Federal Democratic Republic of Ethiopia
Amhara Water Resource Development Bureau

THE SECOND PREPARATORY SURVEY
ON
THE PROJECT FOR SMALL TOWN WATER SUPPLY
IN SOUTHERN PART OF THE AMHARA REGIONAL STATE
IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

FINAL REPORT

November 2012

Japan International Cooperation Agency (JICA)

Kokusai Kogyo Co., Ltd.

PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to Kokusai Kogyo Co., Ltd.

The survey team held a series of discussions with the officials concerned of the Government of Ethiopia, and conducted a field investigation. As a result of 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 Ethiopia for their close cooperation extended to the survey team.

November, 2012

Mr. Masami Fuwa
Director General,
Global Environment Department
Japan International Cooperation Agency

SUMMARY

1. Outline of the Recipient Country

Amhara Regional State is located in northwestern Ethiopia, neighboring Tigray Region, Afar Region, Oromia Region and Ganbera region, and is also bordered by Sudan in the west region. Amhara Regional State has the second largest area in Ethiopia, next to Oromia Region. Most of Amhara Regional state is Ethiopian highlands exceeding altitude of 2,000 m.

Peneplain of Ethiopia highland is inclining relatively gently, becomes complex topography that is formed by basalt lava that erupted from a shield volcano, and has been eroded and dissected subsequently. In addition, the origin of the Abbai River (Blue Nile) which makes Lake Tana is formed from a nearly vertical cliff and stepped terrain that gentle slopes and flat surfaces are continuous, they constitute the grand Abbai gorge which has eroded the Ethiopia highland in arborescence intricately

Climate of Amhara Regional state is divided into three seasons, light rain from February to May, rainy season from June to September and dry season from October to January. The temperature decreases as altitude increases, precipitation tends to increase at higher altitudes.

Average temperature is high from March to May (dry season), and is lower from July to September (rainy season).

2. Background and Outline of the Project

(1) Upper Plan

The Universal Access Program (UAP, 2005-2012) was launched in 2005 as a plan containing specific measures to accomplish the water sector development program (WSDP) that was launched in 2002. When the UAP reached implementation stage its target year was brought forward from 2016 to 2012, and the target daily per capita water supply was lowered from 20 L to 15 L. The water supply rate of urban areas was increased to 100 %, while the water supply rate of rural areas was increased to 98 %.

After evaluating the improvement in water supply rate from 2007 to 2009, however, a revised Universal Access Program 2 (UAP2, 2009-2015) was launched in November 2009. UAP2 aims to raise the water supply rate of urban areas to 100 %, and rural areas to 98 %. Meanwhile the target daily per capita water supply in urban areas was set at 20 L (with nearest water source within 0.5 km of their residence), and at 15 L in rural areas (with nearest water source within 1.5 km of their residence). This project is part of the UAP2.

(2) Current Conditions and Problems

The rural water supply rate in Ethiopia is 26 % (WHO/UNICEF, 2008), which is much lower than the sub-Saharan average of 47 % (WHO/UNICEF, 2008). This means that, with 80 % of Ethiopia's population living in rural towns and villages, they need to spend a great deal of time and energy just to obtain water, which is one factor that adversely affects poverty. In Ethiopia, overcoming the

chronic shortage of water essential for daily life is an issue of utmost importance.

Ethiopia has been undertaking the aforementioned WSDP (2002-2015), a comprehensive program for national water sector development, with the aim of improving water supply, irrigation, public hygiene and living standards, not least in rural areas. Ethiopia also established the UAP (2005-2012), a program for the development of the water sector that aims to provide 51,700,000 people with access to safe water and achieve a water supply rate to urban areas of 100 % and rural areas of 98% by 2012. However, because the UAP was not achieving its objectives, UAP2 (2009-2015) was established with the aim of improving the water supply rate even further.

Japan has, over the past nearly 20 years, been working to improve the rate of access to and the volume of water supply, particularly in rural areas, and has implemented nine grant aid projects for the construction of water supply facilities and provision of equipment for well drilling. In addition, Japan has been implementing technical cooperation projects at the Ethiopian Water Technology Center (EWTEC) to develop personnel and strengthen capacity in operation and maintenance of water supply facilities.

However, in recent years, while water supply demand has increased with the growth of population in small rural towns, the programs for the construction of water supply facilities are not making progress, and on top of this existing facilities are ageing and deteriorating. These and numerous other issues mean that the water supply rate still remains low, at approximately 53 % as of 2008.

(3) Background and Outline of Grant Aid

In August, 2008, Federal Democratic Republic of Ethiopia requested the grant aid of Japan concerning the rehabilitation and extension of water supply facilities in the small cities of the southern part of Amhara regional state. JICA received this request, carried out “The First Preparatory Survey for the Project for Small Town Water Supply in Southern Part of the Amhara Regional State” in March, 2010, checked the validity concerning project implementation, and narrowed down the site for survey to sixteen (16) sites from twenty nine (29) sites which had the request from the Federal Democratic Republic of Ethiopia.

However, one and half years had passed since “The First Preparatory Survey” was completed, and five (5) sites of sixteen (16) new water supply project sites have been started. It was agreed to carry out this survey at the remaining eleven (11) sites, besides the already started five (5) sites, as a result of deliberations with Amhara Water Resource Development Bureau (AWRDB). Although the field survey was started based on this determination, since it was difficult to secure groundwater or spring water in some sites, preliminary survey for adding sites to be surveyed has been performed. It was agreed to select two (2) sites from eight (8) sites that are additional requests from AWRDB, and finally, total thirteen (13) sites were selected as subject of this survey.

3. Summary of the Survey and Contents of the Project

(1) Summary of the Survey

Field survey in Ethiopia and analysis in Japan were conducted for thirteen (13) sites requested by the Ethiopian side. The thirteen (13) sites were evaluated by the criteria as previously mentioned, the candidate sites that have been evaluated as suitable sites for the Project were selected. The flow of selection for candidate site and the result of selection of candidate sites are as follows:

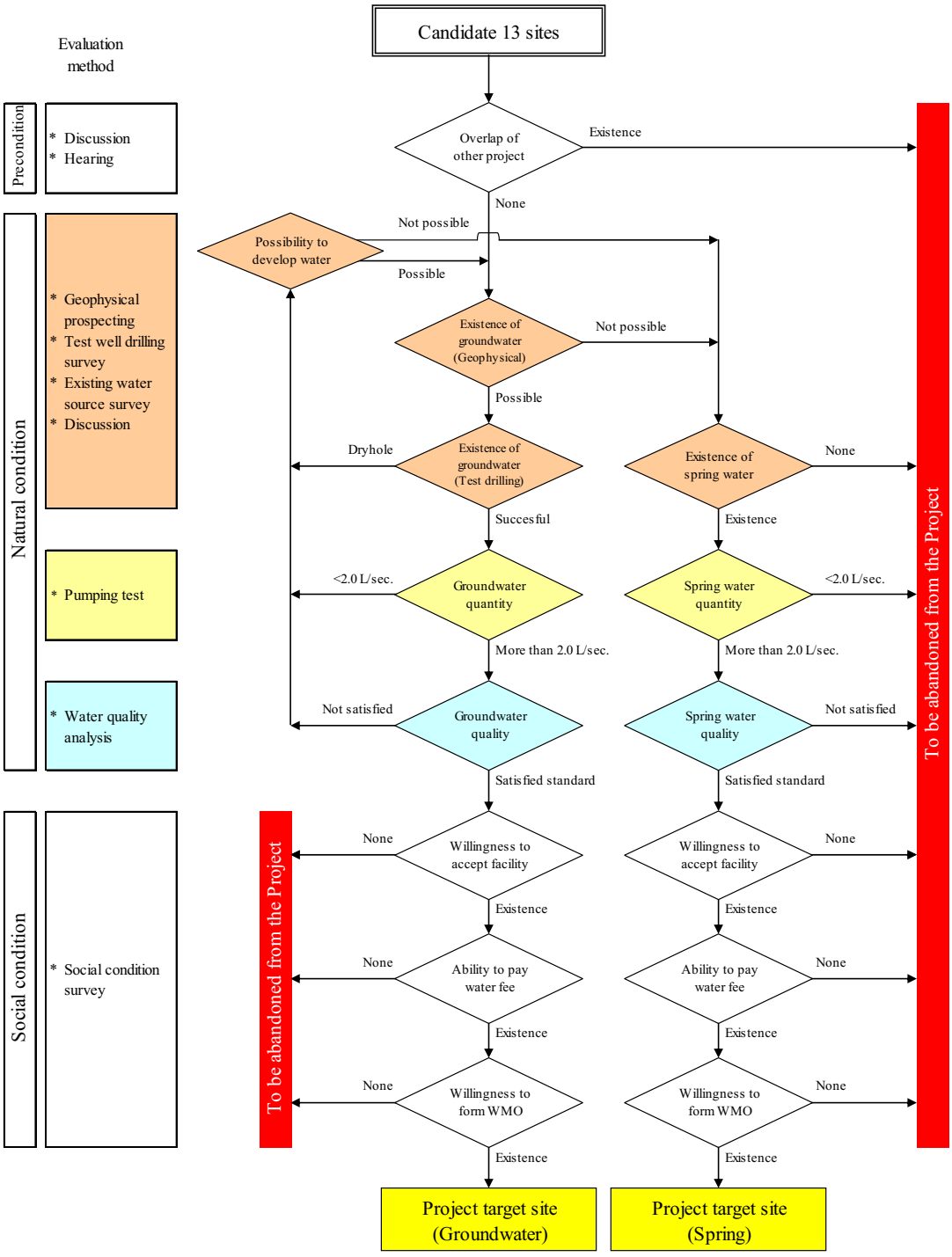


Figure 1: Flow of selection of the candidate sites

Table 1: The result of selection of candidate sites

Zone	ID	Town	Precondition	Natural condition				Social condition			Result of selection
			Overlap of other project	Existence of water source		Water source potential		Willingness to accept water supply facility	Ability to pay water fee	Willingness to form WMO	
				Groundwater	Spring	Quantity	Quality				
East Gojam	9	Mertule Maryam	None	None	5 points	11.42 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	10	Yetimen	None	Existence	—	8.70 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	11	Keranyo	None	None	None	—	—	—	—	—	To be abandoned
	12	Lumame	None	Existence	—	8.86 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	14	Wojel	None	Existence	—	7.80 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	15	Sedie	None	Existence	—	8.90 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	16	Dibo	None	Existence	—	8.90 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	-	Amanuel	None	Existence	—	3.00 L/sec	Satisfied	Existence	Existence	Existence	Project target site
West Gojam	24	Addisalem	None	None	None	—	—	—	—	—	To be abandoned
	26	Kuch	None	None	None	—	—	—	—	—	To be abandoned
	27	Gobeze Maryam	None	None	1 point	3.96 L./sec	Satisfied	Existence	Existence	Existence	Project target site
	29	Kunzila	None	None	None	—	—	—	—	—	To be abandoned
	-	Bikolo	None	Existence	—	14.00 L/sec	Satisfied	Existence	Existence	Existence	Project target site

Criteria:	Precondition	Overlap of other project	There is overlap project in the target site or not.
	Natural condition	Existence of groundwater source	Groundwater is existing in the target site or not.
		Existence of spring water source	Spring is existing in the target site or not.
		Water source potential (quantity)	Water quantity is more than 2.0 L/sec. or not.
		Water source potential (quality)	Water quality is satisfied Ethiopian water quality standard or not.
	Social condition	Willingness to accept water supply facility	Residents are willing to accept water supply facility or not.
		Ability to pay water fee	Residents have the ability to pay water fee or not.
		Willingness to form WMO	Residents are willing to form WMO or not.

Based on the result of field survey in Ethiopia and analysis in Japan, four (4) sites; Keranyo, Addisalem, Kuch and Kunzila were evaluated as necessary to be excluded from the Project, because of difficulty of development of water source at these sites.

Therefore, the number of candidate sites for the Project is totally nine (9); seven (7) sites will planned by groundwater source, two (2) sites will be planned by spring water source as mentioned below:

Table 2: Candidate sites for the Project

	Sites	Name
The site to be planned water supply facility by groundwater	7	Yetimen, Lumame, Wojel, Sedie, Dibo, Amanuel, Bikolo
The site to be planned water supply facility by spring	2	Mertule Maryam, Gobeze Maryam
Target site	9	
The site to be abandoned	4	Keranyo, Addisalem, Kuch, Kunzila
Total	13	

The outline of the Project is as follows:

Table 3: Outline of the Project

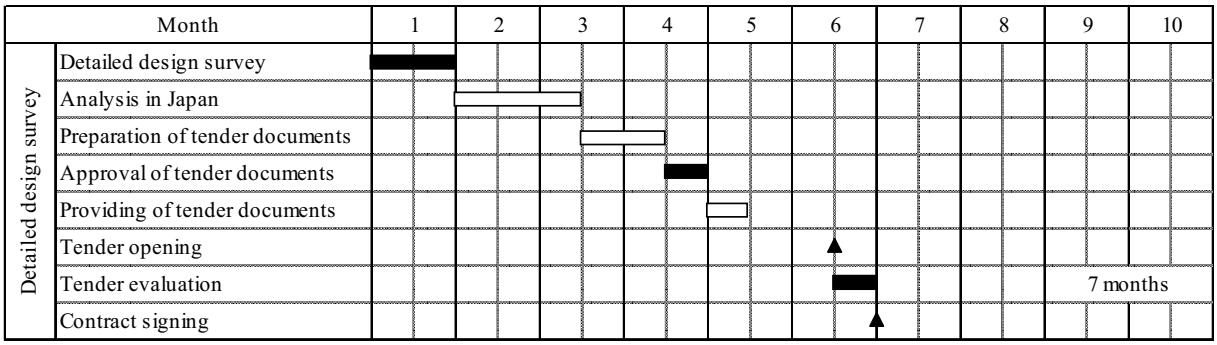
Item	Contents and activity
Facility construction	[Water supply] Construction of water supply facilities with public faucets and rehabilitation of existing facilities ・ Water supply facilities by groundwater: 7 sites ・ Water supply facilities by spring: 2 sites ・ Elevated reservoir tank: 3 ・ Ground reservoir tank: 6 ・ Generator house: 11 ・ Public faucet: 86/90 (new/existing exchange) ・ Transmission pipe: 23.843 km ・ Distribution pipe: 37.497 km
Soft component	[Water supply] Support to strengthen of capability of O&M by WMO and Woreda water office

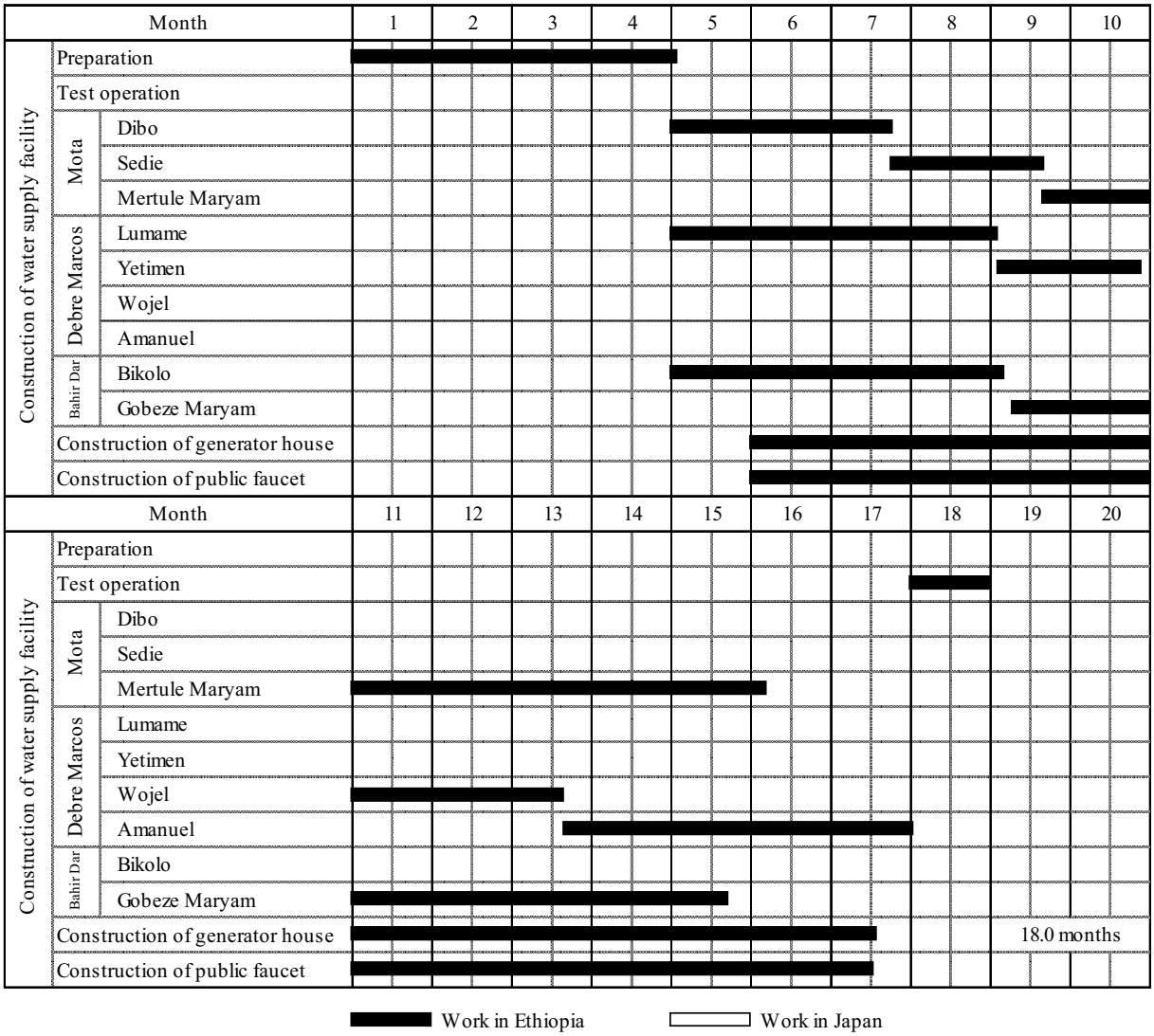
4. Implementation Schedule and Project Cost

(1) Implementation Schedule

Implementation schedule for the Project is shown below.

Table 4: Implementation schedule





(2) Project Cost

In order to implement this Project, the Project cost borne by Ethiopian side is 2,377,804 Birr.

5. Project Evaluation

(1) Relevancy

The Project implementation by Grant Aid is evaluated to be reasonable based on the result of this

survey for the following reasons.

