
iii:	Electrification	No public line
iv:	Type of Water Facility	Deep tube well and water tank were constructed by March 2014 and O&M started at the same time.
<Situation of O&M>		

v: VWC has been formed with a membership of 5 men (no woman). The reason why no woman participates is mostly because physical strength is required for general works including pump operation and maintenance of facilities as well as water services are provided to users in morning and evening when women need to do house chores.
Only 25 households out of 200 in this village utilize this water facility. On the other hand, other 175 households basically possess hand pumps in their residences. 5 members of VWC are basically selected from 25 households. Water tariff is not principally collected but the cost of diesel purchase is shared by 11 groups of users, which are divided from 25 households. Each group bears 200 MMK (2 L of diesel) each time when it is in charge. Although this facility is under good condition, water from it contains salt enough to stop users drinking. Therefore, they use this water for other house chores such as washing cloths and bathing. Since the commencement of O&M, VWC does not have any case of breakage and damage in water facilities.

Air Compressor with Diesel Engine

Water Storage Tank

Based on close observation and interview to stakeholders of rural water supply in target regions, current organizational arrangement is assessed empirically and summarized in Table 2.4.9.

Table 2.4.9 Current Organizational Arrangement and Status on O&M (Empirical)

No.	Organization		Roles and Responsibilities	Current Situation
	DRD	Headquarters	Development of policy, regulation, and guideline for O&M	Policy, regulation and guideline for O&M are undeveloped.
			Budget arrangement for assisting O&M	No budget is planned for assisting O&M.
		Region	Provision of technical assistance for maintenance and repair of facilities	On request basis, rehabilitation of tube wells and cost estimation of repair/maintenance is provided.
		Township	Provision of technical and financial training to VWCs	Training on maintenance/repair of generator/pump is provided to VWCs but that on water service management.
2	VWC		O&M of facilities, collection of water fee	Condition of facilities is well maintained. Cost recovery is not considered in setting water tariff.
			Regular report on O&M to authorities and users	No regular report on O&M is sent to DRD or other authority.
3	Villagers		Selection of members of VWC	Arrangement on establishment of VWC and tariff setting is not uniform/ consistent in regions.
			Payment of water fee	Users pay water fee as agreed in each village and also provide contribution in case of large amount of expenditure.
4	Private Sector (retailer, suppliers)		Sales of spare parts (generator, pump, pipe, etc.) , provision of maintenance and repair services	Spare parts for generators and pumps used in agriculture in regions are available widely and technician & services of maintenance/repair are also easily accessible.

In fact, there is no standard model of O&M which was fully guided by particular regulations and/or guidelines. Therefore, it should be remarked that the assessment conducted in this survey could illustrate only one phase of situation and still require more comprehensive studies for precise understanding on the situation.

(4) Outlines of O&M Plan after the Implementation of Action Plan

1) Organizational Structure for O&M

It could be assumed that the organizational arrangement described in Table 2.4.9 shall be the most practical and acceptable for target villages if new arrangement or approach is not introduced in the rural water strategy currently under development. This existing organizational arrangement is not only widely accepted and practiced by target villages, but also adapted to a local custom. Therefore, it can be easily institutionalized to target villages as well as township offices in regions.

2) O&M Cost Estimation Analysis for Target Villages

In order to estimate the cost of O&M for selected 100 target villages, the conditions of O&M are set as described as following. Firstly the consumption rate per person and day shall be 20 gallons (about 90 liters). Standard discharge rate of pumping is supposed 100 liters/minutes based on the rate in existing water supply facilities in regions. With regard to the depreciation cost of constructed facilities is not included in the estimation because it is not considered in the water fees for facilities constructed in the CDZ Phase 1 project and other existing facilities. Major components of O&M expenditures would be fuel purchase (diesel), salary for employed operators, purchase of spare parts for generators and pumps (maintenance cost), stationary, and communication. The proportion of total expenditure shall be assumed as 80% for fuel purchase, 10% for maintenance cost, 5% each for salary and other miscellaneous costs.

In order to estimate critically the expenditure for fuel purchase, which is the biggest component of total expenditure, a load rate to generators are calculated based on rated outputs of submersible pumps to be installed, and then fuel consumption rates (liter/hour) at a calculated load rate are estimated by taking a weighted average of consumption rates at 50% load rate and 75% load rate (by referring DENYO generators). The results of the cost estimation of O&M for selected 100 target villages are summarized in Table 2.4.10.

Table 2.4.10 Estimated Monthly Average Expenditure for O&M in Target Villages

Region	Project ID	Village	No. of H/H	Population	Annual Average Income (MMK)	Annual Cost of O&M for Each H/H (MMK)	% of O&M Cost over Average H/H Income
Sagaing	SA2-01	Yonedaw	96	450	1,578,000	49,834	3.16
	SA2-02	Nyaungbinthar	53	223	2,305,200	44,731	1.94
	SA2-03	MaungHtanng	1,010	4,303	2,964,000	45,293	1.53
	SA2-04	Kantawthar	110	450	1,596,000	43,491	2.73
	SA2-05	Mhonehtoo	50	204	1,206,000	43,375	3.60
	SA2-06	Wattuu I	220	860	2,448,000	41,558	1.70
	SA2-07	Thann Pin Kan	198	935	1,740,000	57,376	3.30
	SA2-08	Nat Yay Kan	171	900	1,896,000	63,947	3.37
	SA2-09	Sithar	85	412	1,506,000	51,530	3.42
	SA2-10	Oakkan	300	800	1,524,000	28,350	1.86
	SA2-11	Waryaung	920	4,000	2,892,000	52,826	1.83
	SA2-12	WarTannKalay	100	1,000	2,184,000	106,313	4.87
	SA2-14	Zeepinlae	350	1,879	1,950,000	57,074	2.93
	SA2-16	MinDaw	280	1,100	4,860,000	41,766	0.86
	SA2-17	Kine	72	280	1,344,000	41,344	3.08
	SA2-18	Kalapyan	78	383	1,806,000	52,202	2.89
	SA2-19	HLayOoKan	63	585	1,596,000	112,822	7.07
	SA2-21	Watkya	153	748	2,424,000	51,976	2.14

Region	Project ID	Village	No. of H/H	Population	Annual Average Income (MMK)	Annual Cost of O&M for Each H/H (MMK)	% of O&M Cost over Average H/H Income
	SA2-22	ThaHtayKone	55	410	3,762,000	90,572	2.41
	SA2-24	Thindaw	60	817	2,268,000	144,762	6.38
	SA2-25	LwinGyi	60	499	1,944,000	101,047	5.20
	SA2-26	Kyaunkone	253	1,171	2,532,000	56,236	2.22
	SA2-27	Inngoteto	280	1,278	1,986,000	48,524	2.44
	SA2-28	Myayhtoo	386	1,844	1,340,004	89,483	6.68
	SA2-29	Khnowntar	104	1,004	2,280,000	102,632	4.50
	SA2-30	Nyaungkanthar	123	539	2,064,000	53,243	2.58
	SA2-31	Myaymon	415	2,527	2,688,000	64,735	2.41
	SA2-32	Layytwinzin	150	714	4,938,000	57,834	1.17
	SA2-33	Chaungchar	102	513	2,436,000	61,108	2.51
	SA2-34	Minyogone	79	445	1,968,000	59,885	3.04
	SA2-35	Shandaw	70	415	2,761,200	72,032	2.61
	SA2-36	Kyuntaw	100	420	1,734,000	44,651	2.58
	SA2-37	Palae Thwe	63	250	1,572,000	42,187	2.68
	SA2-38	Poukkan	267	1,500	1,728,000	59,726	3.46
Madalay	MA2-01	Htantawgy	100	284	4,025,460	30,193	0.75
	MA2-02	Asone	145	635	1,332,000	46,558	3.50
	MA2-03	Khinthar	80	490	2,064,000	65,117	3.15
	MA2-04	Chaysay	243	1,326	2,538,000	58,013	2.29
	MA2-05	Talgyi	160	761	3,672,000	50,564	1.38
	MA2-07	Yonehto	147	703	1,290,000	50,842	3.94
	MA2-11	Kaungzin	144	864	1,464,000	72,900	4.98
	MA2-14	Kyaungkangyibin	77	435	1,808,724	105,820	5.85
	MA2-15	Nyaunggone	136	689	2,676,000	53,860	2.01
	MA2-17	Chaungsone	80	793	3,632,724	120,437	3.32
	MA2-19	Tharzi	183	988	1,932,000	101,129	5.23
	MA2-20	KanAye	94	300	1,977,000	59,780	3.02
	MA2-21	Tharyarmyaing	380	1,927	2,190,000	94,987	4.34
	MA2-22	Oakpo	210	1,500	1,350,000	75,937	5.63
	MA2-23	Kangyi	320	1,503	2,832,000	87,978	3.11
	MA2-24	Htanekan	230	1,200	4,320,000	63,391	1.47
	MA2-25	Waryonesu	197	1,000	1,764,000	53,965	3.06
	MA2-26	Talkone	53	427	2,028,000	150,911	7.44
	MA2-27	Tawbyar	57	300	2,460,000	98,586	4.01
	MA2-28	Setsetyo	174	991	1,560,000	135,515	8.69
	MA2-29	Kanzauk	243	1,150	3,096,000	57,500	1.86
	MA2-30	Talbindel	101	512	1,302,000	94,955	7.29
	MA2-31	Mongywettaaw	82	300	1,464,000	68,528	4.68
	MA2-32	PhoneKan	70	392	4,008,000	59,536	1.49
	MA2-33	Nyaungpinthar	23	113	1,932,000	59,694	3.09
	MA2-34	Saingkan	201	908	1,782,000	107,486	6.03
	MA2-35	Byugyi	320	1,987	1,920,000	147,744	7.70
	MA2-36	Aleywar	226	1,089	1,650,000	90,258	5.47
	MA2-38	Thayattaw	145	300	1,776,000	21,996	1.24
	MA2-39	Tangakan	185	1,000	1,627,500	128,615	7.90
	MA2-40	Nakyatkhwal	1,067	6,130	1,632,000	107,612	6.59
Magway	MG2-01	Natkan	310	1,244	3,972,000	42,662	1.07
	MG2-02	Thanbo	64	297	2,856,000	49,336	1.73
	MG2-03	Nyaungpinthar	267	1,450	2,382,000	101,724	4.27
	MG2-04	Konegyi	254	1,187	2,466,000	87,535	3.55
	MG2-05	Sainggya	416	1,760	3,306,000	79,248	2.40

Region	Project ID	Village	No. of H/H	Population	Annual Average Income (MMK)	Annual Cost of O&M for Each H/H (MMK)	% of O&M Cost over Average H/H Income
	MG2-06	Thapyaysan (N)	72	250	4,110,000	42,187	1.03
	MG2-07	Shwekyaw	95	253	1,356,000	32,357	2.39
	MG2-08	Leikkan	228	1,134	1,740,000	52,877	3.04
	MG2-09	Ywarthitgyi	310	1,820	2,112,000	71,333	3.38
	MG2-10	Kanyaygyi	230	1,246	2,637,600	128,900	4.89
	MG2-11	Myaysoon	63	328	1,921,200	97,522	5.08
	MG2-12	Zeenwar	245	1,175	3,648,000	50,987	1.40
	MG2-13	Yenpyay	36	155	1,254,000	52,313	4.17
	MG2-14	Kyatesu	165	720	1,554,000	46,391	2.99
	MG2-15	Winkabar	580	2,600	1,176,000	47,657	4.05
	MG2-16	Kyatkan	116	478	2,784,000	43,808	1.57
	MG2-17	Sudat	96	450	1,974,000	111,533	5.65
	MG2-18	Myaynialin	38	235	1,509,600	115,838	7.67
	MG2-19	Lelkyinyoe	297	1,500	2,424,000	94,602	3.90
	MG2-20	Laytinesin	597	2,246	2,238,000	45,710	2.04
	MG2-21	Tharmyar	571	3,211	2,604,000	68,326	2.62
	MG2-22	Ayaungmyinthar	197	1,260	2,088,000	67,997	3.26
	MG2-23	Ngwelay	340	910	2,544,000	28,454	1.12
	MG2-24	Indaw(N)	203	490	1,200,000	25,662	2.14
	MG2-26	Manowtgone	182	795	1,200,000	46,439	3.87
	MG2-27	Kangyigone	65	350	2,904,000	100,860	3.47
	MG2-28	Htonepouthchine	380	2,050	2,748,000	57,353	2.09
	MG2-33	Wayonegone	150	727	2,301,000	51,526	2.24
	MG2-34	Nyaunggone	312	1,200	1,200,000	40,890	3.41
	MG2-35	Kyugyaung	90	550	1,301,328	114,469	8.80
	MG2-36	Ko kkohla	220	904	1,638,000	76,968	4.70
	MG2-37	Kangyigone	235	1,100	3,126,000	56,873	1.82
	MG2-38	Htaukkyantgwin	270	1,539	1,512,000	106,768	7.06
	MG2-39	Hlebwegyi	190	543	1,584,000	53,532	3.38
	MG2-40	Yayhtwetgyi	137	655	1,464,000	58,090	3.97

Remark: coloured cells show villages with excess of monthly share % of O&M cost more than 5% of average H/H income

The number of target villages, in which monthly share (%) of O&M cost per each household exceeds 5% of average household income in each target village, is totally 20, Magway: 5, Mandalay: 11, Sagaing: 4, respectively. In these villages, the pump head is relatively high more than 200m, which requires a bigger type of generator (> 30KVA) and eventually inflates the expenditure for fuel purchase. Besides, in a target village where family member in a household is more than 6 persons, the cost share of O&M per household tends to increase and exceeds 5% of their household income.

(5) Recommendation to the Myanmar Side

There are some negative factors as long term risks on O&M of water supply facilities identified during the survey. In the following section, the recommendation for mitigation/prevention of identified risks is explained thoroughly.

1) Institutionalization of Organizational Structure and Responsibilities for O&M

In 20-Year Plan, it is targeted that 100% of accessibility to clean and safe water will be achieved in rural areas. In order to achieve this, only the construction of new water supply

facilities is selected as a method/process in this plan. Logically this approach is not promising the achievement of 100% water coverage in rural areas because there would water supply facilities which may stop their operation due to various reasons such as breakage, abandon, etc. This means that the sustainability of water supply facilities is also an absolute factor to achieve a primary objective of 20-Year Plan. For this new aspect, it should be recommended that a certain organizational structure for O&M is supposed to be introduced and institutionalized in the rural water strategy with a certain consideration of current conditions of functionality of facilities in rural areas.

In addition to this, the development of various guidelines is also recommended to make sure the rural water strategy to be implemented effectively. Especially a guideline for O&M, which identifies stakeholders involved and stipulates their roles and responsibilities, needs to be developed with higher priority. Considering a current situation, guidelines for the establishment of VWC and setting of water tariff are also recommended as well.

2) Provision of Support to O&M at Villages from Authorities at Township

When VWC of a village faces a shortage of water funds to maintain/repair their water supply facility, initially VWC requests villages to provide their contribution to increase the water fund. However, VWC commonly requests township authorities (DRD and township administration) to provide financial support in case the amount of contribution collected at the village level does not reach the required amount. In such a case, township authorities include a requested amount to their budget plan for the coming fiscal year, which means that VWC is not able to take any action of maintenance/repair and resume the operation of water supply facility until township authorities provides assistance. Such a situation will greatly discourage VWC to sustain their facilities in the long run and will affect negatively the functionality of existing facilities and eventually the achievement of 100% accessibility targeted in the 20-Year Plan. In order to mitigate such a situations, township authorities are recommended to establish a specific fund for O&M of water supply facilities and to be ready to provide finance to VWCs as per requested. In addition to this, introduction of a licensing system of VWC at township level might be effective to manage the provision of a specific funds for O&M. This licensing system requires all VWCs to report the progress of O&M in their facilities and in return they can have access to a specific fund for O&M.

3) Support to Target Villages With Burden of O&M Cost

Suppose that all population in target villages consume 20 gallon/day (about 90 L/day), there will be households where the monthly share % of O&M cost exceeds 5% of their household income. Especially households categorized as worse off with less than 100,000 kyat as monthly household income may have relatively higher share % of O&M cost than other households of better off and middle classes. Special attention needs to be paid to target villages where share % of O&M cost exceeds more than 5 % of average household income shown in Table 2.4.10 These villages may have a more critical situation, in which lots of households would come to perceive a burden on payment of O&M cost seriously, than other villages

In order to mitigate or prevent confusion/refusal of sharing O&M cost among communities in future, township DRD offices are strongly recommended to retain close communication with VWCs and representatives of target villages by providing adequate explanation on the cost of O&M as well as obtain the agreement of the commencement of the Project before the implementation starts. Furthermore, before and after the completion of the construction, township DRD offices also are recommended to assist VWC of target villages to mobilize people to accept technically adequate water tariff and set the special treatment to household with

difficulty of payment for water services.