- Target of this Project is 56,912 peoples of target nine (9) towns in the southern part of the Amhara regional state, a considerable number of whom are in the "worse off" category.
- The villagers in the target nine (9) towns use poor water sources (water quality and quantity). The implementation of this Project will enable the distribution of safe and sustainable water to the villagers and contribute to improving their lives.
- The Government of Ethiopia aims at "improving living conditions and hygienic conditions in small towns" as the overall goal. Therefore, implementation of this Project aims to achieve this goal.
- AWRDB and Woreda office, as an implementing agency, has enough capability and experience in rehabilitation, operation and maintenance. In addition, water supply facilities to be constructed in this Project are of a common level in Ethiopia, and special techniques are not needed.
- This Project is not a profit-earning project.
- Negative impact on the environment is not generated by the Project implementation according to the Environment Impact Assessment (EIA).
- The Project implementation by Japanese Grant Aid scheme is not particularly difficult.

(2) Effectivity

1) Quantitative Impact

Quantitative impact to be expected by implementation of this Project is mentioned below.

Table 5: Quantitative Impact after Implementation of this Project

Indicator	Baseline (2012)	Target value (2016)
Water coverage ratio at target 9 towns	23.0 %	80.4 %
Population of water coverage at target 9 towns	13,810 people	56,912 people
WMO to be able to operate and maintain water supply facilities sustainably	0	9

2) Qualitative Impact

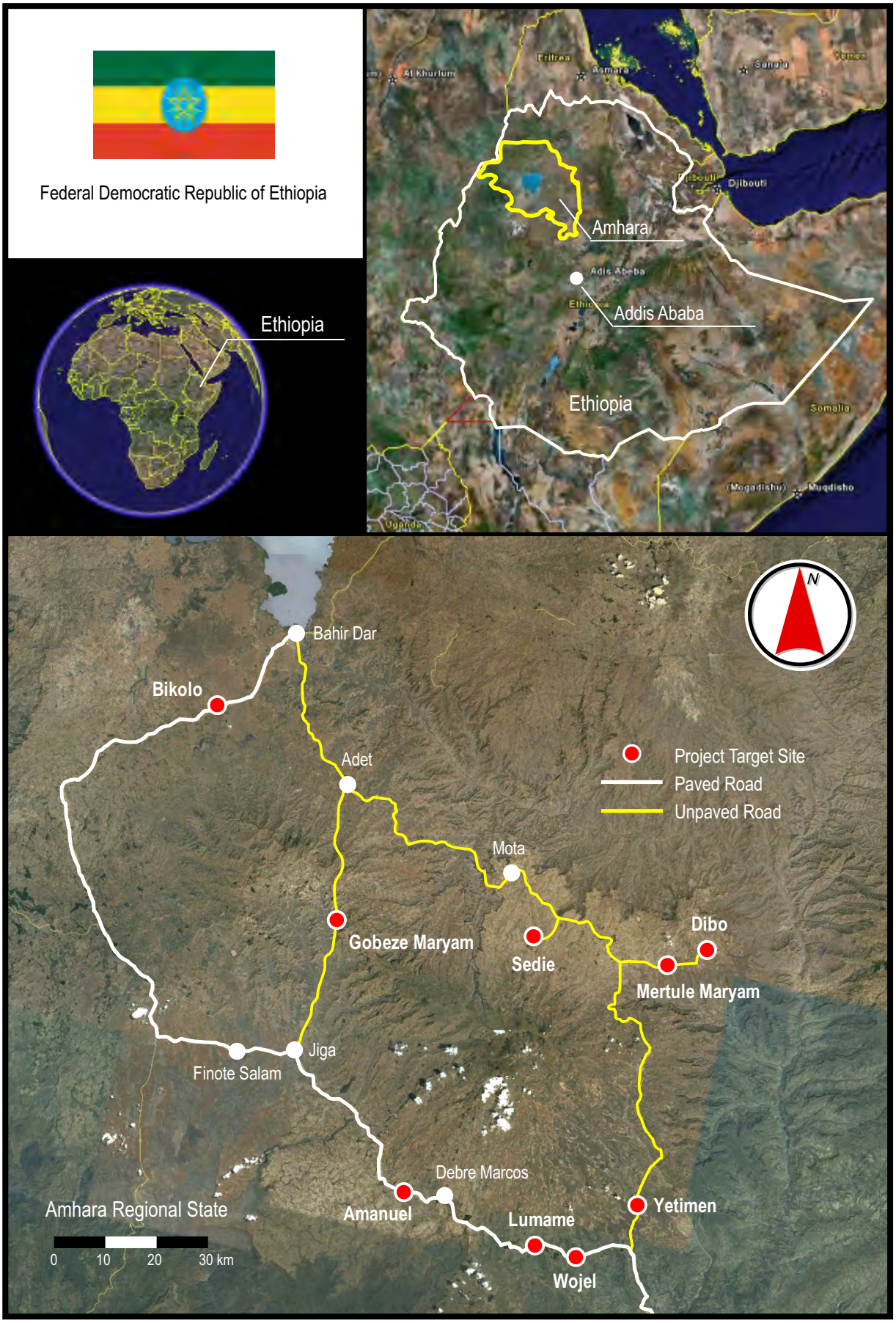
Quantitative impact to be expected by implementation of this Project is mentioned below.

- Mitigation of workload (time) for fetching water
- Mitigation of water related diseases
- Improvement of enrollment ratio of children
- Mitigation of household budget expenditure (economical improvement)

From the above-mentioned contents, implementation of this Project is assessed to be reasonable and effective.

CONTENTS

[Appendices]



Location Map

Perspective

LIST OF FIGURES & TABLES

ABBREVIATIONS

ADSWE	:	Amhara Design and Supervision Works Enterprise
AfDB	:	African Development Bank
AWRDB	:	Amhara Water Resource Development Bureau
AWWCE	:	Amhara Water Works Construction Enterprise
BoFED	:	Bureau of Financial and Economical Development
CSA	:	Central Statistical Agency
EEPC	:	Ethiopia Electric Power Corporation
EFY	:	Ethiopian Fiscal Year
EPLAUA	:	Environment Protection, Land Administration and Use Authority
EWTEC	:	Ethiopian Water Technology Centre
GS	:	Galvanized Steel
HEP	:	Horizontal Electric Prospecting
HICE	:	Household Income, Consumption and Expenditure
M/D	:	Minutes of Discussion
MDGs	:	Millennium Development Goals
O&M	:	Operation and Maintenance
PASDEP	:	Plan for Accelerated and Sustained Development to End Poverty
PPP	:	Public Private Partnership
PRSP	:	Poverty Reduction Strategy Paper
SDPRP	:	Sustainable Development and Poverty Reduction Program
UAP	:	Universal Access Program
UNICEF	:	United nations Children's Fund
VAT	:	Value Added Tax
VES	:	Vertical Electrical Sounding
WASH	:	Water Sanitation and Hygiene
WHO	:	World Health Organization
WMO	:	Water Management Organization
WSDP	:	Water Sector Development Program
WSP	:	Water and Sanitation Project
WSSDP	:	Water Supply and Sanitation Development Program
WSSM	:	Water Supply and Sanitation Master Plan
WSSO	:	Water Supply Service Office
WWDA	:	Water Well Drilling Authority

Chapter 1

Background of the Project

Chapter 1 Background of the Project

1-1 Background and Outline of Grant Aid

In August, 2008, Federal Democratic Republic of Ethiopia requested the grant aid of Japan concerning the rehabilitation and extension of water supply facilities in the small cities of the southern part of Amhara regional state. JICA received this request, carried out "The First Preparatory Survey for the Project for Small Town Water Supply in Southern Part of the Amhara Regional State" in March, 2010, checked the validity concerning project implementation, and narrowed down the sites for survey to sixteen (16) sites from twenty nine (29) sites which was the request from the Federal Democratic Republic of Ethiopia.

However, one and half years had passed since "The First Preparatory Survey" was completed, and five (5) sites of sixteen (16) new water supply project sites have been started. It was agreed to carry out this survey at the remaining eleven (11) sites, besides the already started five (5) sites, as a result of deliberations with Amhara Water Resource Development Bureau (AWRDB). Although the field survey was started based on this determination, since it was difficult to secure groundwater or spring water in some sites, preliminary survey for adding sites to be surveyed has been performed. It was agreed to select two (2) sites from eight (8) sites that are additional requests from AWRDB, and finally, a total of thirteen (13) sites were selected as targets of this survey.

The final sites for this survey are as follows.

Table 1-1: Survey target sites

Zone	ID	Survey target site		Population	
		Woreda	Town	2012	2016 *2
East Gojam	9	Enebsie Sar Midir	Mertule Maryam	15,124	17,829
	10	Enemay	Yetimen	3,289	3,877
	11	Hulet Egu Enesie	Keranyo	2,101	2,477
	12	Awabel	Lumame	11,410	13,451
	14	Awabel	Wojel	3,188	3,758
	15	Hulet Egu Enesie	Sedie	3,348	3,947
	16	Enebsie Sar Midir	Dibo *1	2,129	2,510
	-	Machakel	Amanuel	10,768	12,694
West Gojam	24	Gonji Kollela	Addisalem	5,247	6,186
	26	Bure	Kuch	6,865	8,093
	27	Quarit	Gobeze Maryam	5,860	6,908
	29	Semen Achefer	Kunzila	5,767	6,799
	-	Macha	Bikolo	4,929	5,811
Total				80,025	94,340

*1 Population calculated based on the number of households counted by satellite imagery.

*2 Population growth rate is 4.2 % per year.

1-2 Natural Conditions

1-2-1 Geography

Amhara Regional State is located in northwestern Ethiopia, neighboring Tigray Region, Afar Region, Oromia Region and Ganbera region, and is also bordered by Sudan in the west region. Amhara Regional State has the second largest area in Ethiopia, next to Oromia Region. Most of Amhara Regional state is Ethiopian highlands exceeding altitude of 2,000 m.

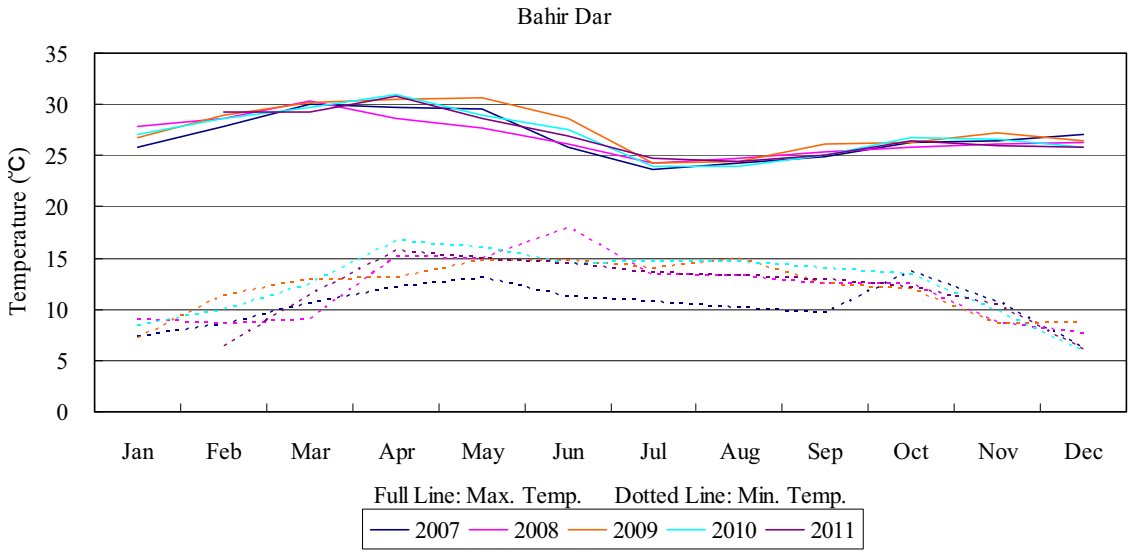
Peneplain of Ethiopia highland is inclining relatively gently, becomes complex topography that is formed by basalt lava that erupted from a shield volcano which has been eroded and dissected subsequently. In addition, the origin of the Abbai River (Blue Nile) which feeds into Lake Tana is formed from a nearly vertical cliff and stepped terrain made up of a series of gentle slopes and flat surfaces, they constitute the grand Abbai gorge which has eroded the Ethiopia highland intricately

1-2-2 Weather Condition

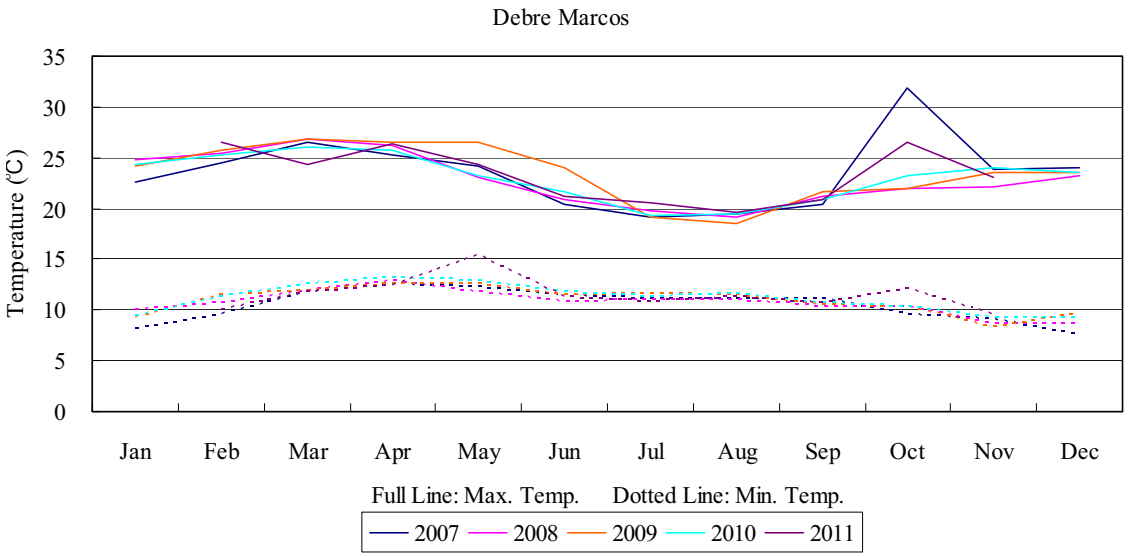
Climate of Amhara Regional state is divided into three seasons, light rain from February to May, rainy season from June to September and dry season from October to January. The temperature decreases as altitude increases, precipitation tends to increase at higher altitudes.

Average temperature over the past five (5) years in Bahir Dar and Debre Marcos is as follows. Average temperature is high from March to May (dry season), and is lower from July to September (rainy season).

Table 1-2: Average temperature over past 5 years



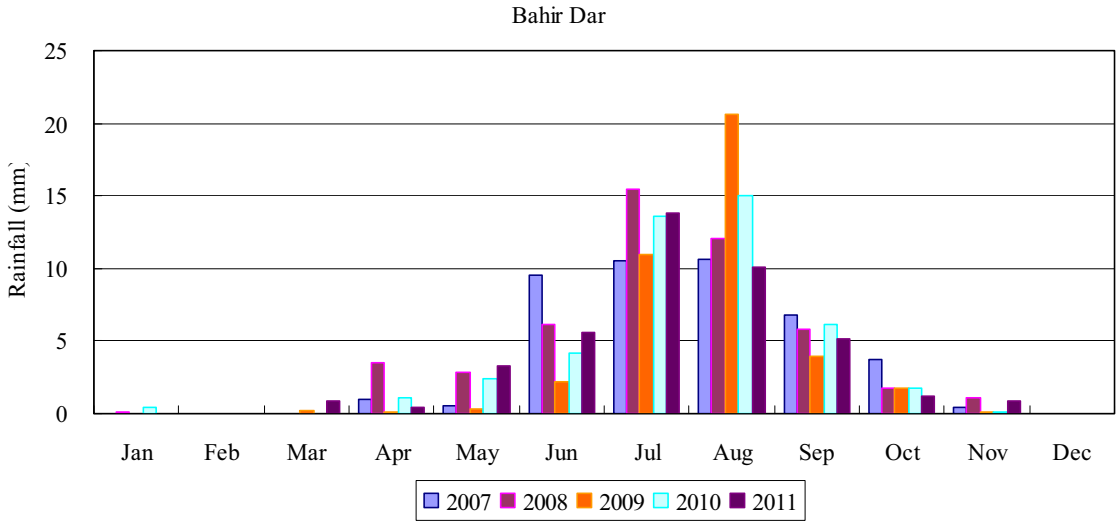
* Source: Bahir Dar Observatory



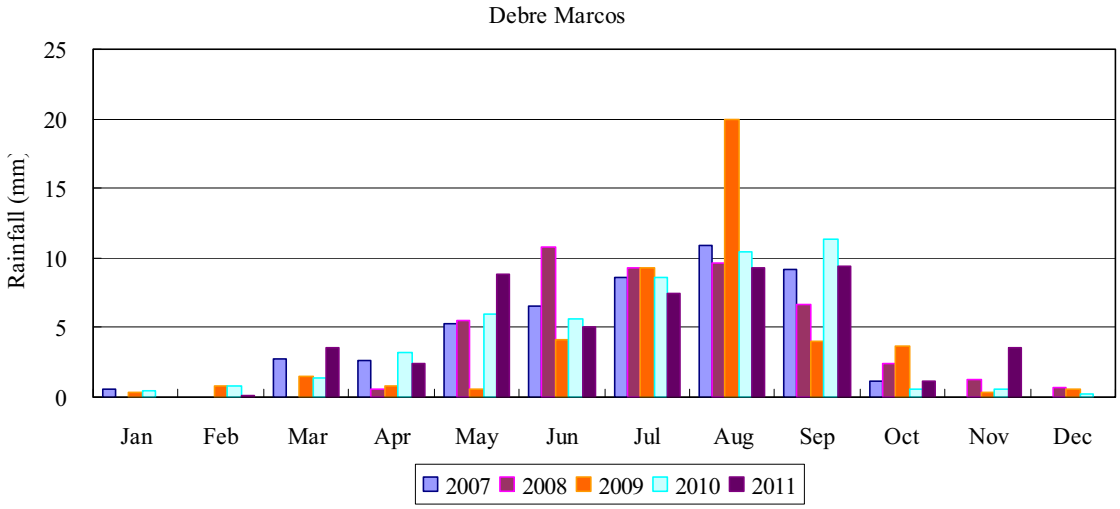
* Source: Bahir Dar Observatory

The following explains the amount of rainfall over the past five (5) years. Rainfall is concentrated from May to September (Light rain and rainy season).