Furthermore, after O&M starts in target villages, DRD is recommended to carry out regular hearings on financial burdens mostly to households in the worse off level. In case they have significant financial difficulties caused by payment of the water tariff, DRD needs to introduce deduction/reduction of water tariff as special treatment for worse off households. Besides, DRD is also required to monitor the status of O&M including finance and physical conditions and provide technical as well as administrative guidance for making sure their sustainable provision of water services to users.

2.5 PROJECT COST ESTIMATION

2.5.1 INITIAL COST ESTIMATION

The approximate cost to be borne by the Myanmar side is summarized in Table 2.5.1 (same as Table 2.3.1).

Table 2.5.1 Cost to be Borne by the Myanmar Side

2,296 millionn MMK (About 257 million Yen)

Item	Cost (x10^3 MMK)
A. Cost for the First Year	
1) B/A and A/P	11,446
2) Deep Well Drilling	162,500
3) Construction of Water Supply Facility	268,300
4) Maintenance of the procured equipment	25,075
5) Travel allowance and expense for attending the soft component	3,500
6) Water Quality Analysis	356
Total for the First Year ①	471,177
B. Cost after the First Year	
1) Deep Well Drilling	162,500
2) Construction of Water Supply Facility	268,300
3) Maintenance of the procured equipment	25,075
4) Water Quality Analysis	356
Total for each Year after the First Year ②	456,231
Total after the First Year ③＝②× 4	1,824,924
Grand Total for 5 Years ①＋③	2,296,101

Condition of the cost estimation is as follows:

- Date of estimation : July 2015
- Exchange rate : 1 US$ = 122.43 Japanese Yen
- : 1 MMK = 0.112 Japanese Yen
- Project period : The period for the detailed design and procurement is as shown in Table 2.4.8. Implementation Schedule.
- Other : The project is implemented under the Japan's Grant Aid Assistance Scheme.

2.5.2 OPERATION AND MAINTENANCE COST

Operation and maintenance costs for the equipment are as shown in Table 5.2.2. The cost shown in Table 5.2.2 is for annual cost. Therefore, the total cost is five (5) times of it, 125,375 thousand MMK. The annual costs is also shown in "3) Maintenance Cost of the Procured

Equipment" in Table 2.5.2. Breakdown of the cost is shown in Appendix 5.8.

Table 2.5.2 Operation and Maintenance Cost

(unit : MMK)

Item	Number	Cost per Unit	Annual Cost
Drilling rig	2	5,800,000	11,600,000
Cargo truck with crane	2	5,500,000	11,000,000
Air compressor	2	625,000	1,250,000
Submersible pump	2	150,000	300,000
Generator (*	1	625,000	625,000
Logging machine	2	150,000	300,000
Total			25,075,000

*) for submersible pump

CHAPTER 3 PROJECT EVALUATION

3.1 PRECONDITIONS OF PROJECT IMPLEMENTATION

The contents of the Project are to provide drilling rigs, related equipment and supporting vehicles, as well as technical transfer on the well logging and the pumping test techniques. Preconditions on the Myanmar side for the implementation of the Project are that the issues described in 2.3 of Chapter 2 should be secured by the Myanmar side. Among them, especially important issues are as follows.

(1) To bear necessary Commissions for the Banking Services based upon the Banking Arrangement (B/A)

It is indispensable to engage the Agreement with a Japanese consultant and Contract with a Japanese supplier in order to implement the Project. Payments based on the Agreement and Contract are assured by an Authorization to Pay (A/P). Therefore, the Myanmar side is requested to take necessary procedures for issuance of A/P as soon as possible after verification of the Agreement and Contract by JICA, to pay the Agreement and Contract prices based on the A/P, and to bear necessary commissions for the banking services.

(2) Immediate customs clearance for the equipment and materials necessary for the Project

The equipment and materials recurred in the Project are transported to Yangon Port, where customs clearance is done. After customs clearance, the equipment and materials are transported to the DRD's yard in Yangon and they are inspected there. Delay of customs clearance will cause delay of delivery of the equipment and materials, and will cause delay of the implementation of the Project. Therefore, the DRD is requested to assist the smooth customs clearance of the equipment and materials.

(3) To exempt tax and custom clearance of the Japanese nationals whose services may be required for implementation of Japan's Grant Aid

It is a principle that tax and custom of the Japanese nationals whose services may be required for implementation of the Japan's Grant Aid project are exempted. Therefore, the DRD is requested to surely take necessary procedures.

(4) To secure staff for operation and maintenance for the procured Equipment

The DRD has an intention to increase the following staff if the Project is implemented. It is requested to the DRD to provide the necessary number of staff following the plan.

- Two (2) drilling teams will be added to the current five (5) drilling teams (8 persons/team x 5 teams) of the CDZ Project Office.
- Several staff will be added to the staff of the workshop of the CDZ Project Office.

(5) To submit to JICA annual progress reports on the construction work utilizing the equipment and materials procured under the Project, and monitoring results of the water quality in the target villages

The DRD will construct 100 deep wells in the target villages in the CDZ utilizing the

equipment and materials procured under the Project. It was agreed that the DRD will submit annual progress reports on the construction work to the JICA Myanmar Office following the format, Annex 8 Monitoring Form attached to the Minutes of Discussions signed on 20 October 2015 between the DRD and JICA. In addition, it is also requested to include the result of water quality monitoring as described in Table 2.4.3 Necessary Items for Water Quality Monitoring.

3.2 NECESSARY INPUT BY THE MYANMAR SIDE

Necessary input by the Myanmar side for attaining the Project target is as follows.

3.2.1 DRILLING OF WELLS BY THE RIGS PROCURED IN THE PROJECT

The equipment and materials to be procured in the Project are for the drilling of wells in the target villages in the CDZ. Therefore, after procurement, those equipment and materials shall be used for the drilling of the 100 deep wells in the target villages as planned in the Project.

3.2.2 CONSTRUCTION OF RURAL WATER SUPPLY FACILITIES USING THE DRILLED WELLS AS THE WATER SOURCE

The wells to be drilled in the Project are used as the water source of the rural water supply facility in the target villages. Therefore, it is necessary that the rural water supply facilities should be immediately constructed by the DRD after the completion of the drilling of wells.

3.2.3 OPERATION AND MAINTENANCE OF THE CONSTRUCTED RURAL WATER SUPPLY FACILITIES

The rural water supply facilities of which water source are the wells drilled in the Project will be operated and maintained by the Village Water Committee (VWC) organized in the respective target villages. It is desirable that recommendations described in “2.4.5 Operation and Maintenance of Water Supply Facilities to be Constructed” in Chapter 2 should be considered in the operation and maintenance.

3.3 IMPORTANT ASSUMPTIONS

In order to realize and sustain the effects of the Project implementation, the following external conditions are required.

- Priority of the CDZ on rural water supply of Myanmar is continued.
- Relevant staff who received technical transfer in the Project pursue the rural water supply project by the DRD.

3.4 EVALUATION OF THE PROJECT

3.4.1 RELEVANCE

In the CDZ, the target area of the Project, there are many villages where safe and sustainable water sources are not available because the surface water except for the Irrawaddy River is not available and deep wells are required to get groundwater. Implementation of the Project will newly provide safe and sustainable water sources to 100 villages in the CDZ which had no such water sources, and a positive spreading impact to decrease fetching work of water by the community people is expected.

The policy to improve socio-economic conditions of the rural populace and to narrow down the development gap between rural and urban area is advocated in Myanmar. Accordingly, the DRD is accelerating the development of rural water supply facilities in the rural area. In the CDZ

where villages are obliged to rely on water sources on groundwater, to strengthen the ability of the DRD to develop groundwater and accelerate the development of rural water supply facilities to meet Myanmar's policy.

The target area of the Project is mainly farming areas and implementation of the Project will contribute to improvement of the life of community people and stabilization of the people's livelihood from the viewpoint of basic human needs to supply safe and sustainable water to the people. Since one of the prioritized area of Japan's assistance policy is assistance to improve the livelihood of the people (including assistance to ethnic minorities and the poverty group, agricultural development and regional development), implementation of the Project meets the Japan's assistance policy.

3.4.2 EFFECTIVENESS

(1) Quantitative Effectiveness

After the equipment and materials are procured in the Project, the 100 deep wells will be drilled in the 100 target villages in the CDZ by the DRD. In addition, the capacity of the DRD on the groundwater development is strengthened by the soft component. Through these input, the quantitative shown in Table 3.4.1 is expected.

Table 3.4.1 Quantitative Effectiveness by the Project

Index	Base Line (2015)	Target (2022) (5 years after the completion of the Project)
Number of new wells drilled in the target villages	0 well	100 wells

(2) Qualitative Effectiveness

The implementation of the Project is expected to have the following qualitative effects.

- Fetching work and hours of water of the people in the CDZ will be reduced.
- Number of people who have access to safe water is increased in the target villages.

3.4.3 CONCLUSION

As discussed in 3.4.1 and 3.4.2, it is evaluated that the relevance to implementation of the Project is high and great effectiveness is expected.

APPENDIX 1

MEMBER LIST OF THE STUDY TEAM

Appendix 1　Member List of the Study Team

(1) During Field Survey

No.	Name	Position	Organization
1	Mr. Toshio MURAKAMI	Team Leader	JICA
2	Ms. Tomoko KASHIHARA	Survey Planning	JICA
3	Mr. Yasumasa YAMASAKI	Chief Consultant / Groundwater Development Planner	ESS
4	Mr. Toru YORITATE	Hydrogeologist-1 / Geophysicit-1	OCG
5	Dr. Yuji MARUO	Hydrogeologist-2	ESS
6	Mr. Kengo OHASHI	Geophysicit-2	ESS
7	Mr. Akira SASAKI	Water Quality Specialist	ESS
8	Mr. Tomohiro KATO	Operation and Maintenance Planner	ESS
9	Mr. Yusuke OSHIKA	Equipment Planner / Procurement Planner	ESS
10	Mr. Yuki YAMASHIRO	Cost Estimator	ESS
11	Dr. Zayer Win	Coordinator / Implementation and Procurement Planner-2	OCG

(2) During Explanation and Discussion on Draft Preparatory Survey Report and Draft Specification of Equipment

No.	Name	Position	Organization
1	Ms. Eriko TAMURA	Team Leader	JICA
2	Mr. Yasumasa YAMASAKI	Chief Consultant / Groundwater Development Planner	ESS
3	Mr. Toru YORITATE	Hydrogeologist-1 / Geophysicit-1	OCG
4	Mr. Yusuke OSHIKA	Equipment Planner / Procurement Planner	ESS

<NOTE>

JICA: Japan International Cooperation Agency

ESS: Earth System Science Co., Ltd.

OCG: Oriental Consultants Global Co., Ltd.

APPENDIX 2

STUDY SCHEDULE

Appendix 2　Study Schedule

(1)　Field Survey

Date			JICA Official		Study Team								
			Dr. Murakami	Ms. Kahihara	Mr. Yamasaki	Mr. Yoritate	Mr. Maruo	Mr. Ohashi	Mr. Sasaki	Mr. Kato	Mr. Oshika	Mr. Yamashiro	Mr. Zayer Win
			Mission Leader	Planner/ Manager	Chief Consultant/ Groundwater Development Planner	Hydrogeologist-1/ Geophysicist-1	Hydrogeologist-2	Geophysicist-2	Water Quality Sepcialist	Operation and Maintenance Planner	Eqiuipment Planner/ Procurement Planner	Cost Estimator	Coordinator/ Equipment and Procurement Planner-2
April,2015	26	Sun	Transfer (NRT-BGN)			Transfer (NRT-BGN)					Transfer (NRT-BGN)		Transfer (NRT-BGN)
	27	Mon	Courtesy call on JICA			Courtesy call on JICA					Courtesy call on JICA		Courtesy call on JICA
	28	Tue	Discussion on the Minutes			Discussion on the Minutes					Discussion on the Minutes		Discussion on the Minutes
	29	Wed	Field Survey			Field Survey					Field Survey		Field Survey
	30	Thu	Signature on the Minutes			Signature on the Minutes					Signature on the Minutes		Signature on the Minutes
May, 2015	1	Fri	Report to JICA and Embassy			Report to JICA and Embassy					Report to JICA and Embassy		Report to JICA and Embassy
	2	Sat	Transfer (BGN-NRT)			Internal Meeting					Internal Meeting		Internal Meeting
	3	Sun				Move to Naypyidaw					Organize of materirals		Organize of materirals
	4	Mon				Move to Nyaungoo, Discussion with CDZ					Prepare for Local Contract		Prepare for Local Contract
	5	Tue							Transfer (NRT-BGN)				
	6	Wed							Prepare for Field Survey				
	7	Thu				Field Survey	Field Survey				Suvey for Procurement		Suvey for Procurement
	8	Fri							Prepare for Local Contract				
	9	Sat			Transfer (NRT-BGN)			Transfer (NRT-BGN)					
	10	Sun			Internal Meeting						Internal Meeting		Internal Meeting
	11	Mon			Prepare for Local Contract				Prepare for Local Contract		Suvey for Procurement		Suvey for Procurement
	12	Tue			Move to Naypyidaw	Field Survey	Field Survey	Move to Naypyidaw	Move to Naypyidaw		Move to Naypyidaw		Move to Naypyidaw
	13	Wed			Discussion with DRD			Discussion with DRD	Discussion with DRD		Discussion with DRD		Discussion with DRD
	14	Thu				Discussion with CDZ	Discussion with CDZ						
	15	Fri			Discussion with CDZ			Discussion with CDZ	Discussion with CDZ		Discussion with CDZ		Discussion with CDZ
	16	Sat											
	17	Sun			Data Analysis			Prepare for Field Survey	Data Analysis		Organize of materirals		Organize of materirals
	18	Mon			Field Survey	Field Survey	Field Survey	Geophysical Survey	Field Survey				
	19	Tue									Discussion with CDZ		Discussion with CDZ
	20	Wed			Discussion with DRD			Data Analysis	Discussion with DRD				
	21	Thu						Geophysical Survey					
	22	Fri			Discussion with CDZ	Discussion with CDZ	Discussion with CDZ		Discussion with CDZ	Transfer (NRT-BGN)	Move to Yangon	Transfer (NRT-BGN)	Move to Yangon
	23	Sat						Data Analysis		Prepare for Survey	Meeting for Cost Estimation		
	24	Sun			Data Analysis	Field Survey	Field Survey		Field Survey	Data Analysis	Data Analysis		
	25	Mon			Discussion with DRD	Data Analysis					Suvey for Procurement		
	26	Tue					Data Analysis		Organize of materirals	Prepare for Local Contract			
	27	Wed			Data Analysis						Move to Nyaungoo		
	28	Thu			Discussion with CDZ	Discussion with CDZ	Discussion with CDZ		Discussion with CDZ	Move to Nyaungoo	Discussion with CDZ		
	29	Fri					Data Analysis			Field Survey	Suvey for Procurement		
	30	Sat				Move to Magway							
	31	Sun			Data Analysis	Geophysical Survey	Move to Naypyidaw		Data Analysis		Move to Naypyidaw		
June, 2015	1	Mon				Discussion with DRD	Discussion with DRD				Discussion with DRD		
	2	Tue				Data Analysis				Social Suvey	Meeting for Cost Estimation		
	3	Wed			Move to Nyaungoo		Move to Yangon		Move to Nyaungoo		Move to Yangon		
	4	Thu					Report to JICA						
	5	Fri			Discussion with CDZ	Discussion with CDZ			Discussion with CDZ		Suvey for Procurement		
	6	Sat					Data Analysis						
	7	Sun			Internal Meeting				Internal Meeting				
	8	Mon			Prepare for Local Contract				Prepare for Local Contract		Suvey for Procurement		
	9	Tue								Data Analysis	Transfer (BGN-NRT)		Transfer (BGN-NRT)
	10	Wed				Data Analysis	Transfer (BGN-NRT)		Data Analysis			Suvey for Cost Estimation	
	11	Thu			Data Analysis			Data Amnalysis		Visitation of Existing Facility			
	12	Fri				Visitation of Existing Facility			Visitation of Existing Facility				
	13	Sat				Data Analysis		Geophysical Survey	Data Analysis	Data Analysis			
	14	Sun							Geophysical Survey			Data Analysis	
	15	Mon			Prepare for Local Contract			Prepare for Local Contract	Sampling for Water Quality Anaysis				
	16	Tue			Data Analysis	Data Analysis						Suvey for Cost Estimation	
	17	Wed			Discussion with CDZ	Discussion with CDZ			Discussion with CDZ				
	18	Thu			Discussion with DRD	Data Analysis			Discussion with DRD	Discussion with DRD			
	19	Fri			Data Analysis	Move to Yangon			Data Analysis				
	20	Sat			Move to Yangon	Data Analysis		Geophysical Survey	Move to Yangon	Move to Yangon			
	21	Sun			Data Analysis				Data Analysis	Data Analysis		Data Analysis	
	22	Mon				Transfer (BGN-BKK)						Suvey for Cost Estimation	
	23	Tue			TV Meeting				TV Meeting	TV Meeting		TV Meeting	
	24	Wed			Discussion with MOH				Discussion with MOH	Discussion with MOH		Data Analysis	
	25	Thu			Discussion with UNICEF			Discussion with DRD	Data Analysis	Discussion with UNICEF		Transfer (BGN-NRT)	
	26	Fri							Interview to Analysis Company				
	27	Sat			Data Analysis			Geophysical Survey	Data Analysis	Data Analysis			
	28	Sun						Discussion with DRD	Transfer (BGN-NRT)				
	29	Mon						Geophysical Survey					
	30	Tue			Discussion with DRD			Discussion with DRD		Discussion with DRD			
July, 2015	1	Wed						Move to Yangon					
	2	Thu			Signature on Technical Note			Transfer (BGN-NRT)		Signature on Technical Note			
	3	Fri			Report to JICA and Embassy								
	4	Sat			Data Analysis								
	5	Sun			Move to Yangon					Data Analysis			
	6	Mon			Transfer (BGN-NRT)								
	7	Tue											
	8	Wed											
	9	Thu								Report to JICA			
	10	Fri								Transfer (BGN-NRT)			