Table 1-3: Rainfall over past 5 years



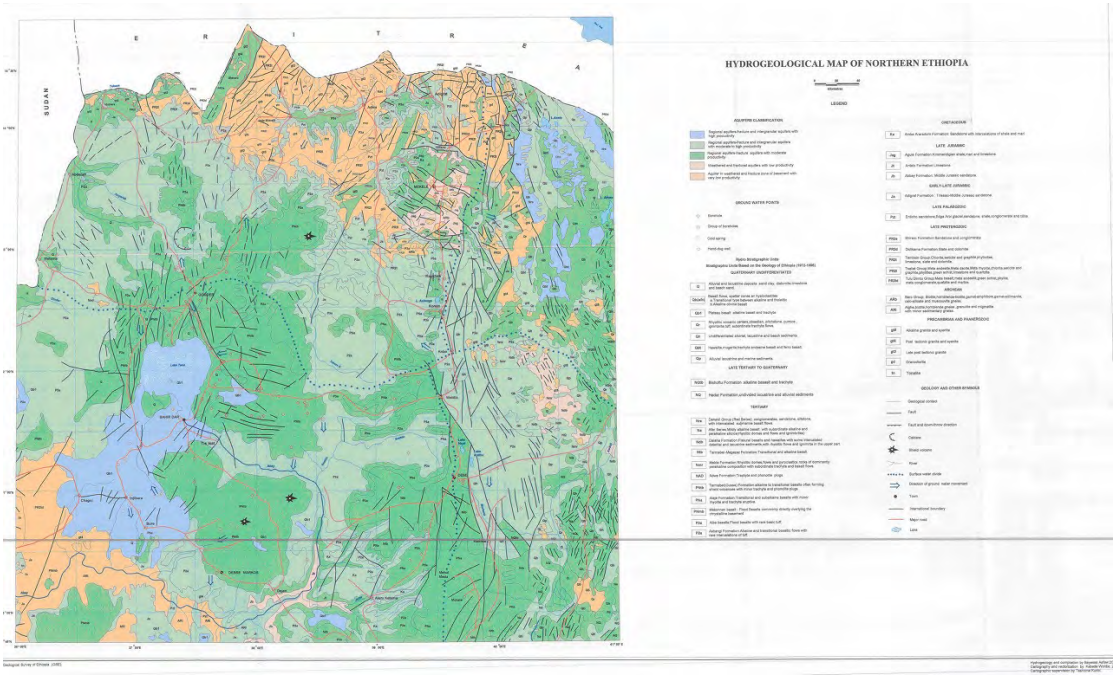
* Source: Bahir Dar Observatory



* Source: Bahir Dar Observatory

1-2-3 Geological Condition

About the geological condition of target sites, basalt of the Tertiary and Quaternary are distributed except for some plain and valley sediments are distributed along the Lake Tana. Geological map of northern Ethiopia is as follows.



* Source: GSE (Geological Survey of Ethiopia)

Figure 1-1: Geological map of northern part of Ethiopia

It is surmised that Groundwater, that is available in the target sites, shall be distributed in the basalt Quaternary sediments, basalt of Tertiary and Quaternary. Geological conditions, such as the extent of weathering and cracking vary greatly by location. Hydrogeological characteristics such as distribution and property of aquifer vary from site to site. Geological overview of each group is as follows.

Table 1-4: Geological overview of each group

Geological classification	Site	Outline
Ashangi Basalt (P2a)	Yetimen	Basalt called Flood Basalt erupted from fissures during Paleocene through Eocene. Represent the earliest basalt volcanism in northwest plateau of Ethiopia. The layer thickness of the basalt is weathered, crushed spans several to hundred km, is found in the lower disconformable area of Oligocene. There are weak alkali basalt with weathering, fracturing and pyroclastic rock, commonly seen dolerite dyke.
Tarmaber Basalts (PNtb)	Mertule Maryam, Keranyo, Lumame, Wojel, Sedie, Dibo, Amanuel, Addisalem, Gobeze Maryam	Basalt that erupted in the northwest and southeast plateau during the Oligocene-Miocene. Representative of the movement of shield volcano.Tarmaber Basalts erupted early is to tholeiitic and alkalescent basalt. In the northwest plateau, era of shield volcano's activity has gradually become younger from north to south. Plug of trachyte-phonolite grow with formation of Tarmaber Basalts.
Quarternary Volcanics (Qb1)	Kunzila, Bikolo	Trachyte and basalt that erupted to cover the existing terrain in northwest plateau in Diluviual epoch.Erupted lava of alkaline basalt and trachyte blanketed the Lake Tana graben, basalt lava flows and volcanic cones are still well preserved in Lake Tana graben.
Recent Deposit (Q)	Kuch	Sand, silt, clay, diatom earth, limestone, Alluvial deposits such as beach sand. Mainly distributed around the lake.

1-3 Result of Field Survey

1-3-1 Existing Facility Survey

(1) Mertule Maryam (East Gojam)

Water supply facilities with public faucets by spring water are available in Mertule Maryam. Concrete protection around the spring points prevents polluted water from flowing in to mix with spring water, and the spring water is transmitted to the distribution reservoirs by gravity and/or by pumping, and then water is distributed to the public faucets.

Spring water generally occurs through cracks in slopes and/or in depressions in the ground. Quantity of spring water varies seasonally. Especially, the quantity often decreases in dry season. Spring water without protection against contamination is utilized in small villages in mountain areas. Such spring water from the unprotected source eventually creates unintended spring-fed ponds where dirty surface water mixes with spring water. Nevertheless the water is used as drinking water.

The reservoir tanks are three (3) ground type composed of stone masonry (83 m^3 and 50 m^3 x 2). Moreover, the reservoir tanks are not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. The facilities were constructed a long time ago, moreover, there was no person in charge of construction at that time, and no drawings of pipe layout of the facilities can be found. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

In a part of Mertule Maryam, there are water supply leading pipes in each household as house connection supply, existing WMO manages water used amount by measuring water meter. To get started in house connection, each household has the responsibilities to install the leading-in pipe drawn from main distribution pipe and pay the cost of material and construction and so on. In other words, the ratio of installation for house connection supply shows the index for economic might and presence of awareness for water supply. Specifically, water committees manage water use amount by measuring water meters.

Table 1-5: Existing water supply facility (Mertule Maryam)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
2 springs	3 (ground type)	1,291 m	17	1,091	

(2) Yetimen (East Gojam)

Water supply facilities with public faucets by groundwater are available in Yetimen. Pumping water by submersible motor pumps is realized by commercial and public electricity supply and/or by generators. The water is, then, transmitted to distribution reservoirs by the power of the pump. O&M for the submersible motor pumps is conducted by a caretaker who stays in a small house above the generator. The caretaker manually operates the generator. Because of this system, a generator control room and a bedroom are generally constructed above the generator house for the caretaker to live in.

The reservoir tank is one (1) ground type composed of stone masonry (60 m^3). At the reservoir

tanks, leakage from cracks in the joint between stone and concrete block was observed. Based on a long-term perspective, it was judged improper to continue using this reservoir tank in future. Moreover, the reservoir tank is not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

In a part of Yetimen, there are water supply leading pipes in each household as house connection supply, existing WMO manage water use amount by measuring water meters.

Table 1-6: Existing water supply facility (Yetimen)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
1 groundwater	1 (ground type)	1,291 m	11	268	

(3) Keranyo (East Gojam)

Water supply facilities with public faucets by groundwater are available in Keranyo. Pumping water by submersible motor pumps is realized by commercial and public electricity supply and/or by generators. The water is, then, transmitted to distribution reservoirs by the power of the pump.

The reservoir tank is one (1) elevated-steel type built over reinforced concrete pillars (60 m^3). Moreover, the reservoir tank is not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

In a part of Keranyo, there are water supply leading pipes in each household as house connection supply, existing WMO manage water use amount by measuring water meters.

Table 1-7: Existing water supply facility (Keranyo)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
1 groundwater	1 (elevated type)	1,291 m	5	110	

(4) Lumame (East Gojam)

Water supply facilities with public faucets by groundwater are available in Lumame. Pumping water by submersible motor pumps is realized by commercial and public electricity supply and/or by generators. The water is, then, transmitted to distribution reservoirs by the power of the pump.

The reservoir tank is one (1) elevated-steel type built over reinforced concrete pillars (50 m^3). Moreover, the reservoir tank is not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

In a part of Lumame, there are water supply leading pipes in each household as house connection supply, existing WMO manage water use amount by measuring water meters.

Table 1-8: Existing water supply facility (Lumame)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
2 groundwater	1 (elevated type)	7,423 m	11	528	

(5) Wojel (East Gojam)

There are water supply facilities with public faucets by groundwater in Wojel, however shallow wells are used because of failure of water supply facilities. Water fee (Operation and maintenance cost) for utilization of such shallow wells isn't generally collected. However, some households without a shallow well pay money to use water from a shallow well in their neighbors.

Groundwater is the general source of water supply. Pumping water by submersible motor pumps is realized by commercial and public electricity supply and/or by generators. The water is, then, transmitted to distribution reservoirs by the power of the pump.

The reservoir tank is one (1) ground type composed of stone masonry (60 m^3). The reservoir tanks, leakage from cracks in the joint between stone and concrete block was observed. Based on a long-term perspective, it was judged improper to continue using this reservoir tank in future. Moreover, the reservoir tank is not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

In a part of Wojel, there are water supply leading pipes in each household as house connection supply, existing WMO had managed water use amount by measuring water meters.