(2) Explanation and Discussion on Draft Preparatory Survey Report

Date			JICA Official	Study Team		
			Ms. Tamura	**Mr. Yamasaki**	**Mr. Yoritate**	**Mr. Oshika**
			Team Leader	Chief Consultant/ Groundwater Development Planner	Hydrogeologist-1/ Geophysicist-1	Eqiuipment Planner/ Procurement Planner
October, 2015	18	Sun	Transfer (NRT-BGN)			
	19	Mon	Explation and Discussion of Draft Final Report with DRD			
	20	Tue	Discussion and Signature on M/D, Call on village			
	21	Wed	Report on JICA and Embassy	Participate in WASH Strategy Workshop		
	22	Thu	Transfer (BGN-NRT)	Visit to DRD Yard in Yangon		
	23	Fri		Acceptance of Local Contract Result		
	24	Sat		Transfer (BGN-NRT)		

APPENDIX 3

LIST OF PARTIES CONCERNED

Appendix 3 List of Parties Concerned in Myanmar

(1) Field Survey

Name	Position
Embassy of Japanese in Myanmar	
Mr. Hideaki MATSUO	Counsellor
Mr. Syoichi WATABE	2nd Secretary
JICA Myanmar Office	
Mr. Keiichiro NAKAZAWA	Chief Representative
Mr. Kyosuke INADA	Senior Representative
Mr. Kohei ISA	Representative
Mr. Jun YAMAZAKI	Representative
UNICEF Myanmar Office	
Mr. Bishunu Pokhrel	
Mr. Khin Aung Thein	
Bridge Asia Japan	
Ms. Akiko MORI	Country Representative
Ministry of Livestock, Fishery and Rural Development, Department of Rural Development	
Mr, Khant Zaw	Director General
Mr. Mynt Oo	Deputy Director General (Chief Engineer)
Mr. U Hla Thein Aung	Deputy Chief Engineer
Mr. Hla Khaing	Director, Rural Water Supply and Sanitation Division
Dr. Zarni Minn	Deputy Director
Mr. Kyaw Thu Aung	Deputy Director, Rural Water Supply and Sanitation Division
Dr. Win Min Oo	Assistant Director, Rural Water Supply and Sanitation Division
Mr. Thant Sin Win	Assistant Engineer, Rural Water Supply and Sanitation Division
Mr. Win Nyunt	Deputy Director, Magway Region & CDZ
Mr. Soe Naing	Deputy Director, Labutta District, Ayeyarwaddy Region
Mr. Aung Shein	Assistant Director, Nyaung Oo District & CDZ
Mr. Ye Khaung	Deputy Director, Poverty Reduction Support Division
Ms. Hual Zik	Deputy Director, Finance Division
Ministry of Health	
Dr. Kyi Lwin Oo	Deputy Director, Occupational and Environmental Health Division

(2)　Explanation and Discussion on the Draft Preparatory Survey Report

Name	Position
Embassy of Japanese in Myanmar	
Mr. Hideaki MATSUO	Counsellor
Mr. Syoichi WATABE	2nd Secretary
JICA Myanmar Office	
Mr. Keichiro NAKAZAWA	Chief Representative
Mr. Kyosuke INADA	Senior Representative
Mr. Kohei ISA	Representative
Mr. Jun YAMAZAKI	Representative
Mr. Tun Myint Thein	Program Officer
UNICEF Myanmar Office	
Ms. Penelope Campbell	Chief, Young Child Survival & Development Section
Ministry of Livestock, Fishery and Rural Development, Department of Rural Development	
Mr. Khant Zaw	Director General
Mr. Hla Thein Aung	Deputy Chief Engineer
Mr. Kyaw Thu Aung	Deputy Director, Rural Water Supply and Sanitation Division
Mr. Win Nyunt	Deputy Director, Magway Region & CDZ
Mr. Soe Naing	Deputy Director, Labutta District, Ayeyarwaddy Region
Dr. Win Min Oo	Assistant Director, Rural Water Supply and Sanitation Division
Ministry of Health	
Dr. Kyi Lwin Oo	Deputy Director, Occupational and Environmental Health Division

APPENDIX 4

MINUTES OF DISCUSSIONS

4.1 Minutes of Discussions (30th April, 2015)

4.2 Technical Note (2nd July, 2015)

4.3 Minutes of Discussions (20th October, 2015)

Appendix 4. Minutes of Discussions

4.1 Minutes of Discussions (Date of Signature: 30th April, 2015)

MINUTES OF DISCUSSIONS
ON
THE PREPARATORY SURVEY
ON
THE PROVISION OF EQUIPMENT FOR RURAL WATER SUPPLY PROJECT
IN THE CENTRAL DRY ZONE PHASE II
IN THE REPUBLIC OF THE UNION OF MYANMAR

Considering the urgent needs of providing safe drinking water in the Central Dry Zone, the Government of Japan decided to conduct a Preparatory Survey on the Provision of Equipment for Rural Water Supply Project in the Central Dry Zone Phase II (hereinafter referred to as "the Project") and entrusted the survey to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Myanmar the Preparatory Survey Team (hereinafter referred to as "the Team"), which is headed by Mr. Toshio Murakami, Senior Advisor, JICA, and the survey is scheduled to stay in the country from 26th April to 9th July, 2015.

The Team held discussions with the officials concerned of the Government of Myanmar and conducted a site visit at the survey area.

In the course of discussions and site visit, both parties confirmed the main items described in the attached sheets.

Nay Pyi Taw, 30 April, 2015

Toshio Murakami
Leader
Preparatory Survey Team
Japan International Cooperation
Agency (JICA)

U Khant Zaw
Deputy Chief Engineer
Department of Regional Development,
Ministry of Livestock, Fisheries and Rural
Development
The Republic of the Union of Myanmar

1

ATTACHMENT

1. Objective of the Project

Objective of the Project is to provide equipment and materials for the construction of deep wells to develop stable water resources, thereby contributing to the improvement of living environment in the Central Dry Zone.

2. Project site

The Project sites requested by the Myanmar side are located at three regions (Mandalay, Magway and Sagaing) in the Central Dry Zone as in **Annex-1.**

3. Implementing Agency

3-1 The Responsible Agency is Ministry of Livestock, Fisheries and Rural Development.

3-2 The Implementing Agency is Department of Rural Development (hereinafter referred to as "DRD"). The organization chart of DRD is shown in **Annex-2.**

4. Items requested by the Myanmar side

After discussions between the Myanmar side and the Team (hereinafter referred to as "the both sides"), the items described in **Annex-3** were finally requested by the Myanmar side.

The both sides confirmed that the appropriateness of the request would be examined in accordance with the further studies and analysis, and the final components of the Project would be decided by the Japanese side.

5. Japan's Grant Aid Scheme

5-1) The Myanmar side understood the Japan's Grant Aid Scheme explained by the Team, as described in **Annex-4.**

5-2) The Myanmar side will take the necessary measures, as described in **Annex-5**, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

6. Tentative Schedule of the Survey

6-1) The consultant members of the Team will conduct studies in Myanmar until 9th July, 2015.

6-2) JICA will prepare the draft preparatory survey report in English and dispatch a mission in order to explain its contents to the Myanmar side in the middle of October, 2015.

6-3) In case that the contents of the report are accepted in principle by the Myanmar side, JICA will finalize the report and send it to the Myanmar side by March 2016.

6-4) The Myanmar side understood that the execution of the Preparatory Survey (hereinafter referred to as "the Survey") would not necessarily imply the Japanese Government's commitment of the project implementation.

7. Background of the Request by the Myanmar side

7-1) Development Plan

The Myanmar side explained that provision of safe drinking water supply at rural area is the second top priority area of action set by the Government of Myanmar. Thus, DRD which is focal department for rural development in Myanmar is implementing the rural drinking water supply projects and activities according to the 20 year rural drinking water supply plan (2011/2012-2030/2031 fiscal year) as **Annex-6**. According to the 20 years plan, about 23,198 villages in the whole country will access to sufficient amount of safe drinking water. Procured drilling machine will be used for the implementation of the above development plan.

7-2) Selection of the targeted villages

The Myanmar side explained that the targeted villages to be surveyed are selected in consideration of scarcity of water for drinking and domestic use, level of drinking water need and geophysical constraint.

8. Scope of the Project

The Myanmar side agreed that the scope of the Project will be decided in consideration of the priority of the components and the appropriate size of the total Project cost as Grant Aid. The both sides agreed that the scope of the Project would be finally adjusted by adding/ reducing number of casing and/or screening of the production well, if all of the components could not be included in the Project based on the result of the Survey.

The Team proposed some technical issues on the diameter of the casing of the production well, proper method of pumping test, logging equipment and improvement of water supply facility to be discussed with concerned officials of DRD during the survey.

The Myanmar side requested 1 set of geophysical survey equipment to be included in the scope of the Project. DRD explained that DRD has only 1 set of geophysical survey equipment, which is not enough to conduct smooth implementation of geophysical survey. DRD also requested to include 2 sets of air compressor along with the 2 sets of drilling machines. DRD owns 7 air compressors and deployed at 2 for Northern Shan State, 4 for Central Dry Zone and 1 for Nay Pyi Taw. As most of the deep tube well drilling and construction activities are concentrated at the Central Dry Zone, DRD needs more air compressors for speedy action of drilling and well development. DRD also further requested to include 3 logging equipment in the scope of the Project due to having only one set logging equipment which is also not functioning well. The Team took note of it and agreed to continue discussion on the necessity of the equipment during the survey.

The Myanmar side requested to include spare parts for the 2 drilling rigs to be procured and also for the existing drilling rigs which may be necessary for drilling wells in the targeted villages. The Team reply that DRD should make at most effort to procure necessary spare parts with its

own fund but took note of it for continuous discussion during the Survey

9. Technical Assistant

Necessary soft component and On-the-Job Training (OJT) programs are to be considered for the Project scope. Detail components will be determined through the preparatory survey, avoiding a duplication of the activities of the any other on-going projects.

10. Water Quality

The Team mentioned the concentration of Fluoride and Nitrate-Nitrogen exceed Myanmar national proposed water quality standard in some deep tube well water in target area, and it might be the cause of negative impact to villagers' health. DRD explained that they will take appropriate countermeasures for those deep tube wells based on the result of the Survey and recommendations which will be made by the Team.

11. Measures to be taken by the Myanmar side

11-1) During the Survey

(1) The Myanmar side agreed to facilitate the Survey by following activities.

a) To provide available data, information and materials necessary for the execution of the Survey
b) To provide 2 geophysical survey team and equipment of geophysical survey (Syscal R2) with its accessories
c) To appoint full time counterpart personnel for the Team during their stay in Myanmar to take the roles of a coordinator. They are asked to make the appointments and to set up the meetings with the relevant person/ organizations whoever the Team intends to visit, and to accompany the Team in the field survey and other visiting places, if necessary.
d) To provide office space.
e) To secure permission and arrangement necessary for the geophysical exploration in the target villages for smooth execution of the work.
f) To take any measures deemed necessary to secure the safety of the members of the Team.
g) To make arrangements for the Team to bring back to Japan any necessary data, maps and other materials related to the Study for the analytical works and the preparation of reports.
h) Coordination with relevant agencies.

(2) The Myanmar side also agreed with **Annex-5** "Major Undertakings to be taken by Each Government" and to secure the necessary budget including the cost for B/A, A/P for the fiscal year 2016. More information about the necessary amount of budget will be informed by the end of August 2015, after the Survey progresses.

(3) The Myanmar side agreed that the Team will conduct selection of subcontractor of water quality test and social survey in the condition that the Team will inform the result of selection to

DRD. The Team requested DRD to attend the bid opening and assist them to obtain permission to visit the survey area.

11-2) During and after the Project

(1) Implementation structure of deep tube well construction by the Myanmar side

The both sides confirmed that the construction works of the deep tube wells in the Project shall be executed by the Myanmar side with its full responsibility:

a) DRD will assign appropriate number of staff who have experience and skill of drilling deep tube wells. The staff allocation plan is shown in **Annex-8**. The plan to drill deep tube wells by utilizing procured drilling rig(s) and existing drilling rigs are shown in **Annex-9**.

b) DRD will secure the necessary budget timely.

(2) Operation and Maintenance of Facilities, Equipment and Materials

The water supply facilities constructed by the Myanmar side shall be properly operated and maintained by the target villages with support by DRD. The equipment and materials procured through the Project shall be properly operated and maintained by DRD.

(3) Progress Monitoring Report

Progress of the deep tube well construction work shall be monitored and reported by DRD to JICA Myanmar Office. Format of the report shall be duly confirmed by both sides at the stage of signing of Grant Agreement or at the timing of the mission for Draft Final Report.

12. Other relevant issues

12-1) Inception Report

The content of Inception report, which the Team explained to the Myanmar side, was understood and accepted in principle by the Myanmar side.

12-2) Tax Exemption

The both sides confirmed that the tax exemption including Value Added Tax (VAT), custom duty, and any other taxes and fiscal levies in Myanmar which is to be arisen from the Project activities will be ensured by the Myanmar side. The Myanmar side will take any procedures necessary for tax exemption, and in case that tax exemption is not secured, the cost of tax will be covered by the Myanmar side.

12-3) Overlapping with Other Projects

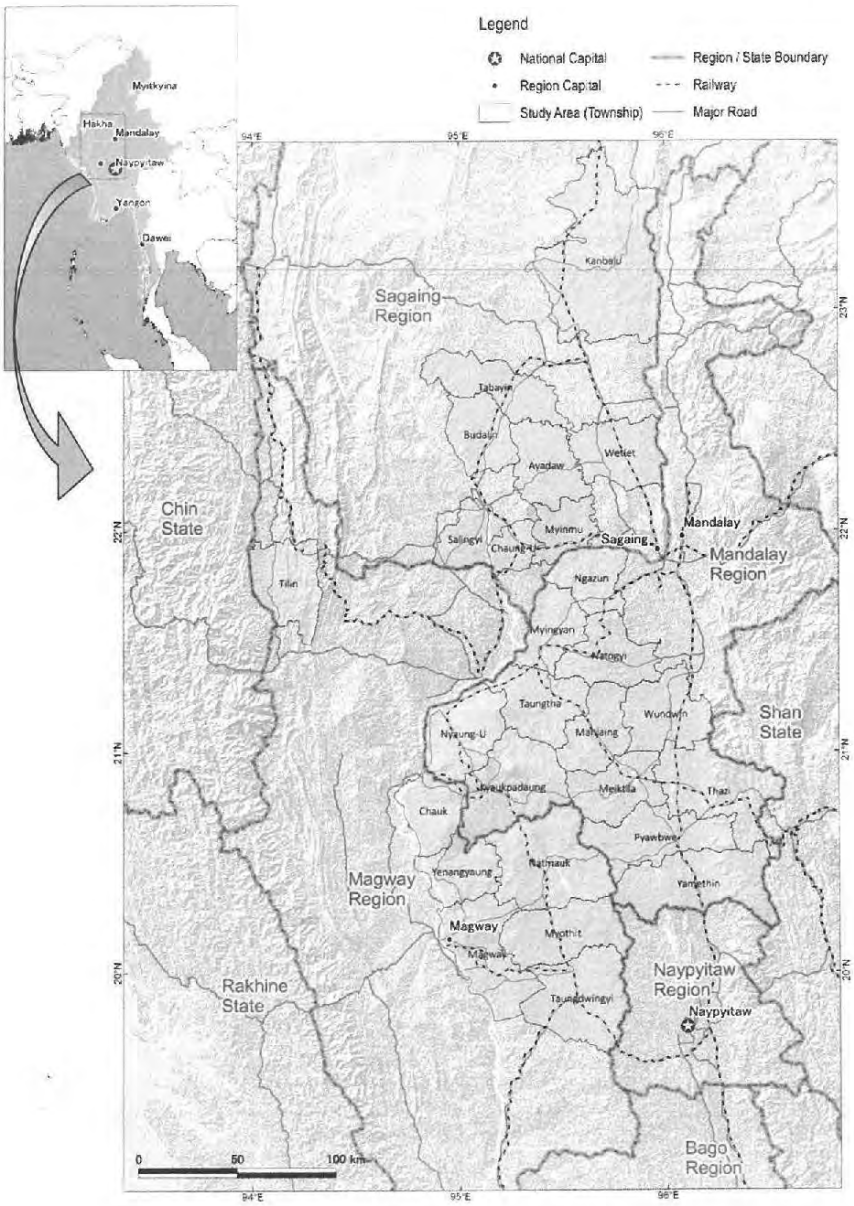
The Myanmar side explained that the Project would not be overlapped with any other projects supported by other donor agencies, NGOs, and Myanmar official organizations.

12-4) Official Request

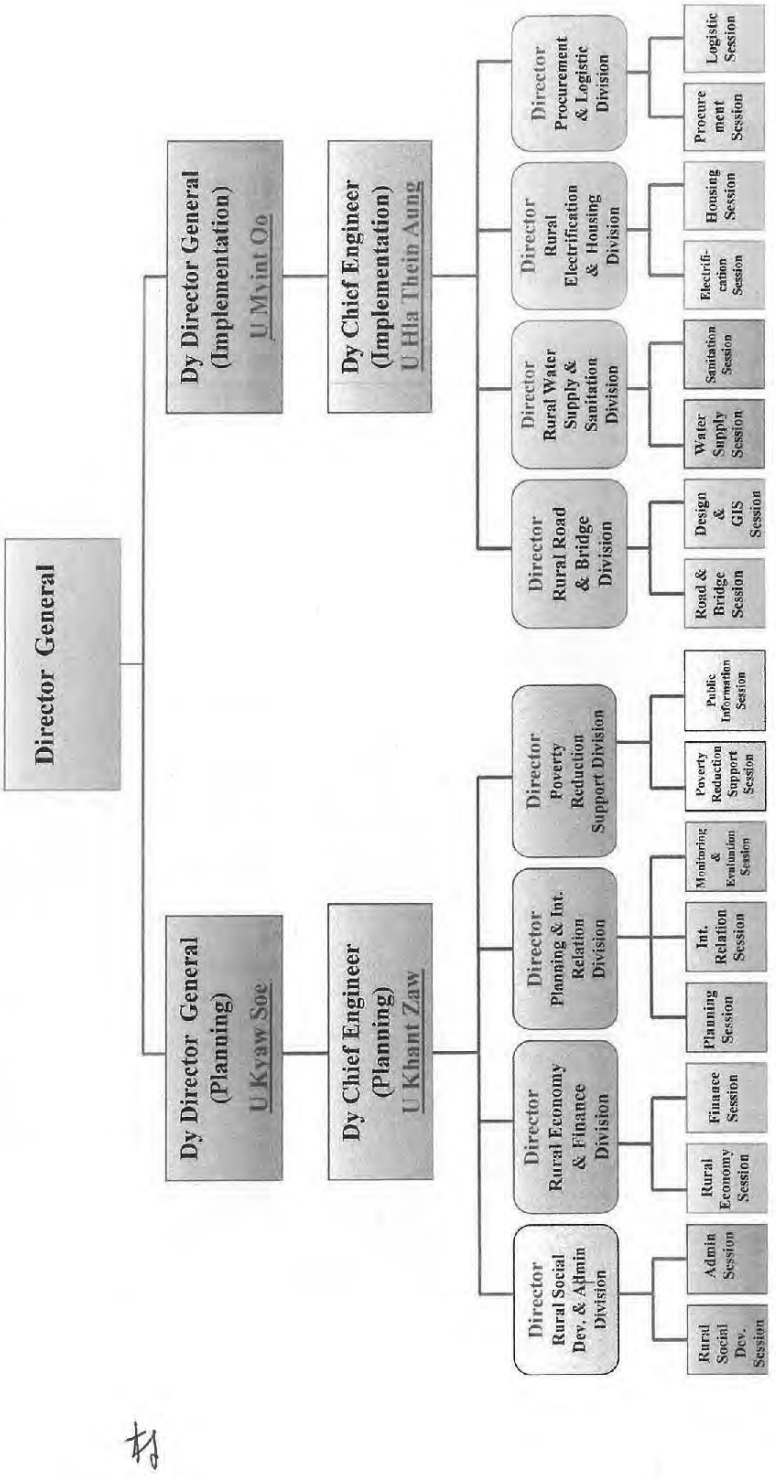
Both sides confirmed that DRD should submit the official application form for grant aid from Japan through the diplomatic channel by the end of June, 2015.

Annex-1	Project Sites Map
Annex-2	Organization Chart of DRD
Annex-3	Items Requested by the Myanmar Side
Annex-4	Japan's Grant Aid Scheme
Annex-5	Major Undertakings to be taken by Each Government
Annex-6	Development Plan to Promote Adequate Provision of Rural Water Supply in the Central Dry Zone
Annex-7	List of Target Villages
Annex-8	Allocation Plan of DRD Staffs
Annex-9	Utilization Plan of Procured Drilling Rig(s)

Annex-1: Project Site



Annex:2-Organization Chart of Department of Rural Development (HQ)



Annex-3: Items Requested by the Myanmar Side

Items	Quantity
Truck Mounted Drilling Machine (Capable of drilling more than 300m), with auxiliary tools and equipment	2 sets
Air Compressor	2 sets
Crane Truck	2 cars
Geophysical Survey equipment	1 set
Logging equipment	3 set
Consumable Material for drilling works (Bentonite, CMC)	1 lot
Submersible Pump and Generator with auxiliary materials	120 sets
Casing and Screen	120 sets

Note: Items and quantity of the Project will be determined based on the result of the survey.

Annex-4: Japan's Grant Aid Scheme

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as part of this realignment, JICA was reborn on October 1, 2008. After the reborn of JICA, following the decision of the Government of Japan (hereinafter referred to as "the GOJ"), Grant Aid for General Project is extended by JICA.

Grant Aid is non-reimbursable fund to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures (Attachment 1)

Japanese Grant Aid is conducted as follows-

- Preparatory Survey (hereinafter referred to as "the Survey")
  - The Survey conducted by JICA
- Appraisal & Approval
  -Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Determination of Implementation
  -The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  -Agreement concluded between JICA and a recipient country
- Implementation
  -Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the Survey is to provide a basic document necessary for the appraisal of the Project by JICA and the GOJ. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of agencies concerned of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed on by both parties concerning the basic concept of the Project.
- Preparation of a outline design of the Project.
- Estimation of costs of the Project.

1

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed considering the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA uses (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

The Report on the Survey is reviewed by JICA, and after the appropriateness of the Project is confirmed, JICA recommends the GOJ to appraise the implementation of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the E/N will be singed between the GOJ and the Government of the recipient country to make a plead for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

The consultant firm(s) used for the Survey Will be recommended by JICA to the recipient country to also work on the Project's implementation after the E/N and the G/A, in order to maintain technical consistency.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

(4) Necessity of "Verification"

The Government of recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This

"Verification" is deemed necessary to secure accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Attachment 2

(6) Proper Use

The Government of recipient country is required to maintain and use the facilities constructed and the 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) Export and Re-export

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

(8) Banking Arrangements (B/A)

a) 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"). JICA 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 the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

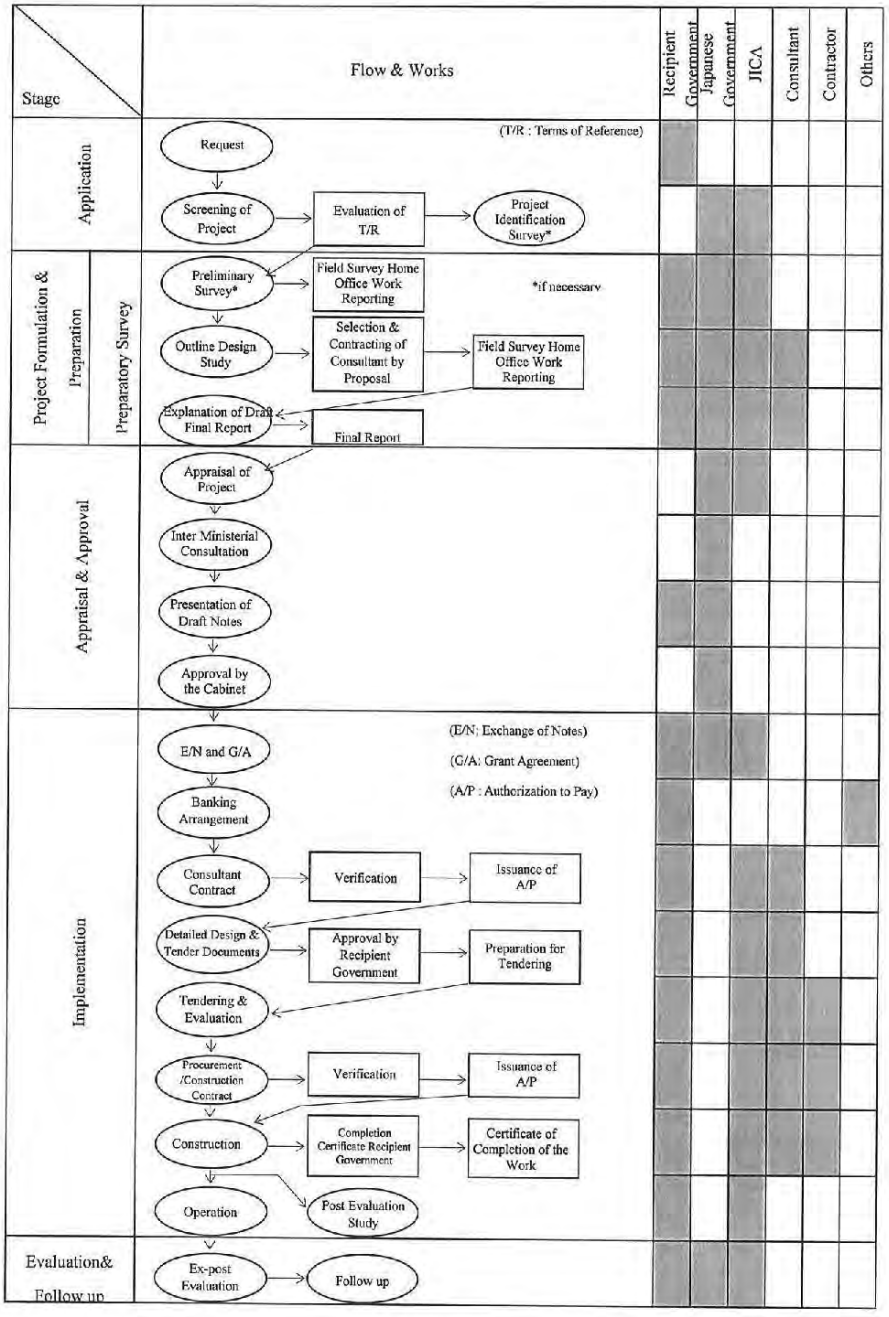
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions to the Bank.

(10) Social and Environmental Considerations

A recipient country must ensure the social and environmental considerations for the Project and must follow the environmental regulation of the recipient country and JICA socio-environmental guideline.

Attachment 1

Flow Chart of Japan's Grant Aid Procedures



Annex-5: Major Undertakings to be taken by Each Government

No	Items	To be covered by Grant Aid	To be covered by Recipient
1	To bear the following commissions to a bank of Japan for the banking services based upon the B/A		
	1) Advising commission of A/P		•
	2) Payment commission		•
2	To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the products from Japan to the recipient country	•	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		•
	3) Internal transportation from the port of disembarkation to the project site	(•)	(•)
3	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		•
4	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract		•
5	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid		•
6	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for the transportation and installation of the equipment		•
7	To give due environmental and social consideration in the implementation of the Project		•

(B/A: Banking Arrangement, A/P: Authorization to pay, N/A: Not Applicable)

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Annex-6: Department of Rural Development 20 Year plan for Rural Water Supply

Sr	State/Region	First (5) Year Plan											Second (5) Year		Third (5) year		Fourth (5) Year	
		2011-2012		2012-2013			2013-2014		2014-2015		2015-2016		from 2016-2017 to 2020-2021		from 2021-2022 to 2025-2026		from 2026-2027 to 2030-2031	
							Plan		Plan		Plan							
		Planned	Implemented	Planned	Implemented	to be implement	Budget	Aid	Budget	Aid	Budget	Aid	Budget	Aid	Budget	Aid	Budget	Aid
1	Kachin	29	29	30		30	50	10	50	15	50	8	326	47	350	55	350	64
2	Kayah	10	10	30		30	50	5	50	15	50	8	164	28		25		11
3	Kayin	41	41	30		30	50	15	50	10	50	19	250	32	420	62	420	95
4	Chin	12	12	30		30	50	20	50	15	50	5	250	42	179	56		17
5	Sagaing	95	95	34		34	50	4	50	5	50		318	78	330	66	330	37
6	Thanintharyi	78	78	30		30	50	5	50	8	50	10	200	44		29		26
7	Bago	358	358	30		30	50	25	50	27	50	23	326	55	360	83	350	98
8	Magway	122	122	43		43	50	12	50	8	50	8	416	112	570	78	662	75
9	Mandalay	205	205	33		33	50	4	50	9	50	17	250	112	250	59	150	60
10	Mon	29	29	30		30	50	10	50	5	50	10	140	44		25		23
11	Rakhine	94	94	30		30	50	10	50	10	50	8	409	37	526	80	662	91
12	Yangon	230	230	30		30	50	15	50	10	50	25	250	32	220	34		21
13	Shan	102	102	30		30	50	25	50	15	50	22	416	74	720	105	832	146
14	Ayeyarwaddy	206	206	30		30	50	10	50	13	50	7	435	54	570	89	666	75
15	PaO			30		30	50	12	50	12	50	10	250	29	255	24	328	52
16	Palaung			30		30	50	9	50	11	50	8	94	30		29		13
17	Danu			30		30	50	10	50	9	50	9	50	26		28		13
18	Kokant			30		30	50	7	50	13	50	10	112	26		22		11
19	Wa			30		30	50	10	50	10	50	8	250	28	250	25	250	40
20	Narga			30		30	50	2	50		50	5	94	28		15		12
		1,611	**1,611**	**620**		**620**	**1,000**	**220**	**1,000**	**220**	**1,000**	**220**	**5,000**	**958**	**5,000**	**989**	**5,000**	**980**