Table 1-9: Existing water supply facility (Wojel)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
1 groundwater	1 (ground type)	1,704 m	8	21	Failure facilities

(6) Sedie (East Gojam)

Water supply facilities with public faucets by groundwater are available in Sedie. Pumping water by submersible motor pumps is realized by commercial and public electricity supply and/or by generators. The water is, then, transmitted to distribution reservoirs by the power of the pump.

The reservoir tank is one (1) elevated-steel type built over reinforced concrete pillars (60 m^3). Moreover, the reservoir tank is not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

There are no house connection supply facilities in Sedie.

Table 1-10: Existing water supply facility (Sedie)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
1 groundwater	1 (elevated type)	1,771 m	6	None	

(7) Dibo (East Gojam)

There are no water supply facilities in Dibo, therefore, hand pumps are used to secure life water. Since the water resource for hand pump is the groundwater, relatively-adequate supply of water is constantly available. However, the amount of pumping discharge is limited to only approx. 10 L/min due to with the specification of the hand pump.

Table 1-11: Existing water supply facility (Dibo)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
None	None	None	None	None	

(8) Amanuel (East Gojam)

Water supply facilities with public faucets by groundwater are available in Amanuel. Pumping water by submersible motor pumps is realized by commercial and public electricity supply and/or by generators. The water is, then, transmitted to distribution reservoirs by the power of the pump.

The reservoir tanks are two (2) elevated-steel type built over reinforced concrete pillars (60 m^3 and 30 m^3). Leakage from welding joint points in steel tanks was observed. Based on a long-term perspective, it was judged improper to continue using these existing tanks in future. Moreover, the reservoir tank is not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

There are no house connection supply facilities in Amanuel.

Table 1-12: Existing water supply facility (Amanuel)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
2 groundwater	2 (elevated type)	855 m	18	None	

(9) Addisalem (West Gojam)

There are water supply facilities with public faucets by groundwater in Addisalem, however hand pumps are used because of failure of water supply facilities. Groundwater is the general source of water supply. Pumping water by submersible motor pumps is realized by commercial and public electricity supply and/or by generators. The water is, then, transmitted to distribution reservoirs by the power of the pump.

The reservoir tank is one (1) elevated-steel type built over reinforced concrete pillars (20 m^3). Moreover, the reservoir tank is not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

In a part of Addisalem, there are water supply leading pipes in each household as house connection supply, existing WMO had managed water use amount by measuring water meters.

Table 1-13: Existing water supply facility (Addisalem)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
1 groundwater	1 (elevated type)	3,026 m	6	29	Failure facilities

(10) Kuch (West Gojam)

Water supply facilities with public faucets by groundwater are available in Kuch. Pumping water by submersible motor pumps is realized by commercial and public electricity supply and/or by generators. The water is, then, transmitted to distribution reservoirs by the power of the pump.

The reservoir tank is one (1) elevated-steel type built over reinforced concrete pillars (14 m^3). Moreover, the reservoir tank is not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

In a part of Kuch, there are water supply leading pipes in each household as house connection supply, existing WMO manage water use amount by measuring water meters.

Table 1-14: Existing water supply facility (Kuch)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
1 groundwater	1 (elevated type)	6,042 m	8	990	

(11) Gobeze Maryam (West Gojam)

Water supply facilities with public faucets by spring water are available in Gobeze Maryam. Pumping water by motor pumps is realized by commercial and public electricity supply and/or by generators. The water is, then, transmitted to distribution reservoirs by the power of the pump.

The reservoir tank is one (1) ground type composed of stone masonry (50 m^3). Moreover, the reservoir tank is not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

In a part of Gobeze Maryam, there are water supply leading pipes in each household as house connection supply, existing WMO had managed water use amount by measuring water meters.

Table 1-15: Existing water supply facility (Gobeze Maryam)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
1 spring	1 (ground type)	4,912 m	12	232	

(12) Kunzila (West Gojam)

Water supply facilities with public faucets by groundwater are available in Kunzila. Pumping water by motor pumps is realized by commercial and public electricity supply and/or by generators. The water is, then, transmitted to distribution reservoirs by the power of the pump.

The reservoir tank is one (1) ground type composed of stone masonry (70 m^3). The reservoir tanks, leakage from cracks in the joint between stone and concrete block was observed. Based on a

long-term perspective, it was judged improper to continue using this reservoir tank in future. Moreover, the reservoir tank is not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

In a part of Kunzila, there are water supply leading pipes in each household as house connection supply, existing WMO had managed water use amount by measuring water meters.

Table 1-16: Existing water supply facility (Kunzila)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
1 groundwater	1 (ground type)	4,120 m	10	27	

(13) Bikolo (West Gojam)

Water supply facilities with public faucets by groundwater are available in Bikolo. Pumping water by motor pumps is realized by commercial and public electricity supply and/or by generators. The water is, then, transmitted to distribution reservoirs by the power of the pump.

The reservoir tank is one (1) ground type composed of stone masonry (25 m^3). The reservoir tanks, leakage from cracks in the joint between stone and concrete block was observed. Based on a long-term perspective, it was judged improper to continue using this reservoir tank in future. Moreover, the reservoir tank is not only small in capacity, but also unable to transmit sufficient water. All of transmission and distribution pipes are made of steel, there are no cast iron and/or PVC pipes. There are remarkably no broken points that are leaking. Many of the public faucets have been left broken and deserted.

In a part of Bikolo, there are water supply leading pipes in each household as house connection supply, existing WMO had managed water use amount by measuring water meters.

Table 1-17: Existing water supply facility (Bikolo)

Water source	Reservoir	Distribution pipes	Public faucets	House connection	Remarks
1 groundwater	1 (ground type)	1,847 m	7	254	

Table 1-18: List of existing water supply facilities

Zone	ID	Town	Curent water supply facilitie	Existing water source	Reservoir	Distribution pipe (m)	Public faucets		House connection		Remarks
							No. of faucets	Ratio of population per faucets	No. of meter	Ratio of house connection	
East Gojam	9	Mertule Maryam	Public faucet	2 springs	Ground type (83 m^3, 50 m^3 x 2)	13,060	17	890	1,091	30.3%	
	10	Yetimen	Public faucet	1 groundwater	Ground type (60 m^3) *	3,707	11	299	268	34.2%	
	11	Keranyo	Public faucet	1 groundwater	Elevated type (60 m^3)	1,291	5	420	110	22.0%	
	12	Lumame	Public faucet	2 groundwater	Elevated type (50 m^3)	7,423	11	1,037	528	19.4%	
	14	Wojel	Shallow well	1 groundwater	Ground type (60 m^3) *	1,704	8	399	21	2.8%	Failure facilities
	15	Sedie	Public faucet	1 groundwater	Elevated type (60 m^3)	1,771	6	558	None	-	
	16	Dibo	Hand pump	None	None	None	None	-	None	-	
	-	Amanuel	Public faucet	2 groundwater	Elevated type (60 m^3, 30 m^3)*	855	18	598	None	-	
West Gojam	24	Addisalem	Hand pump	1 groundwater	Elevated type (20 m^3)	3,026	6	875	29	2.3%	Failure facilities
	26	Kuch	Public faucet	1 groundwater	Elevated type (14 m^3)	6,042	8	858	990	60.6%	
	27	Gobeze Maryam	Public faucet	1 spring	Ground type (50 m^3)	4,912	12	488	232	16.6%	
	29	Kunzila	Public faucet	1 groundwater	Ground type (70 m^3) *	4,120	10	577	27	2.0%	
	-	Bikolo	Public faucet	1 groundwater	Ground type (25 m^3) *	1,847	7	704	254	21.6%	

* The reservoir confirmed leaking

1-3-2 Water Management Organization Survey

(1) Activity of Water Management Organization

There are Water Management Organizations (WMOs) for operation and maintenance activity of water supply facilities at all thirteen (13) towns. In Addisalem only, Community Committee manages water facilities. At all twelve (12) towns except for Addisalem, Water Committee is organized and manages water supply facilities. The main activities in management groups for water supply facilities are maintenance for water sources and water supply facilities, collection of water fee (water usage charge), repair of water supply facilities, holding of regular meeting as a routine work. Specifically, the activity in management groups is currently tied up in one (1) town, Wojel.

Table 1-19: WMO at each town

Zone	ID	Town	Type of facilities	Existing WMO	Staff	Remarks
East Gojam	9	Mertule Maryam	Public faucet	Water committee	Men: 6, Woman: 1	
	10	Yetimen	Public faucet	Water committee	Man: 1, Woman: 1	
	11	Keranyo	Public faucet	Water committee	Men: 6	
	12	Lumame	Public faucet	Water committee	Men: 8	
	14	Wojel	Shallow well	Water committee	Men: 7	No activity
	15	Sedie	Public faucet	Water committee	Men: 6, Woman: 1	
	16	Dibo	Hand pump	Water committee	3	
	-	Amanuel	Public faucet	Water committee	Men: 6, Woman: 1	
West Gojam	24	Addisalem	Hand pump	Community committee	4	
	26	Kuch	Public faucet	Water committee	Men: 8	
	27	Gobeze Maryam	Public faucet	Water committee	7	
	29	Kunzila	Public faucet	Water committee	Men: 6, Woman: 1	
	-	Bikolo	Public faucet	Water committee	Men: 5, Woman: 2	

Note: This data is based on direct interview survey in WMO.