Annex-7: List of Target Villages to be Surveyed

1. Mandalay Region

No.	Township	Village Track	Village	Household	Population
1	Meiktila	Thikone	Kyatatpin	22	120
2		Khinte	Khinthar	85	320
3		Kyweltalin	Bonesukan	140	850
4	Wundwin	Taungse	Taungnyo	86	379
5	Thazi	Nghat Min Kone	Thamankyar	228	438
6		Kyweltatsone	Payarngartu(Ta)	114	750
7	Mahlaing	Yayhtwet	Htantawgyi	95	552
8		Kyatse	Asone Village	127	542
9		Yaychobutar	Khinthar (Ta)	82	577
10	Myingyan	Chay Say	Chay Say	243	1,312
11		Ku Ywar	Ku Ywar	525	2,283
12		Yone Hto	Yone Hto	147	813
13		Phat Pin I	Phat Pin I	303	1,447
14	Ngazon	Konelel	Konelel	292	1,528
15		Makyikyat	Phaungkataw	199	1,121
16		Kaungzin	Kaungzin	141	856
17		Thanbo	Ywarsite	30	139
18	Natogyi	Kyaungnan	Kyaungnan	203	1,109
19		Myinni	Kyaungkan	77	435
20		Nyaungkone	Nyaungkone	130	653
21		Zaydate	Htantaw	478	2,583
22	Taungtha	Obo	Chaungnarr	84	499
23		Zagyan	Chaungsone(La)	155	802
24		Kanmyel	Tharsi	187	931
25			Kanaye	211	930
26		Tharyarmyaing	Tharyarmyaing	372	2,026
27	Yamethin	Myinnar	Aungpinlel	38	161
28	Pyawbwe	Seitcho	Htanekan	205	806
29			Waryonesu	180	797
30	Nyaung U	Oyin	Taungyar	86	900
31		Nyaungto	Nyaungtotetite	150	720
32		Kutaw	Sinekantetite	130	600
33		Nyaungpinkan	Latpanwintetite	63	350
34		Kanma	Zaymagyi	52	341
35		Kya-O	Kanthar	67	292
36		Thapyay -I	Koneshaytetite	22	120
37	Kyaukpadaung	Tangakan	Alelywar-2	220	1,098
38		Nyaungto	Matarywarma	122	527
39			Atarsankone	224	933
40		Na Kyat Khwal	Na Kyat Khwal	958	3,813
Total of the Mandalay Region				7,273	35,453

2. Magway Region

No.	Township	Village Track	Village	Household	Population
1	Magway	Natkan	Natkan	264	1,244
2		Sharzaungkan	Sharzaungkan	330	1,611
3		Kyarkan	Nyaungpinthar	240	1,535
4		Nyaungpinthar	Konegyi	264	1,244
5		Waiwinsan	Sinekya	98	477
6		Thapyaysan	Thapyaysan(Ma)	240	1,535
7		Suupyitsan	Shwekyaw	73	388
8		Nyaungkan	Lakekan	186	770
9		Nyaungkan	Ywarthitgyi	302	1,628
10	Chauk	Thanbo	Yaykangyi	217	723
11		Myaysoon	Myaysoon Ywarthit	63	310
12		Zepwar	Zepwar	235	1,027
13		Chaungtat	Yaypyay	55	169
14		Pakhannge	Kyatesu (Ma)	164	714
15		Salintaung	Winkabar	514	2,235
16		Magyikone	Kyatkan	97	475
17		Gwaypin	Suutat	92	547
18	Yenangyaung	Intaw	Lelkyinnyoe	285	1,441
19	Myothit	Laytinesin	Laytinesin (Ta)	587	2,435
20			Gwaytaw	148	600
21		Makyikonekyi	makyikonekyi	700	3,095
22		Bolt	Bolt	587	2,435
23		Htautsharkan	Intaw (Ma)	700	3,095
24		Dantdalonpin	Htanaungkwin	302	1,574
25		Manawtkone	Manawtkone	170	791
26	Natmauk	I-Sauk	Kankyikone	56	373
27		Htonepoutchine	Htonepoutchine	367	1,018
28		Padauknghote	Padauknghote (Ywarkyi)	56	373
29		Selel	Selel	367	1,018
30		Thamhonepin	Padaukkone	119	779
31		Tegyi	Ywartharlay	75	374
32		Waryonekone	Waryonekone	148	721
33		Htonepoutchine	Nyaungkone	82	480
34	Taungdwingyi	Pantwinlay	Kukohla	195	686
35		Payatkye	Kangyigon	205	1,018
36		Wathonepyu	Daungkyankyon	205	1,080
37		Lhe pawe gyi	Lhe Pawe Gyi	100	455
38		Lhe pawe gyi	Yae Htuot Gyi	112	607
39	Ti Lin	Sin Zwe	Sin Zwe	122	936
40		Kya Oo Yin	Kya Oo Yin	70	458
Total of the Magway Region				9,192	42,474

3. Sagain Region

No.	Township	Village Track	Village	Household	Population
1	Budalin	Htanaungkone	Yonetaw	65	369
2		Ngapayin	Nyaungthar	45	217
3		Maung Htaung	Maung Htaung	842	4,318
4		Ywar Thit	Kan Thaw Thar	83	404
5		Konethar	Mhone Htoo	38	172
6		Wat Luu I	Wat Luu I	167	979
7	Chaung U	Thann Win Kan	Thann Win Kan	195	935
8		Nat Yay Kan	Nay Yay Kan	177	800
9	Ayadaw	Ngarr Taw Ma	Si Thar	84	361
10		Ma Lel Thar	Kan Yinn	392	2,809
11		Ngarr Yaung	Warr Yaung	532	4,251
12		Ye Chinn	Warr Tann Kalay	64	426
13		Nyaung Chay Htauk	Ya Thar	160	765
14		Warr Yaung	Zee Pin Lel	164	1,983
15	Salingyi	Yone Pin Yoe	Yone Pin Yoe	95	514
16			Minn Taw	205	1,071
17		Moe Kyoe Pyin	Kine	62	290
18	Myinmu	Kalarpyan	Kalarpyan	75	385
19		Nyaung Pin Kan	Hlay U Kan	129	580
20		Ma Kyee Kan	Ma Kyee Kan	244	1,143
21		Lat Pan Kyin	Wat Kya	132	744
22		Lat Pan Kyin	Tha Htay Kone (Ywar Ma)	80	410
23		Inma	Ma Kyee Taw	37	164
24	Kanbalu	Thin Taw	Thin Taw	148	817
25		Thin Taw	A Lel Khone	384	1,818
26		Koe Taung Boh	Koe Taung Boh	143	715
27		Ngapyaw Tine	Kyee Pin At	310	1,643
28		Myay Htoo	Myay Htoo	385	1,997
29		Kha Own Tar	Kha Own Tar	278	1,004
30		Kha Own Tar	Pay Kyi	170	983
31		Myay Mon	Myay Mon	550	2,527
32		Paze Kyi	Layy Twin Sin	150	714
33		Pay Kone (Ta)	Chaung Char	100	513
34	Tabayin	Thit Yar Aite	Thit Yar Aite	292	2,510
35		Min Tel Kone	Shan Taw	70	348
36		Sat Pyar Kyinn	Kyun Taw (Ta)	75	434
37	Wet Let	Shar Kwal	Palethwe (Ywar Thit)	52	298
38		Pouk Kan	Pouk Kan	250	1,159
39		Shwe Kyin	Shwe Nyaung Taw	41	210
40		Khaw Taw	Sabei Taw	96	242
Total of the Sagain Region				7,561	42,022

Annex-8 Allocation Plan of DRD Staffs

Staff Allocation Plan for Procured Drilling Rig No (1)

	Present department	Experiences of drilling deep well (more than 300m depth)	Experiences trained by JICA's technical assistance project
U Thant Sin Win	AE(H.Q)		8 years experience
U Zay Ya Win	SAE(HQ)		8 years experience
U Tun Thein	SAE		8 years experience
U Myint Aung	SAE		8 years experience
U Sein Win	Driller 1		8 years experience
U Zaw Min Latt	Driller 2		8 years experience
U Si Thu Aung	Driller 2		8 years experience
U Zaw Naing	Driller 2		8 years experience

Staff Allocation Plan for Procured Drilling Rig No (2)

Name of staff	Present department	Experiences of drilling deep well (more than 300m depth)	Experiences trained by JICA's technical assistance project
U Han Tin	AE(HQ)		8 years experience
U Mg Kyaw	SAE(Sagaing)		8 years experience
U Aung Soe	Head of Driller (HQ)		8 years experience
U Than Aung	JE(MonYwa)		8 years experience
U Soe linn	Driller 1		8 years experience
U Tun Naing	Driller 2		8 years experience
U Zin Min Htay	Driller 2		8 years experience
U Myo Thein	Driller 2		8 years experience

Annex-9 Utilization Plan of Procured Drilling Rig(s)

Sr. No	Articles	Nos.	Sagaing	Magway	Mandalay	HQ
1	Truck mounted well drilling rig, 500 m deep with 14-3/4" to 6-1/4" borehole diameter with accessories and tools	2 sets	-	1	1	-
2	Cargo truck (4 × 4 left hand drive), 6000 kg capacity with 4 ton crane	2 sets	-	1	1	-
3	Logging Equipment	1 sets	-	-	-	1
4	Geophysical Survey equipment	1 sets	-	-	-	1
5	Air compressor for air flush	2 sets	-	1	1	-
6	Submersible motor pump for pumping test completed with piping and pump accessories	2 sets	-	1	1	-
7	Consumables for drilling work (Bentonite, CMC, Form agent)	1 lot	-	-	-	1
8	Casing and screen pipes for 120 tube wells	1 lot	-	-	-	1
9	Submersible pump with generators and accessories	120 sets	40	40	40	-

4.2 Technical Note (Date of Signature: 2nd July, 2015)

TECHNICAL NOTE
ON
THE PREPARATORY SURVEY ON THE PROVISION OF EQUIPMENT
FOR RURAL WATER SUPPLY PROJECT IN THE CENTRAL DRY ZONE PHASE II
IN
THE REPUBLIC OF THE UNION OF MYANMAR

In response to the request from the Government of the Republic of THE Union of Myanmar (hereinafter referred to as "Myanmar"), the Government of Japan decided to conduct a Preparatory Survey on the Provision of Equipment for Rural Water Supply Project in the Central Dry Zone Phase II (hereinafter referred to as "the Project") and entrusted the survey to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team (hereinafter referred to as "the Team"), which is headed by Mr. Toshio Murakami, Senior Advisor, JICA, to Myanmar. The Team stayed in Myanmar from April 27 to July 9, 2015.

After signing of the Minutes of Discussion between the Government of Myanmar and the Team on 30April 2015, the consultant team under the Team was scheduled to conduct the field survey until 9July 2015.

During the field survey, the consultant team had a series of discussions with Department of Rural Development (hereinafter referred to as "DRD") at the central and local level as well.

As the results of discussions and field surveys, both side confirmed the technical note described as per the attached.

2nd July 2015

Mr. MyintOo
Deputy Director General
Department of Rural Development
Ministry of Livestock, Fishery and Rural Development

Mr. Yasumasa Yamasaki
Chief Consultant
JICA Study Team
Earth System Science Co., Ltd.

1. Target Villages (Result of Village Reconnaissance Survey)

The Study Team proposed 110 villages as the target villages based on the result of the Village Reconnaissance Survey.

After having discussion, the both party agreed the target villages as shown in Table 1 (the detailed list of the target villages is shown in Appendix-1) and confirmed that no change in target village was allowed after this agreement.

Thetarget villages (110 villages) will be evaluatedbased on the results of geophysical survey and socio-economic survey.

Table 1 Result of Village Reconnaissance Survey

Region	No. of Village Requested	No. of Village Excluded	No. of Target Village of the Project
Sagaing	40	1	39
Mandalay	40	6	34
Magway	40	3	37
Total	120	10	110

2. Measure to Avoid Duplication of the Project

During the field survey, it was observed in some target villages requested by DRD that DRD had already constructed wells and water supply facilities. Therefore, it was obliged to change the target villages. In order to avoid the duplication of the Project with other project(s), DRD will share the list of the target villages with their Regional offices, the Township offices and the target villages shown in Appendix-1.

3. Confirmation and Modification of the Request for the Equipment

Request of the equipment by DRD was confirmed in the Minutes of Discussions signed on 30April 2015 between DRD and JICA.

The Study Team examined the necessity of the equipment through the Village Reconnaissance Survey and studying the existing data and information.

The Study Team explained the contents of the Equipment for the Phase 2 project based on the result of the meeting with the CDZ project office. After discussion, the both party agreed the contents of the Equipment shown in Table 2. The Study Team will continue the study for determination of more detailed specification and estimation of the procurement cost.

Table 2 Result of List of Equipment for Phase 2 Project

Equipment/Materials	Specification/Number Requested	Result of Discussion with CDZ
Drilling Rig	Drilling capacity: 400m x 2sets	Drilling capacity: 200m x 1 set, 250m x 1 set
Air Compressor	2sets (1 set + additional 1 set)	1 or 2 set If one of the compressor is repaired, the number will become 1 set.
Cargo Truck with Crane	2 vehicles	2 vehicles
Materials for well construction	1 lot	1 lot
Submersible pump, Generator, Ancillary materials	120 sets	At most 110 sets. As for generator, the number is decreased considering the possibility of public electric power supply to the target villages.
Casing and Screen	For 120 villages	For 110 villages (At most). Necessary quantity is calculated under the following condition of

Equipment/Materials	Specification/Number Requested	Result of Discussion with CDZ
		screen length. (1) Screen length 12 m, a half of total wells (2) Screen length 18 m, a half of total wells
Geophysical Survey Equipment	1 set (additional request)	None (Excluded from the request)
Well Logging Machine	3 sets (additional request)	1 set with 400m cable 1 set with 300m cable
Pumping Test Equipment (Proposed by the Team)	-	1 set

Regarding the public electric power supply, it was confirmed in the socio-economic survey thata total of 19 villages (8 villages in Sagaing, 7 villages in Mandalay and 4 villages in Magway) were connected to the national grid lines. Generators for the such villages will be excluded from the procurement of the equipment.

DRD expressed necessity of technical transfer of well logging and pumping test by using the submersible pump.

The Study Team understood the necessity of the technical transfer of such technique (Soft Component). Contents of the soft component are described in Item

4. Countermeasures against high contents of poisonous element such as Arsenic in the groundwater.

The Study Team asked the countermeasure of DRD if high contents of poisonous element such as Arsenic is detected in the groundwater in the well drilled in the phase 2 project.

DRD explained that any severe case has not been identified from the wells drilled by DRD. Furthermore, DRD explained that CDZ area is facing scarcity of water source therefore the water developed will be used for the purpose other than drinking. In such case, DRD will inform the community people of the deterioration of groundwater and put a sign board to instruct not use for drinking.

5. Water Quality Analysis and Monitoring

The Study Team asked the future system of water quality analysis because currently DRD is capable to analyse 10 parameters and asking remaining parameters to Ministry of Health.

DRD explained that current situation will not be changed because human resource is not sufficient and explained the necessity of technical transfer of water quality analysis.

However, the National Drinking Water Quality Standard was officially announced in 2015, therefore, DRD will formulate the water quality analysis and monitoring system after discussion with Ministry of Health and other relevant ministries.

The both parties confirmed about the water quality and monitoring on the wells drilled in the phase 2 Project as follows:

(1) DRD will analyse water quality after the completion of drilling of well. The result of water quality analysis shall be reported to JICA Myanmar Office including in the Progress Monitoring Report ((3), 11-2), 11. Measures to be taken by the Myanmar side) agreed between DRD and JICA on 30th April 2015 as the Minutes of Discussions. For this purpose, DRD will provide necessary budget before commencement of the Project.

(2) In the following cases, DRD monitors the water quality once a year.

a) water quality of a well meets the standard and/or WHO Guidelines (ver. 4) but it is very close to the standard or Guidelines

b) there is an existing deep well, of which water quality does not meet standard or Guidelines, close to the well drilled in the Phase 2 project.

c) there is any facility which may cause groundwater pollution (factories, mines, etc.) in the adjacent area of the target village.

(3) If the water quality does not satisfy the standard, such water shall be used only for purposes other than drinking. In such case DRD shall properly inform and instruct to the community people not to drink the water of such well to avoid occurrence of health hazards. If the community people use the water for drinking, DRD will take necessary measure such as refilling the well.

(4) The Study Team will propose the water quality monitoring plan at the timing of mission for Draft Final Report.

6. Well Structure to be Constructed

(1) Diameter of Casing and Screen Pipes

The Study Team proposed to install six inches of casing and screen pipes instead of 4 inches of pipes considering the security and maintenance of submersible pumps, and future expansion of water supply facilities.

DRD agreed to the proposal by the Study team.

(2) Length of Section of Screen Pipes

Thorough the discussion, the both parties agreed the length of screen section in the wells as follows:

- 50% of the total length of well: 18m (length of screen section)
- 50% of the total length of well: 12m (length of screen section)

7. Improvement of Water Supply Facility

In order to improve the rural water supply, the Study Team proposed to the design of water tank from the ground tank to the elevated tank (the base of the tank is 2.5-3m above the ground level).

DRD will consider this proposal in the future construction of water supply facilities.