(2) Water Fee

There are two (2) types of collection of water fee, which are a payment style for water fee per jerry can (20 liter size) in water supply point and another style of yearly payment or monthly payment per household registered as water facilities' user. Household with house connection water supply to user's cost pays water fee per household, using water meter installed in each household. Meanwhile, in case of household using immobilized and primitive water source like spring water, river, and pond, there is no collection of water charge.

The system of water fee collection is not unified on local towns in Amhara regional state. So price setting is handed to WMO in each town, and water fee is variant in every town. The water fee collected appropriates the payment for fuel oil cost, electricity cost, parts replacement cost, staff salary and allowance, and so on. O&M cost for water supply pipe and water meter is not included in water charge for house connection supply.

Table 1-20: Water fee at each town

Unit: Birr

Zone	ID	Town	Public faucet			House connection	Remarks
			Water fee		m^3 *	Water fee (m^3)	
East Gojam	9	Mertule Maryam	2.50	Monthly payment per HH	1.38	7.00	
	10	Yetimen	12.00	Yearly payment per HH	0.53	3.00	
	11	Keranyo	0.20	Charge per jerry can	10.00	3.00	
	12	Lumame	6.00	Monthly payment per HH	5.29	3.00	
	14	Wojel	0.30	Charge per jerry can	15.00	-	Facilities broken down
	15	Sedie	0.13	Charge per jerry can	6.50	-	No house connection
	16	Dibo	12.00	Yearly payment per HH	0.55	-	No house connection
	-	Amanuel	0.25	Charge per jerry can	12.50	-	No house connection
West Gojam	24	Addisalem	1.00	Charge per jerry can	50.00	-	Facilities broken down
	26	Kuch	0.25	Charge per jerry can	12.50	5.85	
	27	Gobeze Maryam	0.20	Charge per jerry can	10.00	3.80	
	29	Kunzila	0.20	Charge per jerry can	10.00	3.50	
	-	Bikolo	0.10	Charge per jerry can	5.00	3.00	

Note: The value is calculated, based on current water usage amount in each site.

(3) Accountant Balance

WMOs for water supply facilities in twelve (12) towns are precisely getting a control of budget balance. The breakdown of revenue is only water charge collected, and the breakdown of expenditure is fuel oil cost, electricity cost, parts replacement cost, staff salary and allowance.

WMOs of achieving a budget surplus are nine (9) towns in twelve (12) towns shown above. The reason of considerable variation in budget balance is assumed to be unsetting for appropriate water fee, to be surely unexecuted for collection of water fee, and to be in un-receivable condition of WMO staff receiving the appropriate income. In fact, caretaker for water supply facilities doesn't receive the income. Moreover, it is assumed that WMO in unclear budget regarding revenue and expenditure doesn't adequately manage budget account note for group management.

Table 1-21: Accountant balance at each town

Unit: Birr

Zone	ID	Town	Accountant balance (2011/2012)		
			Revenue	Expenditure	Balance
East Gojam	9	Mertule Maryam	289,316	283,704	5,612
	10	Yetimen	43,280	29,280	14,000
	11	Keranyo	29,600	14,400	15,200
	12	Lumame	156,469	156,900	▲ 431
	14	Wojel	8,010	10,080	▲ 2,070
	15	Sedie	24,000	18,000	6,000
	16	Dibo	6,912	4,752	2,160
	-	Amanuel	325,645	195,044	130,601
West Gojam	24	Addisalem	30,000	31,700	▲ 1,700
	26	Kuch	232,442	78,259	154,183
	27	Gobeze Maryam	15,000	12,700	2,300
	29	Kunzila	72,000	n.a.	n.a.
	-	Bikolo	20,000	15,000	5,000

1-3-3 Geophysical Prospecting

(1) Objective

In all the target sites which conduct trial-digging investigation, geophysical prospecting was carried out by local contractor. The purpose of prospecting is as follows.

- Understanding of the characteristics and thickness of the different strata
- Understanding of the degree of weathering and the weathering layer thickness
- Understanding of the presence of the fault and fissure zone
- Understanding of the depth and thickness of the aquifer
- Selection of drilling position
- Assumption of drilling depth

(2) Method

Implementation methods of geophysical prospecting (Number of survey points, the depth of prospecting, placement of the measurement points, etc.), was determined by collection and analysis of existing data, interviews on geological conditions to hydrogeological engineer of AWRDB and classifying lithofacies properly. In order to create a cross-sectional view of a plurality of directions, horizontal electrical sounding (HEP) was carried out first and rough indication of the investigation point was made, vertical electrical sounding (VES) was carried out in several points from three (3) to four (4) per site.

The depth of test drilling well was 150 m, so the depth for geophysical prospecting was set as 200 m. The meeting with hydrogeologist of AWRDB was held first, then survey was conducted by the method adapted to actual natural conditions.

(3) Result

Geophysical prospecting was carried out at all of the thirteen (13) target sites, and the results were utilized for drilling points and specification of depth.

Table 1-22: Result of geophysical prospecting

Zone	ID	Town	Priority	UTM (E)	UTM (N)	Target depth (m)	Zone	ID	Town	Priority	UTM (E)	UTM (N)	Target depth (m)
East Gojam	9	Mertule Maryam	1	421483	1201314	150	West Gojam	24	Addisalem	1	354527	1239062	150
			2	418012	1202361	150				2	355387	1239921	130
			3	417686	1202547	120							
	10	Yetimen	1	406823	1141457	140		26	Kuch	1	282488	1159539	125
			2	406889	1141736	140				2	282484	1159740	85
										3	282687	1159898	100
	11	Keranyo	1	387662	1212083	120		27	Gobeze Maryam	1	328563	1215591	150
			2	387928	1211812	110				2	328271	1215694	120
			3	386857	1212987	130				3	328003	1216761	150
	12	Lumame	1	382652	1133892	140		29	Kunzila	1	285990	1313117	100
			2	382503	1133899	120				2	285943	1313207	100
			3	384097	1134222	150				3	285200	1313210	100
	14	Wojel	1	392445	1129815	150		-	Bikolo	1	287343	1256274	150
			2	392408	1129616	130				2	286182	1256402	120
										3	286238	1256204	110
	15	Sedie	1	378886	1208127	130							
			2	379007	1208687	110							
	16	Dibo	1	431474	1201634	120							
			2	431483	1201697	110							
	-	Amanuel	1	343946	1152177	115							
			2	344062	1152347	110							
			3	343479	1149298	110							

1-3-4 Test Well Drilling Survey

(1) Objective

Test well drilling survey was conducted by local contractor to secure water source and to understand the condition of well as water source. The results were utilized as basic data for planning and design of water facilities.

(2) Method

1) Test Well Drilling

After the completion of test drilling, successful wells were packed by gravel, installed casing and screen, the wells were washed and covered by cap to prevent contamination. Test drilling wells that failed were considered to divert to set hand pump, while wells without water were backfilled as soon as possible. Summary of test well drilling is as follows.

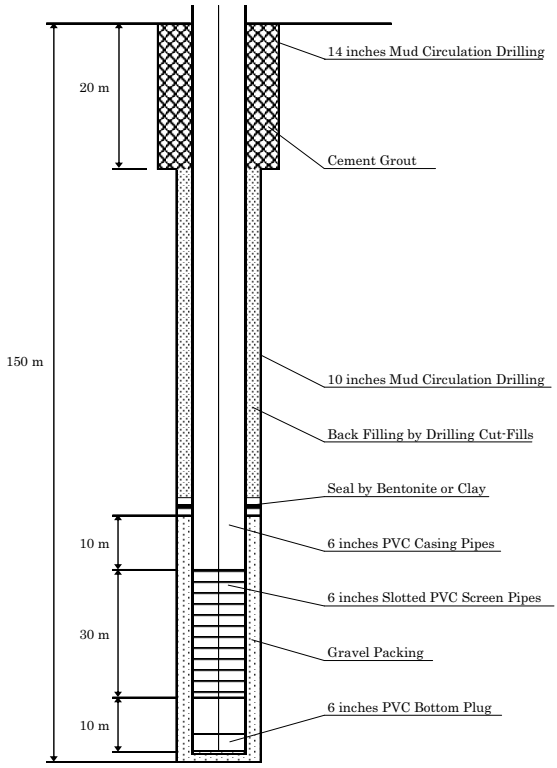


Figure 1-2: Outline drawing for test well

It was determined that the depth of drilling is 100 m (maximum 150 m), casing diameter is 6" with consideration of insertion for submersible pump. Material of casing and screen was PVC.

2) Pumping Test

In order to understand the capacity of the aquifer, test drilling was conducted, and after which the following step drawdown test, continuous test, and recovery test were conducted at sites where enough water was confirmed.

Table 1-23: Contents of pumping test

Item	Step drawdown test	Continuous test	Recovery test
Objective	From the relationship between pumping volume and drawdown of each steps, calculate specific capacity and well calculated loss, loss aquifer, and well efficiency	Calculate aquifer constant (Transmissibility coefficient, Storage coefficient, etc.)	Calculate the Transmissibility coefficient
Test time	10 hours (1 step = 2 hours, Total 5 steps)	24 hours	12 hours
Test procedure	Pumping by submersible pump, measuring the volume of water by triangular weir, measuring water level drop by water level indicator		After Continuous test, measurement residual water level drop starts immediately
Analysis mode	Graph analysis	Theis solution Couper-Jacobs solution	Recovery analysis

(3) Result

1) Test Well Drilling

Test well drilling was conducted at twenty five (25) points. After the confirmation of water quantity (2.0 L/sec or more) that can be used for project, it was evaluated to continue the drilling or stop. And

if the water was not found, the drilling was continued up to 150 m.