8. Organization of DRD for Implementation of the Project

(1) Drilling Team

Although DRD has 11 drilling teams, if 2 sets of drilling rigs is procured in the Project, DRD will organize 2 new drilling teams as described below:

- One (1) Head driller
- Two (2) Operator 2
- Two (2) Operator 2
- Three (3) Labours

(2) Pumping test team

One (1) set of pumping test equipment with submersible pump will be newly procured in the Project. The pumping test equipment will cover all the wells to be drilled in the Phase 2 project. Therefore, DRD will organize a pumping test team before delivery of the equipment.

9. Implementation Cost of the Myanmar Side and Budgetary Arrangement

The implementation cost of the project is estimated by DRD in the second 5-years plan. The final estimated well depth to be drilled will be decided in the draft report to be submitted in the

mid October 2015. Therefore, DRD will re-estimated the implementation cost of the Phase 2 project and take necessary measure for the budgetary arrangement.

10.Delivery of the Equipment and Materials

All the equipment and materials will be delivered to the stock yard of DRD in Yangon.

11. Contents of Technical Transfer (Soft Component)

Both party agreed the necessary contents of technical transfer (soft component) from the Japanese side to DRD as follows:

(1) Well Logging

- Survey method (in class)
- Data acquisition (logging) (in the field)
- Data analysis and determination of well structure (in class)

(2) Pumping test by submersible pump

- Testing plan (in class)
- Testing method (in class)
- Data acquisition (pumping test) (in the field)
- Data analysis and evaluation of aquifer (in class)

4

Attachment:

List of Attendance

The Myanmar side (DRD):

Mr. MyintOo	Deputy Director General (Chief Engineer)
Mr. U Hla Thein Aung	Deputy Chief Engineer
Mr. KyawThau Aung	Deputy Director
Dr. Win Min Oo	Assistant Director
Mr. U Win Nyunt	Deputy Director (Magway Region & CDZ)
Mr. U SoeMaing	Deputy Director (Labutta District, Ayeyarwaddy Region)

The Study Team:

Mr. Yasumasa Yamasaki	Chief Consultant
Mr. Toru Yoritate	Hydrogeologist 1/Geophysicist 1
Dr. Yuji Maruo	Hydrogeologist 2
Mr. KengoOhashi	Geophysicist 2
Mr. Akira Sasaki	Water Quality Specialist
Mr. Tomohiro Kato	Operation and Maintenance Specialist
Mr. Yusuke Oshika	Equipment Planner/Procurement Planner
Mr. Yuki Yamashiro	Cost Estimator
Dr.Zayar Win	Coordinator/Equipment and Procurement Planner 2

Appendix 1: Result of Field Reconnaissance Survey (List of Target Villages)

(1) Sagaing Region

Region	No.	Township	Villages	ID	Estimated Drilling Depth (Pre-survey)		Household	Population	Geophysical Survey Method	Result of Village Survey
					feet	m				
Sagaing	1	Budalin	Yonedaw	SA2-01	600 ft	180 m	85	369	VES	Accepted
	2		Nyaungbinthar	SA2-02	600 ft	180 m	49	223	VES	Accepted
	3		Maunghtaung	SA2-03	500 ft	150 m	1000	5600	VES	Accepted
	4		Kantawthar	SA2-04	660 ft	200 m	80	420	VES	To be considered
	5		Mhonehtoo	SA2-05	500 ft	150 m	36	172	VES	Accepted
	6		Watluu-I	SA2-06	330 ft	100 m	165	768	VES	Accepted
	7	Chaungoo	Thanbinkan	SA2-07	660 ft	200 m	195	935	VES	To be considered
	8		Natyaygan	SA2-08	400 ft	120 m	177	809	VES	To be considered
	9	Ayadaw	Sithar	SA2-09	400 ft	120 m	80	420	VES	Accepted
	10		Oakkan	SA2-10	830 ft	250 m	142	800	VES	Accepted
	11		Warryaung	SA2-11	920 ft	280 m	920	4500	VES	Accepted
	12		Warrtannkalay	SA2-12	500 ft	150 m	100	750	VES	Accepted
	13		Yathar	SA2-13	330 ft	100 m	156	766	VES	To be considered
	14		Zeepinlei	SA2-14	500 ft	150 m	358	1897	VES	Accepted
	15	Salingyi	Yonebinyoe	SA2-15	200 ft	60 m	95	514	VES	To be considered
	16		Minntaw	SA2-16	200 ft	60 m	205	1071	VES	To be considered
	17		Kine	SA2-17	660 ft	200 m	70	305	2D	To be considered
	18	Myinmu	Kalarpyan	SA2-18	600 ft	180 m	75	385	VES	To be considered
	19		Hlayookan	SA2-19	600 ft	180 m	129	580	VES	Accepted
	20		Makyeekan	SA2-20	-	-	244	1143	-	Excluded
	21		Watkya	SA2-21	660 ft	200 m	160	748	VES	Accepted
	22		Thahtaykone(Ywarma)	SA2-22	600 ft	180 m	85	410	VES	To be considered
	23		Magyidaw	SA2-23	330 ft	100 m	44	200	VES	Accepted
	24	Kanbalu	Thindaw	SA2-24	300 ft	90 m	148	817	VES	Accepted
	25		Lwingyi	SA2-25	600 ft	180 m	102	499	VES	Accepted
	26		Koetaungboh(Kyunkone)	SA2-26	560 ft	170 m	253	1171	VES	Accepted
	27		Inngoteto	SA2-27	500 ft	150 m	278	1278	VES	To be considered
	28		Myayhtoo	SA2-28	600 ft	180 m	386	1844	VES	To be considered
	29		Khaowntar	SA2-29	400 ft	120 m	278	1004	VES	Accepted
	30		Nyuangkanthar	SA2-30	500 ft	150 m	123	539	VES	To be considered
	31		Myaymon	SA2-31	500 ft	150 m	550	2527	VES	To be considered
	32		Layytwinzin	SA2-32	330 ft	100 m	150	714	VES	To be considered
	33		Chaungchar	SA2-33	500 ft	150 m	100	513	VES	Accepted
	34	Dabayin	Minyogone	SA2-34	500 ft	150 m	75	410	VES	Accepted
	35		Shandaw	SA2-35	990 ft	300 m	70	348	VES	Accepted
	36		Kyuntaw (S)	SA2-36	330 ft	100 m	75	434	VES	To be considered
	37	Wetlet	PalaeThwe (Ywarthit)	SA2-37	500 ft	150 m	52	298	VES	Accepted
	38		Poukkan	SA2-38	330 ft	100 m	250	1159	VES	Accepted
	39		Shwenyaunglaw	SA2-39	500 ft	150 m	41	210	2D	Accepted
	40		Sabeidaw	SA2-40	500 ft	150 m	100	423	VES	Accepted

(2) Mandalay Region

Region	No.	Township	Villages	ID	Estimated Drilling Depth (Pre-survey)		Household	Population	Geophysical Survey Method	Result of Village Survey
					feet	m				
Mandalay	41	Mahlaing	Htantawgyi	MA2-01	330 ft	100 m	100	550	2D	Accepted
	42		Asone	MA2-02	330 ft	100 m	150	650	VES	Accepted
	43		Khinthar(S)	MA2-03	330 ft	100 m	85	480	VES	Accepted
	44	Myingyan	Chaysay	MA2-04	400 ft	120 m	243	1412	VES	Accepted
	45		Talgyi	MA2-05	230 ft	70 m	191	830	VES	Accepted
	46		Kuywar	MA2-06	400 ft	120 m	547	2477	2D	To be considered
	47		Yonehto	MA2-07	-	-	141	850	-	Excluded
	48		Nyaungwun	MA2-08	830 ft	250 m	105	435	VES	Accepted
	49	Ngazon	Konelel	MA2-09	-	-	320	1524	-	Excluded
	50		Phaungkadaw	MA2-10	-	-	199	1121	-	Excluded
	51		Kaungzin	MA2-11	660 ft	200 m	141	864	2D	Accepted
	52		Ywarsite	MA2-12	-	-	36	231	-	Excluded
	53	Natogyi	Kyaungnan	MA2-13	-	-	203	1109	-	Excluded
	54		Kyaungkangyibin	MA2-14	400 ft	120 m	92	435	2D	To be considered
	55		Nyaunggone	MA2-15	230 ft	70 m	130	689	2D	To be considered
	56	Taungtha	Chaungnar	MA2-16	330 ft	100 m	105	450	2D	To be considered
	57		Chaungsone(La)	MA2-17	460 ft	140 m	178	800	VES	To be considered
	58		Kyaukkartaungkone	MA2-18	330 ft	100 m	65	350	2D	To be considered
	59		Tharzi	MA2-19	830 ft	250 m	170	950	VES	Accepted
	60		Kanaye	MA2-20	830 ft	250 m	180	1150	VES	Accepted
	61		Tharyarmyaing	MA2-21	500 ft	150 m	380	2200	2D	To be considered
	62	Yamethin	Oakpo	MA2-22	500 ft	150 m	-	1660	VES	Accepted
	63		Kangyi	MA2-23	990 ft	300 m	320	1520	VES	Accepted
	64	Pyawbwe	Htanekan	MA2-24	600 ft	180 m	205	807	VES	Accepted
	65		Waryonesu	MA2-25	400 ft	120 m	180	797	VES	Accepted
	66	Nyaungoo	Talkone	MA2-26	790 ft	240 m	52	320	VES	Accepted
	67		Tawbyar	MA2-27	790 ft	240 m	60	360	VES	Accepted
	68		Setsetyo	MA2-28	1320 ft	400 m	147	840	VES	Accepted
	69		Kanzauk	MA2-29	730 ft	220 m	120	565	VES	Accepted
	70		Talbindel	MA2-30	990 ft	300 m	101	523	VES	Accepted
	71		Mongywettaw	MA2-31	990 ft	300 m	85	365	VES	Accepted
	72		Phoenekan	MA2-32	660 ft	200 m	85	394	2D	Accepted
	73		Nyaungbinthar	MA2-33	690 ft	210 m	70	314	2D	Accepted
	74		Saingkan(Telide)	MA2-34	1320 ft	400 m	66	331	VES	Accepted
	75		Byugyi	MA2-35	1060 ft	320 m	334	1804	VES	Accepted
	76	Kyaukpadaung	Aleywar-2	MA2-36	920 ft	280 m	220	1098	2D	Accepted
	77		Tangakan	MA2-37	-	-	151	836	-	Excluded
	78		Leigyi(Ma)	MA2-38	1090 ft	330 m	221	1279	2D	Accepted
	79		Thayattaw	MA2-39	1150 ft	350 m	150	725	VES	Accepted
	80		Nakyatkhwal	MA2-40	990 ft	300 m	958	-	VES	Accepted

(3) Magway Region

Region	No.	Township	Villages	ID	Estimated Drilling Depth (Pre-survey)		Household	Population	Geophysical Survey Method	Result of Village Survey
					feet	m				
Magway	81	Magway	Natkan	MG2-01	600 ft	180 m	264	1244	VES	Accepted
	82		Thanbo(Ywarthit)	MG2-02	400 ft	120 m	65	280	VES	Accepted
	83		Nyaungbinthar	MG2-03	660 ft	200 m	315	1535	VES	Accepted
	84		Konégyi	MG2-04	730 ft	220 m	253	1090	VES	Accepted
	85		Sainggya	MG2-05	660 ft	200 m	460	2300	VES	Accepted
	86		Thapyaysan(N)	MG2-06	630 ft	190 m	50	250	VES	Accepted
	87		Shwekyaw	MG2-07	650 ft	195 m	95	388	VES	Accepted
	88		Leikkan	MG2-08	380 ft	115 m	226	1115	VES	Accepted
	89		Ywarthitgyi	MG2-09	600 ft	180 m	380	1805	VES	Accepted
	90	Chauk	Kanyaygyi	MG2-10	1090 ft	330 m	209	1239	VES	To be considered
	91		Myaysoon(Ywarthit)	MG2-11	870 ft	265 m	63	319	VES	To be considered
	92		Zeebwar	MG2-12	530 ft	160 m	235	1027	2D	To be considered
	93		Yenpyay	MG2-13	560 ft	170 m	40	280	VES	Accepted
	94		Kyatesu(N)	MG2-14	500 ft	150 m	140	740	VES	To be considered
	95		Winkabar	MG2-15	370 ft	110 m	610	2420	VES	Accepted
	96		Kyatkan	MG2-16	560 ft	170 m	97	478	VES	Accepted
	97		Sudat	MG2-17	1320 ft	400 m	110	560	VES	Accepted
	98		Myaynilain	MG2-18	830 ft	250 m	42	253	VES	Accepted
	99	Yenangyaung	Legyinyo	MG2-19	910 ft	275 m	273	1637	2D	Accepted
	100	Myothit	Laytinesin(S)	MG2-20	690 ft	210 m	591	3299	VES	Accepted
	101		Thanmyar	MG2-21	690 ft	210 m	650	3700	VES	Accepted
	102		Aungmyinthar	MG2-22	400 ft	120 m	210	1150	VES	Accepted
	103		Ngwelay	MG2-23	380 ft	115 m	237	1237	VES	Accepted
	104	Natmauk	Indaw(N)	MG2-24	370 ft	110 m	103	530	VES	Accepted
	105		Htanaungkwin	MG2-25	-	-	280	1574	-	Excluded
	106		Manawtgone	MG2-26	420 ft	125 m	160	930	VES	Accepted
	107		Kangyigone	MG2-27	730 ft	220 m	61	360	VES	Accepted
	108		Htonepoutchine	MG2-28	370 ft	110 m	372	2018	2D	Accepted
	109		Padaukngote(Ywargyi)	MG2-29	-	-	286	1248	-	Excluded
	110		Sellel	MG2-30	990 ft	300 m	367	1018	2D	To be considered
	111		Padaukgone	MG2-31	-	-	152	820	-	Excluded
	112		Ywarthatay	MG2-32	580 ft	175 m	75	374	VES	To be considered
	113		Wayonegone	MG2-33	330 ft	100 m	150	950	2D	To be considered
	114		Nyaunggone	MG2-34	370 ft	110 m	320	1814	2D	Accepted
	115		Kyugyaung	MG2-35	730 ft	220 m	61	550	VES	Accepted
	116	Taungdwingyi	Kokkohla	MG2-36	500 ft	150 m	229	860	2D	To be considered
	117		Kangyigone	MG2-37	630 ft	190 m	205	1099	2D	To be considered
	118		Htaukkyantgwin	MG2-38	1150 ft	350 m	270	1502	VES	Accepted
	119		Hlebwegyi	MG2-39	990 ft	300 m	182	1968	VES	Accepted
	120		Yayhtwelgyi	MG2-40	860 ft	200 m	137	662	VES	Accepted

Appendix 2: List of Villages Connected to the National Electric Grid

No.	Region	Township	ID No.	Village
1	**Sagaing**	Budalin	SA2-01	Yonedaw
2			SA2-02	Nyaungbinthar
3			SA2-03	Maunghtaung
4		Ayadaw	SA2-10	Oakkan
5		Kanbalu	SA2-24	Thindaw
6			SA2-25	Lwingyi
7			SA2-26	Koetaungboh (Kyaunkone)
8			SA2-28	Myayhtoo
9	**Mandalay**	Myingyan	MA2-05	Kuywar
10			MA2-06	Yonehto
11		Natogyi	MA2-13	Kyauknan
12		Taungtha	MA2-18	KyaukKarTaungKone
13			MA2-21	Tharyarmyaing
14		Kyaukpadaung	MA2-36	Aleywar-2
15			MA2-40	Nakyatkhwal
16	**Magway**	Magway	MG2-02	Thanbo (Ywarthit)
17		Chauk	MG2-12	Zeebwar
18			MG2-17	Sudat
19		Natmauk	MG2-27	Kangyigone

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4.3 Minutes of Discussions (Date of Signature: 20th October, 2015)

MINUTES OF DISCUSSIONS
ON
THE PREPARATORY SURVEY
ON
THE PROVISION OF EQUIPMENT FOR RURAL WATER SUPPLY PROJECT
IN THE CENTRAL DRY ZONE (PHASE 2)
IN THE REPUBLIC OF THE UNION OF MYANMAR

Considering the urgent needs of providing safe drinking water in the Central Dry Zone, the Government of Japan decided to conduct a Preparatory Survey on the Provision of Equipment for Rural Water Supply Project in the Central Dry Zone (Phase 2) (hereinafter referred to as "the Project") and entrusted the survey to the Japan International Cooperation Agency (hereinafter referred to as "JICA"). Through discussions, field surveys, and technical examination of the study results in Japan, JICA has prepared a draft final report of the survey.

In order to explain and to consult with the Government of Myanmar (hereinafter referred to as "Myanmar") on the components of the draft final report, JICA dispatched the Draft Final Report Explanation Team (hereinafter to as "the Team") headed by Ms. Eriko Tamura, Director, Water Resources Team I, Global Environment Department, JICA, from 19th October to 22nd October, 2015.

As a result of discussions, both sides confirmed the main items described in the attached sheet.

Nay Pyi Taw, 20 October, 2015

田村 えり子

Eriko Tamura
Leader
Preparatory Survey Team
Japan International Cooperation Agency (JICA)

Khant Zaw
Director General
Department of Rural Development,
Ministry of Livestock, Fisheries and Rural Development
The Republic of the Union of Myanmar

ATTACHMENT

1. Components of the Draft Final Report

Department of Rural Development, Ministry of Livestock, Fisheries and Rural Development. (hereinafter referred to as "DRD") agreed and accepted in principle the components of the draft final report explained by the Team. The Project sites map, list of the targeted villages and outline of the Project are respectively shown in **Annex-1**, **Annex-2** and **Annex-3**. Expected project implementation schedule is as attached in **Annex-4**.

2. Responsible and Implementing Agency

The responsible and implementing agency is Department of Rural Development, Ministry of Livestock, Fisheries and Rural Development (DRD) .

3. Japan's Grant Aid Scheme

3-1. DRD understood the Japan's Grant Aid Scheme explained by the Team, as described in **Annex-5**.

3-2. DRD will take the necessary measures, as described in the **Attachment 2 of Annex-5**, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

4. Important issue on the Project Component

4-1. Construction of deep wells and related water supply facilities

Both sides confirmed that DRD will construct deep wells and related water supply facilities for the targeted 100 villages in 5 years, for which DRD will secure necessary human resources and budget.

4-2. Water quality

The Team reminded the risk of concentration of Fluoride and Nitrate-Nitrogen exceeding water quality standard in Myanmar, and it might be the cause of negative impact to villagers' health. Both sides confirmed that DRD will conduct water quality test at the time of completion of deep well construction and take necessary measures as agreed on the Technical Note signed on 2nd July 2015 as follow.

(1) The DRD will analyze the water quality of the deep well with its own budget at the time of completion of the deep well construction and the results shall be recorded in the Progress Monitoring Report to be submitted to the JICA Myanmar office.

(2) The DRD will monitor water quality once a year in the following cases,
   a) in case water quality of a well meets National Drinking Water Quality Standards (hereinafter referred to as "the standard") and/or WHO Guidelines (ver. 4) (hereinafter referred to as "Guidelines") but it is very close to the standard or Guidelines.
   b) in case there is an existing deep well, of which water quality does not meet the standard or Guidelines, close to the well drilled in the Project.
   c) in case there is any facility which may cause groundwater pollution (factories, mines, etc.) in the adjacent area of the target villages.

(3) If the water quality does not satisfy the standard, such water shall be used only for purposes other than drinking. In such case, DRD shall properly inform and instruct the community people not to drink the water of such well to avoid occurrence of health hazards. If the community people use the water for drinking, DRD will take necessary measures such as refilling the well.

(4) Six (6) parameters, such as Total Coliforms, Fecal Coliforms, Color, Lead, Manganese, and Iron among priority parameters in NDWQS are not currently analyzed in DRD due to luck of budget and equipment. DRD also committed to secure necessary budget for reagents and chemicals for water quality tests in DRD and water quality tests by third parties such as Ministry of Health or private companies.

4-3. Operation and Maintenance of the procured equipment and constructed water supply facilities

DRD confirmed that DRD will maintain the procured equipment including air compressor, well logging machine, pumping test equipment etc with its own budget.

DRD also confirmed that DRD will provide initial instruction on the daily maintenance, tariff collection and follow up support to the village water committee, which will actually operate and maintain the constructed water supply facilities.

In addition, the Team made following recommendations to secure the sustainable water supply.

(1) Development of rural water supply strategy including expansion of water supply facilities and maintenance/rehabilitation of the existing water supply facilities.
(2) Framework to support village water committee by DRD
(3) Consideration of water supply service for low income houses

4-4. Technical assistance ("Soft Component" of the Project)

Considering the sustainable operation and maintenance of the provided facility, following technical assistance is planned to be provided under the Project. DRD confirmed that it will assign necessary number of competent and appropriate C/Ps as described in the draft final report.

- Well logging
- Pumping test

4-5. Expected outcomes and Indicators

Both sides agreed that key indicators for expected outcomes are as follows. DRD has responsibility to monitor the progress of the indicators and achieve the target in year 2022.

[Quantitative Effect]

Indicator	Original (Year 2015)	Target (5 years after the completion, planned as Year 2022)
Number of the drilled well	0	100

[Qualitative Effect]

- To save work load and time of the people in the central dry zone to fetch water
- To increase number of the people in the targeted villages with access to safe water
- Utilization of the procured equipment to drill above deep wells shall be confirmed

5. Undertakings of DRD

The Team explained to DRD its undertakings as listed in **Attachment 2 of Annex-5**, and **Annex-6**, and DRD understood and agreed to execute them.

The Team also explained necessary project cost to be covered by DRD and necessary annual operation and maintenance cost as attached in **Annex-7**. The Team also requested DRD to reimburse for some tax items including commercial tax which might not be exempted according to the recent discussion with Ministry of Finance. DRD agreed to secure necessary budget.

The Team reminded the annual progress/completion report to be submitted by DRD on it's construction of work as agreed by Record of Discussion signed on 24th September as attached in **Annex-8.** DRD confirmed on the submission of the annual progress/completion report.

6. Ex-Post Evaluation

JICA will conduct ex-post evaluation after five (5) years after the project completion with respect to five evaluation criteria (Appropriateness, Impact, Effectiveness, Efficiency, Sustainability) of the project. Result of the evaluation will be publicized. DRD is required to provide necessary support for them.

7. Coordination with other projects

Both sides confirmed that the Project shall be coordinated and demarcated with any other project supported by JICA, other development partners, NGOs, and Myanmar official organizations and departments.

8. Schedule of the Preparatory Survey

JICA will complete the final report in accordance with the confirmed items and send it to DRD in January 2016.

Annex-1	Project Sites Map
Annex-2	List of the targeted villages
Annex-3	Outline of the Project
Annex-4	Expected Project Implementation Schedule
Annex-5	Japan's Grant Aid Scheme
	Attachment 1: Flow Chart of Japan's Grant Aid Procedures
	Attachment 2: Major Undertakings to be taken by Each Government
Annex-6	Undertaking by DRD
Annex-7	Cost for Undertakings by DRD and Annual Operation & Maintenance
Annex-8	Monitoring Form (as an attachment of Record of Discussion) for Progress of the Construction Work

Annex-1: Project Sites Map

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Annex-2: List of targeted villages

Region	Township	Village Tracks	ID	Villages	Population	Priority	Coordinate (WGS 84 UTM46N)	
							X	Y
Sagaing (34 villages)	Budalin	Htanaungkone	SA2-01	Yonedaw	369	5	721184	2468685
		Ngapayin	SA2-02	Nyaungbinthar	223	3	720885	2486381
		Maunghtaung	SA2-03	Maunghtaung	5600	4	712894	2487822
		Ywarthit	SA2-04	Kantawthar	420	5	704295	2487734
		Konethar	SA2-05	Mhonehtoo	172	3	729874	2471014
		Watluu-I	SA2-06	Watluu-I	768	5	700719	2482574
	Chaungoo	Thanbinkan	SA2-07	Thanbinkan	935	3	742454	2430400
		Natyaygan	SA2-08	Natyaygan	809	3	743821	2426594
	Ayadaw	Ngarrtowma	SA2-09	Sithar	420	3	742840	2472680
		Leinhla	SA2-10	Oakkan	800	4	747838	2482552
		Warryaung	SA2-11	Warryaung	4500	2	748170	2458383
		Yechinn	SA2-12	Warrtannkalay	750	5	750823	2470044
		Warryaung	SA2-14	Zeepinlel	1897	5	751516	2457534
	Salingyi	Yonebinyoe	SA2-16	Minntaw	1071	4	712670	2428751
		Moe Kyo Pyin	SA2-17	Kine	305	6	711640	2437561
	Myinmu	Kalarpyan	SA2-18	Kalarpyan	385	2	749957	2422670
		Nyaungbinkan	SA2-19	Hlayookan	580	4	758107	2439343
			SA2-21	Watkya	748	4	745604	2447822
		Latpankyin	SA2-22	Thahtaykone(Ywarma)	410	5	747673	2446221
	Kanbalu	Thindaw	SA2-24	Thindaw	817	3	773385	2613108
			SA2-25	Lwingyi	499	3	772013	2612839
		Koetaungboh	SA2-26	Koetaungboh (Kyunkone)	1171	4	773590	2620729
		Nyaungkanthar	SA2-27	Inngoteto	1278	5	768388	2598038
		Myayhtoo	SA2-28	Myayhtoo	1184	6	745839	2565464
		Khaowntar	SA2-29	Khaowntar	1004	4	776585	2551429
		Nyuangkanthar	SA2-30	Nyuangkanthar	539	5	770771	2597741
		Myaymon	SA2-31	Myaymon	2527	3	785110	2544263
		Pazigyi	SA2-32	Layytwinzin	714	4	800148	2549708
		Paygone(S)	SA2-33	Chaungchar	513	3	762397	2587371
	Dabayin	Intimelay	SA2-34	Minyogone	410	5	731866	2513234
		Mintelgone	SA2-35	Shandaw	384	4	725913	2501505
		Satpyargyin	SA2-36	Kyuntaw (S)	434	5	728632	2505189
	Wetlet	Sharkwal	SA2-37	PalaeThwe (Ywarthit)	298	3	798805	2492481
		Poukkan	SA2-38	Poukkan	1159	6	796554	2461964
Mandalay (31 villages)	Mahlaing	Yayhtwet	MA2-01	Htantawgyi	550	5	766932	2339178
		Kyatse	MA2-02	Asone	650	4	769110	2329262
		Yaychobutar	MA2-03	Khinthar(S)	480	4	782257	2317158
	Myingyan	Chaysay	MA2-04	Chaysay	1412	3	752986	2368995
		Pinlai	MA2-05	Talgyi	830	5	758871	2404696
		Yonehto	MA2-07	Yonehto	850	3	762363	2384258
	Ngazon	Kaungzin	MA2-11	Kaungzin	864	4	765082	2403595
	Natogyi	Myinni	MA2-14	Kyaungkangyibin	435	4	757284	2368820
		Nyaunggone	MA2-15	Nyaunggone	689	5	772284	2368730
	Taungtha	Zagyan	MA2-17	Chaungsone(La)	800	3	735423	2354667
			MA2-19	Tharzi	950	4	740022	2346931
		Kanmyel	MA2-20	Kanaye	1150	4	740499	2349032
		Tharyarmyaing	MA2-21	Tharyarmyaing	2200	3	745680	2342452
	Yamethin	Myinnar	MA2-22	Oakpo	1660	4	826577	2270843
		Nabukyin	MA2-23	Kangyi	1520	3	828701	2246082
	Pyawbwe	Seitcho	MA2-24	Htanekan	807	4	804392	2275367
			MA2-25	Waryonesu	797	1	804775	2275467

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Region	Township	Village Tracks	ID	Villages	Population	Priority	Coordinate (WGS 84 UTM46N)	
							X	Y
Mandalay	Nyaungoo	Sinthamway	MA2-26	Talkone	320	2	721219	2347331
		Tawbyar	MA2-27	Tawbyar	360	3	726336	2345860
		Setsetyo	MA2-28	Setsetyo	840	1	721783	2329618
		Pyon	MA2-29	Kanzauk	565	2	709761	2328732
		Kantain	MA2-30	Talbindel	523	2	719609	2332361
		Tawpyar	MA2-31	Mongywettaw	365	2	724266	2337196
		Tuywintaung	MA2-32	Phoenekan	394	5	702946	2332978
		Nyaungbinthar	MA2-33	Nyaungbinthar	314	2	712986	2322241
		Kudaw	MA2-34	Saingkan(Tetide)	331	1	724241	2328758
		Byugyi	MA2-35	Byugyi	1804	1	724225	2325295
	Kyaukpadaung	Tangkan	MA2-36	Aleywar-2	1098	2	718698	2309611
		Lelgyi(N)	MA2-38	Lelgyi(Ma)	1279	3	734592	2325518
		Kannbyu	MA2-39	Thayattaw	725	3	729386	2325074
		Nakyatkhwal	MA2-40	Nakyatkhwal	(4790)	2	719979	2312255
Magway (35 villages)	Magway	Natkan	MG2-01	Natkan	1244	3	706558	2233838
		Sharzaungkan	MG2-02	Thanbo(Ywarthit)	280	5	716115	2216165
		Kyarkan	MG2-03	Nyaungbinthar	1535	2	737905	2244038
		Nyaungbinthar	MG2-04	Konegyi	1090	2	718609	2237658
		Paypinsan	MG2-05	Sainggya	2300	3	725131	2213520
		Thapyaysan	MG2-06	Thapyaysan(N)	250	2	712474	2227465
		Supyitsan	MG2-07	Shwekyaw	388	2	733927	2207547
		Nyaungkan	MG2-08	Leikkan	1115	3	726925	2239708
			MG2-09	Ywarthitgyi	1805	3	722085	2237683
	Chauk	Thanbo	MG2-10	Kanyaygyi	1239	3	702708	2281908
		Myaysoon	MG2-11	Myaysoon (Ywarthit)	319	2	698121	2277376
		Zeebwar	MG2-12	Zeebwar	1027	4	711611	2298972
		Chaungtat	MG2-13	Yenpyay	280	3	691309	2301533
		Pakhannge	MG2-14	Kyatesu(N)	740	3	685590	2292806
		Salintaung	MG2-15	Winkabar	2420	3	684440	2287269
		Magyikone	MG2-16	Kyatkan	478	3	685497	2292703
		Gwaypin	MG2-17	Sudat	560	1	706642	2285676
		Nyaungzin	MG2-18	Myaynilain	253	3	698822	2287055
	Yenangyaung	Indaw	MG2-19	Legyinyo	1637	2	724077	2266805
	Myothit	Laytinesin	MG2-20	Laytinesin(S)	3299	2	732775	2236056
			MG2-21	Tharmyar	3700	2	736194	2241244
			MG2-22	Aungmyinthar	1150	5	733076	2231654
		Wargyiini	MG2-23	Ngwelay	1237	4	738867	2222539
		Htauksharkan	MG2-24	Indaw(N)	530	5	742532	2229825
		Manawtkone	MG2-26	Manawtgone	930	3	732003	2222326
	Natmauk	I-Sauk	MG2-27	Kangyigone	360	2	742461	2259232
		Htonepoutchine	MG2-28	Htonepoutchine	2018	4	730959	2255653
		Wayonegone	MG2-33	Wayonegone	950	5	735749	2267902
		Htonepoutchine	MG2-34	Nyaunggone	1814	3	732682	2256118
		I-Zauk	MG2-35	Kyugyaung	550	3	744568	2259272
	Taungdwingyi	Pantwinlay	MG2-36	Kokkohla	860	6	765819	2218655
		Payatkyal	MG2-37	Kangyigone	1099	4	762556	2192933
		Warthonepyu	MG2-38	Htaukkyantgwin	1052	1	772105	2184938
		Hlebwegyi	MG2-39	Hlebwegyi	1988	2	747939	2200787
			MG2-40	Yayhtwetgyi	662	3	743110	2197239

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Annex-3: Outline of the Project

1. Title of the Project

The Provision of Equipment for Rural Water Supply Project in the Central Dry Zone (Phase 2)

2. Objective of the Project

The project aims to strengthen the capacity of DRD's rural water supply by providing the equipment necessary for construction of new deep wells, thereby contributing to improve the access of the people in the Central Dry Zone to safe and sustainable water resource.

3. Component of the Project

1) Equipment

Item	Specification	Number
Truck mounted drilling rig (drilling capacity, more than 300m) and ancillary materials	Drilling capacity: 250m	1 set
	Drilling capacity: 200m	1 set
Cargo truck with crane	Pay load: more than 10 ton Lifting load: 5 ton	2 cars
Air compressor		2 sets
Well logging machine	Measuring depth: 400m	1 set
	Measuring depth: 300m	1 set
Consumables for borehole construction (bentonite, CMC, etc.)		For 100 boreholes
Casing and screen		For 100 boreholes
Pumping test equipment		1 set

2) Supervision / Soft component

- Procurement Supervision
- Soft component on well logging and pumping test

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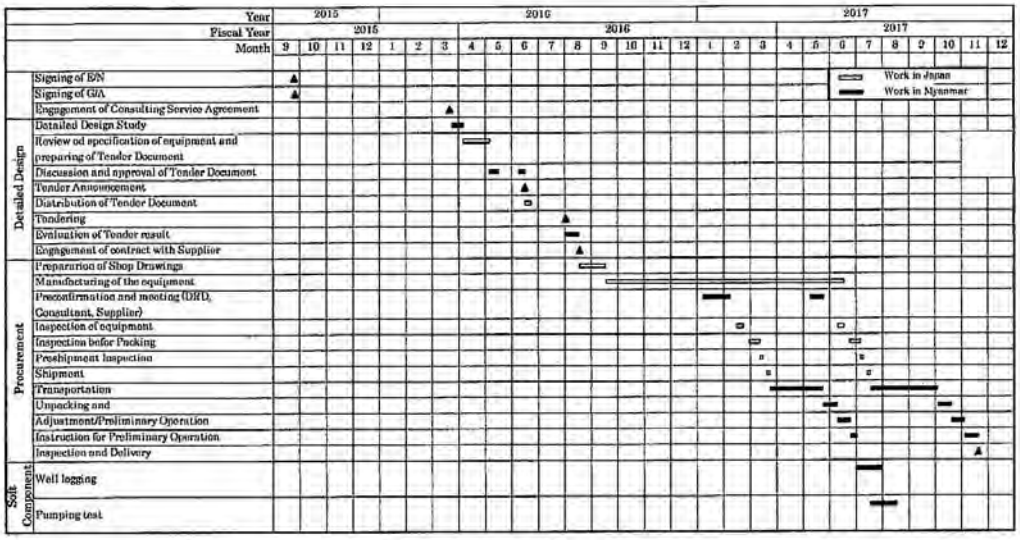
Annex-4: Expected Project Implementation Schedule



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Annex-5: Japan's Grant Aid Scheme

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as part of this realignment, JICA was reborn on October 1, 2008. After the reborn of JICA, following the decision of the Government of Japan (hereinafter referred to as "the GOJ"), Grant Aid for General Project is extended by JICA.

Grant Aid is non-reimbursable fund to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures (Attachment 1)

Japanese Grant Aid is conducted as follows-

- Preparatory Survey (hereinafter referred to as "the Survey")
  - The Survey conducted by JICA
- Appraisal & Approval
  - -Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Determination of Implementation
  - -The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - -Agreement concluded between JICA and a recipient country
- Implementation
  - -Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the Survey is to provide a basic document necessary for the appraisal of the Project by JICA and the GOJ. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of agencies concerned of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed on by both parties concerning the basic concept of the Project.
- Preparation of a outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed considering the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA uses (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

The Report on the Survey is reviewed by JICA, and after the appropriateness of the Project is confirmed, JICA recommends the GOJ to appraise the implementation of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the E/N will be singed between the GOJ and the Government of the recipient country to make a plead for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

The consultant firm(s) used for the Survey Will be recommended by JICA to the recipient country to also work on the Project's implementation after the E/N and the G/A, in order to maintain technical consistency.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

(4) Necessity of "Verification"

The Government of recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Attachment 2

(6) Proper Use

The Government of recipient country is required to maintain and use the facilities constructed and the 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) Export and Re-export

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

(8) Banking Arrangements (B/A)

a) 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"). JICA 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 the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

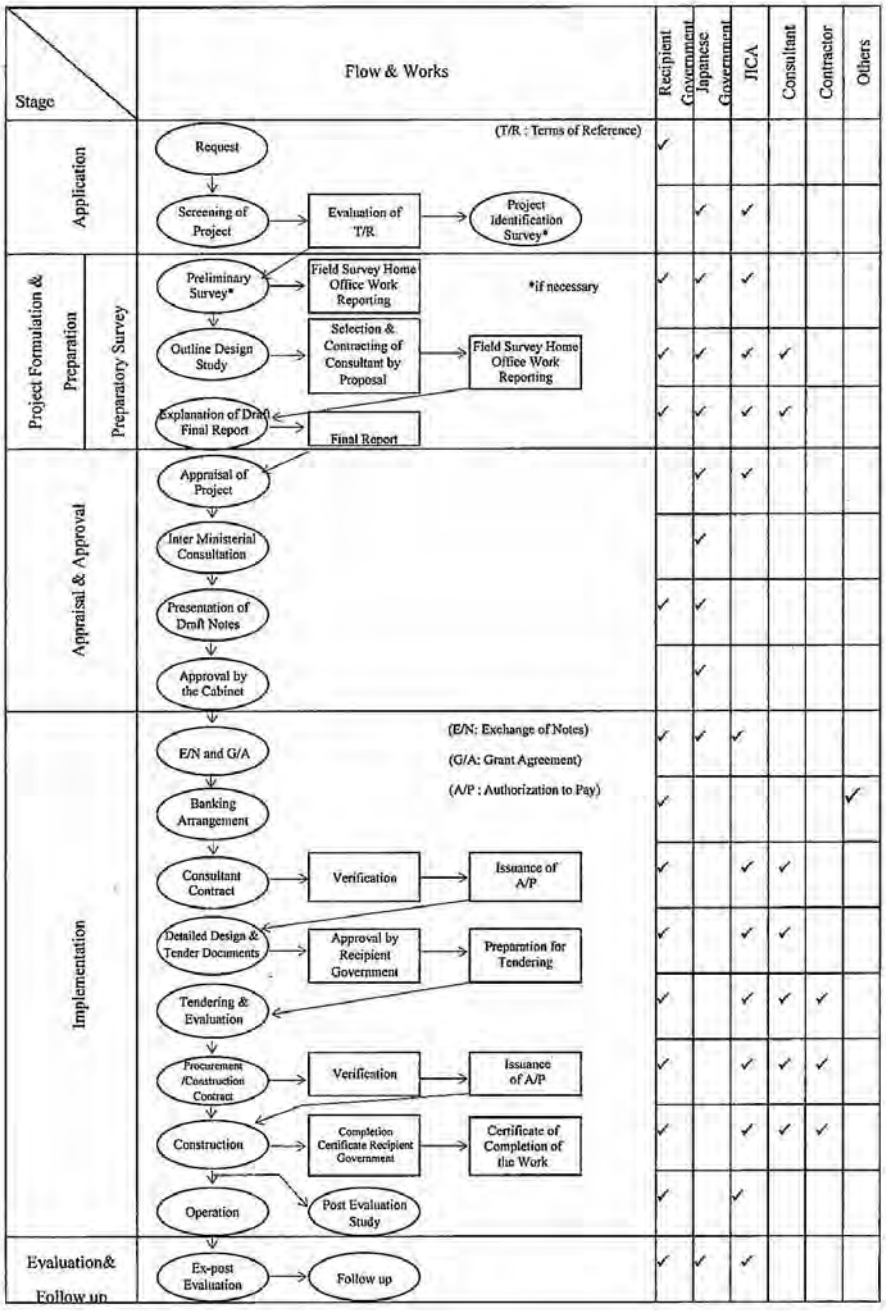
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions to the Bank.

(10) Social and Environmental Considerations

A recipient country must ensure the social and environmental considerations for the Project and must follow the environmental regulation of the recipient country and JICA socio-environmental guideline.

Attachment 1

Flow Chart of Japan's Grant Aid Procedures



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Attachment 2

Major Undertakings to be taken by Each Government

No	Items	To be covered by Grant Aid	To be covered by Recipient
1	To bear the following commissions to a bank of Japan for the banking services based upon the B/A		
	1) Advising commission of A/P		•
	2) Payment commission		•
2	To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the products from Japan to the recipient country	•	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		•
	3) Internal transportation from the port of disembarkation to the project site	(•)	(•)
3	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		•
4	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract		•
5	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid		•
6	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for the transportation and installation of the equipment		•
7	To give due environmental and social consideration in the implementation of the Project		•

(B/A: Banking Arrangement, A/P: Authorization to pay, N/A: Not Applicable)

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Annex-6 Undertaking by DRD

Following is the undertaking whish shall be conducted by DRD in addition to Attachment 2 of Annex-5

No.	Work Items	Description	Responsibility	Implementation timing (tentative)
1	Banking Arrangement Commission (B/A)	Arrangement between Myanma Foreign Trade Bank (MFTB) & The Bank of Tokyo-Mitsubishi UFJ (BTMU) to open Grant Account with BTMU. DRD needs to pay the commission fee for B/A.	DRD	After GA, Before the signing of consultant contract (By February 2016)
2	Authorization to Pay (A/P)	A/P shall be issued by MFTB to BTMU to give authorization for BTMU to pay the consultant on behalf of MFTB. DRD needs to initiate the following procedure. (1) FE (Foreign Exchange) Permission by the Budget Department under the Ministry of Finance (2) Issuing of A/P by MFTB	DRD	At the time of payment (First payment will be advance payment of consultant contract in February 2016)
3	Establishment of Project Implementing and Coordination Committee	DRD proposed to establish Project Implementing and Coordination Committee of the Project within DRD. Structure and name list of the Project Implementing and Coordination Committee shall be informed to JICA	DRD	Soon after signing of consultant contract (By February 2016)
4	Recruit of new staff at workshops	DRD will recruit 2 or 3 new staff for workshops for O&M of equipment	DRD	Before arrival of the equipment (By May 2017)
5	Assign staff for the construction of deep wells and related water supply facilities	DRD shall assign necessary staff (8 staff x 2 team) for the construction of deep wells.	DRD	Before signing of consultant contract (By February 2016)
6	Assignment of C/Ps for the soft component	DRD needs to assign necessary number of competent C/Ps for the following soft component as described in DFR. List of C/Ps shall be informed to JICA - Well logging - Pumping test	DRD	Before signing of consultant contract (By February 2016)
7	Daily allowance and traveling expenses for staff participating in soft component	-	DRD	At the time of necessity
8	Preparation of land space to store procured equipment	DRD shall secure necessary space to store procured equipment in Nyanu Workshop.	DRD	Before shipment of the equipment (By March 2017)

No.	Work Items	Description	Responsibility	Implementation timing (tentative)
9	Construction of deep wells and related water supply facilities	DRD shall construct deep wells and related water supply facilities for the targeted villages in 5 years.	DRD	5 years after the procurement of the equipment (2017-2022)
10	Water quality test	DRD shall conduct water quality test at the time of completion of deep well construction and take necessary measures as follow. Result of the water quality test shall be report to JICA Myanmar Office by Annual Progress/Completion Report. (1)The DRD will analyze the water quality at the completion of the drilling of deep wells and the results shall be included in the Progress Monitoring Report to be submitted to the JICA Myanmar office. Necessary cost for this issue is borne by the DRD. (2)In the following cases, the DRD will monitor water quality once a year. a)water quality of a well meets the standard and/or WHO Guidelines (ver. 4) but it is very close to the standard or Guidelines b)there is an existing deep well, of which water quality does not meet the standard or Guidelines, close to the well drilled in the Phase 2 project. c)there is any facility which may cause groundwater pollution (factories, mines, etc.) in the adjacent area of the target village. (3)If the water quality does not satisfy the standard, such water shall be used only for purposes other than drinking. In such case DRD shall properly inform and instruct the community people not to drink the water of such well to avoid occurrence of health hazards. If the community people use the water for drinking, DRD will take necessary measures such as refilling the well.	DRD	5 years after the procurement of the equipment (2017-2022)
11	Instruction and technical support to the targeted village to operate and maintain the constructed water supply facilities	The drilled well will be handed over to the water management committee in the targeted villages. DRD shall provide instruction and technical support to the water management committee to properly operate and maintain the constructed water supply facilities	DRD	5 years after the procurement of the equipment (2017-2022)
12	Submission of Annual Progress/Completion Report to JICA Myanmar Office	DRD shall submit Annual Progress/Completion Report on its construction work and the water quality test on the deep tube well in the targeted villages to JICA Myanmar Office.	DRD	Annually from commencement of construction work until the completion of the construction work by DRD

Annex-7 Estimated Cost for Undertakings by DRD and Annual Operation and Maintenance

The following tentative estimated cost for the Project will be reviewed periodically after commencement of the Project.

(1) Estimated Cost for Undertakings by DRD

Item	Cost ($x10^3$ MMK)	Yen ($x10^3$ Yen)
A. Cost for the First Year		
1) B/A and A/P	11,446	1,282
2) Deep Well Drilling	162,500	18,200
3) Construction of Water Supply Facility	268,800	30,106
4) Maintenance of the procurred equipment	17,225	1,929
5) Travel allowance and expense for attending the soft component	3,500	392
6) Water Quality Analysis	356	40
Total for the First Year ①	463,827	51,949
B. Cost after the First Year		0
1) Deep Well Drilling	162,500	18,200
2) Construction of Water Supply Facility	268,800	30,106
3) Maintenance of the procurred equipment	17,225	1,929
4) Water Quality Analysis	356	40
Total for each Year after the First Year ②	448,881	50,275
Total after the First Year ③=②×4	1,795,524	201,099
Grand Total for 5 Years ①+③	2,259,351	253,048

Exchange Rate: 1MMK=0.112 Japanese Yen (Jul. 2015)

(2) Estimated Cost for Annual Operation and Maintenance

Item	Number	Cost per Unit (MMK)	Annual Cost (Yen)
Drilling rig	2	1,875,000	3,750,000
Cargo truck with crane	2	5,500,000	11,000,000
Air compressor	2	625,000	1,250,000
Submersible pump	4	150,000	600,000
Generator(for submersible pump)	1	625,000	625,000
Logging machine	2	150,000	300,000
Total			**17,225,000**

Exchange Rate: 1MMK=0.112 Japanese Yen (Jul. 2015)

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Annex-8 Monitoring Form (as an attachment of Record of Discussion signed on 24th September) for Progress of the Construction Work

Record of Discussions

With reference to the Grant Agreement between the Japan International Cooperation Agen (hereinafter referred to as "JICA") and the Government of the Republic of the Union Myanmar (hereinafter referred to as "Myanmar" dated September 24, 2015 concerning t Japan's grant assistance for The Provision of Equipment for Rural Water Supply Project in t Central Dry Zone (Phase 2), the representatives of JICA and of the Government of Myanm wish to record the following:

1. With regard to the Article 11 (1) (c) and (2) of the said Grant Agreement, t representative of JICA stated that:
(a) the Government of Myanmar will submit to JICA annual progress reports on t construction work utilizing the materials and/or equipment procured under the said grant, f which the Government of Myanmar is responsible, by filling in the form attached hereto un all the construction work is completed; and
(b) the Government of Myanmar, will submit to JICA a final report upon completion.

2. The representative of the Government of Myanmar stated that the Government Myanmar has no objection to the statement by the representative of JICA referred to above.

Nay Pyi Taw, September 24, 2015

Keiichiro Nakazawa
Chief Representative
JICA Myanmar Office

Khant Zaw
Director General
Department of Rural Development
Ministry of Livestock, Fisheries and Rural Development

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[Progress / Completion] Report submitted on ○○○

1. Outline of the Project
(1) Name of Country: The Republic of the Union of Myanmar
(2) Name of the Project: The Provision of Equipment for Rural Water Supply Project in the Central Dry Zone (Phase 2)
(3) Date of the Grant Agreement: <Month Date, Year>
(4) Name of the Executing Organization: Department of Rural Development, Ministry of Livestock, Fisheries and Rural Development (hereinafter referred to as "DRD"

2. General Situation (how the equipment and/or materials procured under the Japan's Grant Assistance are used in general)

3. Detailed Explanation

equipment and/or materials;	How they are being used;	In case they haven't been used as planned	
		Reason for it; (Please specify the reason such as budgetary problems and problems in employing appropriate staffs etc.)	Measures to be taken to redress the situation;

4. Progress of the Construction Work done by DRD

Project site	Current situation				In case the work is delayed		Planned completion date	Any other problems;
	Construction		Water quality test at drilled well (*2)		Reason for delay;	Measures to be taken to redress the situation;		
	Component of water supply facility(*1)	Date of construction completion	Result of water quality test	Date of water quality test				
**	Production well, tank	dd/mm/yy	satisfied	dd/mm/yy	n/a	n/a	n/a	n/a
**	Production well	dd/mm/yy	not satisfied	dd/mm/yy -	n/a	n/a	n/a	n/a

(*1) Please write the component of the water supply facility such as production well, tank, distribution pipe, house connection, etc

(*2) If the water quality of the drilled well does not satisfy the water quality standard, DRD shall take necessary measures to avoid any health hazards caused by the well.

Note: Above table could be modified subject to the mutual understanding between DRD and JICA Myanmar Office.

5. Photos (please attach photos showing the progress of the construction work or the overall view of the facilities constructed by DRD.)