If the first drilling was a failure, second drilling was conducted based on the result of first drilling and geophysical prospecting. In the case that second drilling was a failure also, if it was judged the possibility of existence of groundwater is low from the first and second drilling data, drilling was terminated at that site.

In addition, test well drilling survey was not conducted in Bikolo because AWRDB drilled the well themselves.

The second drilling of Lumame and Kunzila, it was confirmed 5.0 L/sec and 2.1 L/sec of volume of water at simple examination held during test drilling, so these wells were completed as production wells. However, at the time of pumping test, both of boreholes produced only 1.0 L/sec or less of water. Therefore those wells were determined to be failures.

The first drilling of Kunzila, it was confirmed sufficient water however, nitrate exceeded the Ethiopian standard (50 mg/L), therefore it was determined a failure.

The first drilling of Amanuel, water vein was found around the depth of 40 m to 50 m, but drilling was continued to get enough water for design up to 120 m. However, additional water could not be found, the well was backfilled deeper than 50 m, and completed as a production well.

Test well drilling was successful at six (6) sites (Yetimen, Lumame (third trial), Wojel, Sedie, Dibo and Amanuel (first trial)), and Bikolo where AWRDB drilled themselves, so totally seven (7) sites. Water facilities of those seven (7) sites are designed by using the water source of groundwater. And about another six (6) sites (Mertule Maryam, Keranyo, Addisalem, Kuch, Gobeze Maryam and Kunzila), investigation of alternative water source was conducted, as mentioned below, “Existing water source survey”.

Table 1-24: Result of test well drilling

Zone	ID	Town	Well No.	Drilling Depth (m)	Simple pumping test (L/sec)	First evaluation	Casing length (m)	Screen length (m)	Pumping test (L/sec)	S.W.L. (m)	D.W.L. (m)	Pump potision (m)	Second evaluation	Remarks
East Gojam	9	Mertule Maryam	#1	150	<1.00	Unsuccessful								
			#2	150	Dryhole	Unsuccessful								
	10	Yetimen	#1	87	8.70	Successful	68	17	8.70	19.10	22.80	60.00	Successful	
	11	Keranyo	#1	150	Dryhole	Unsuccessful								
			#2	150	<1.00	Unsuccessful								
			#3	150	Dryhole	Unsuccessful								
	12	Lumame	#1	150	Dryhole	Unsuccessful								
			#2	147	5.00	Successful	106	34	<1.00				Unsuccessful	Evaluated by pumping test
			#3	61	8.86	Successful	42	17	8.86	17.70	17.90	40.00	Successful	
	14	Wojel	#1	76	7.80	Successful	62	11	7.80	38.90	38.92	55.00	Successful	
	15	Sedie	#1	87	8.90	Successful	74	11	8.90	17.91	22.04	60.00	Successful	
	16	Dibo	#1	80	8.90	Successful	63	11	8.90	32.30	45.20	55.00	Successful	
	-	Amanuel	#1	120	3.00	Successful	48	11	3.00	8.07	30.35	32.00	Successful	Backfill deeper than 50 m
			#2	139	Dryhole	Unsuccessful								
West Gojam	24	Addisalem	#1	150	Dryhole	Unsuccessful								
			#2	150	Dryhole	Unsuccessful								
	26	Kuch	#1	150	Dryhole	Unsuccessful								
			#2	150	Dryhole	Unsuccessful								
			#3	150	Dryhole	Unsuccessful								
	27	Gobeze Maryam	#1	150	Dryhole	Unsuccessful								
			#2	150	Dryhole	Unsuccessful								
	29	Kunzila	#1	86	9.52	Successful	54	22	9.50	8.36	9.12	30.00	Unsuccessful	Evaluated by water quality analysis
			#2	85	2.10	Successful	60	22	<1.00				Unsuccessful	Evaluated by pumping test
			#3	120	Dryhole	Unsuccessful								
			#4	60	<1.00	Unsuccessful								
Total				3,098			577	156						

2) Pumping Test

In this Project, it is planned to pump up the water to reservoir by submersible pump, if water quantity of well is low, cost-effectiveness is diminished. So, 2.0 L/sec is set as the lowest possible amount of water for pumping as success criteria.

As a result of pumping test, first of Mertule Maryam, second of Keranyo, second of Lumame and second and forth of Kunzila, amount of water was less than the standard (less than 1.0 L/sec). Therefore, these wells are not reasonable to use for this project as production wells. In other words, it was determined to be failure wells.

Result of pumping test at seven (7) sites that prospecting is successful, is as follows.

Table 1-25: Result of pumping test

Zone	ID	Town	Pumping result (L/sec)	Daily amount (m^3/day) *
East Gojam	10	Yetimen	8.70	250.56
	12	Lumame	8.86	255.17
	14	Wojel	7.80	224.64
	15	Sedie	8.90	256.32
	16	Dibo	8.90	256.32
	-	Amanuel	3.00	86.40
W. Gojam	-	Bikolo	14.00	403.20

Note: Eight (8) hours operation per day

1-3-5 Existing Water Source Survey

(1) Objective

After the result of test drilling, existing water source survey was conducted by local contractor at the six (6) sites (Mertule Maryam, Keranyo, Addisalem, Kuch, Gobeze Maryam and Kunzila), where it was judged that the possibility of groundwater development is difficult to get information for planning and designing of water facilities.

(2) Method

This survey was conducted by different methods, according to existing wells and springs. The survey for existing wells was conducted as same as pumping test. The survey for spring was conducted by methods such as quantitation method, fixed time method, and triangular weir.

(3) Result

1) Existing Borehole

At six (6) target sites of this investigation, the existing boreholes which can be diverted to this Project did not exist.

2) Spring

At two (2) of the six (6) sites, Mertule Maryam and Gobeze Maryam, 5 (Mertule Maryam) and 1 (Gobeze Maryam) springs were confirmed. After the checking of volume of spring water, it was confirmed that capacity of spring water can accommodate this Project.

Table 1-26: Result of spring survey

Unit: m^3/day

Zone	ID	Town	Existing discharge		Total utilizing quantity	Total not utilizing quantity
East Gojam	9	Mertule Maryam	#1	139.35	95.04	328.97
			#2	92.70		
			#3	42.59		
			#4	57.41		
			#5	91.96		
W. Gojam	27	Gobeze Maryam	#1	164.00	50.00	114.00

Every spring is located in public land. It was confirmed by the staff of Woreda water office that there is no problem such as water right. Spring water is confirmed to be viable for this Project, therefore water facilities are designed for use of spring water.

1-3-6 Water Quality Analysis

(1) Objective

Water quality analysis of test well and existing water source was conducted by local contractor at seventeen (17) points to evaluate whether the water is suitable or not for drinking, by following the Ethiopian standard for water quality (Ethiopian Guidelines－Specification for Drinking Water Quality; September 2002).

(2) Method

Sampling water was taken just before the completion of continuous pumping test. Water quality analysis is conducted at the point of test well drilling and existing water source about twenty seven (27) items in order to determine whether it is suitable for drinking. Water quality analysis of six (6) items (Arsenic, ORP, pH, Bacillus coli, Temperature, Electric conductivity) was conducted by using Portable instrument, another twenty two (22) items of analysis was conducted at water quality analysis laboratories.

Table 1-27: Parameter of water quality analysis

Parameter	Ethiopia standard		WHO guideline (4th edition)		Analysis place		Remarks
	Hazard to health	Complaint level	Guideline value	Acceptable value	Site	Laboratory	
Arsenic	0.01 mg/L	-	0,01 mg/L	-	○		
Boron	0.3 mg/L	-	2.5 mg/L	-		○	
Chrome	0.003 mg/L	-	0.05 mg/L	-		○	
Copper	5 mg/L	-	2 mg/L	1 mg/L		○	
Fluorine	3.0 mg/L	-	1.5 mg/L	-		○	
Manganese	0.8 mg/L	-	0.4 mg/L	0.1 mg/L		○	
Nitrate	50 mg/L	-	50 mg/L	-		○	
Nitrite	6 mg/L	-	3 mg/L (0.2 mg/L)	-		○	WHO upper: Long period, Lower: Short period
Aluminum	-	0.4 mg/L	-	0.2 mg/L		○	
Ammonia	-	2 mg/L	-	1.5 mg/L		○	
Chloride	-	533 mg/L	-	250 mg/L		○	
Hardness	-	392 mg/L	-	-		○	
Iron	-	0.4 mg/L	-	0.3 mg/L		○	
ORP	-	-	-	-	○		Reference value
pH	-	6.5 - 8.5	-	-	○		
Sodium	-	358 mg/L	-	200 mg/L		○	
Sulfate	-	483 mg/L	-	250 mg/L		○	
TDS	-	1776 mg/L	-	1000 mg/L		○	
Calcium	-	-	-	-		○	Reference value
Alkalinity	-	-	-	-		○	Reference value
Total coliform bacteria	Not detection	-	0	-	○	○	
Chromaticity	-	22 TCU	-	15 TCU		○	
Odor	-	Not smell	-	-		○	
Taste	-	Not chill	-	-		○	
Turbidity	-	7 NTU	-	5 NTU		○	
Temperature	-	-	-	-	○		Reference value
Electric conductivity	-	-	-	-	○		Reference value
Total					6	22	

(3) Result

As a result of the examination of water quality analysis of test drilling wells and springs, the nitrate content of the water of first drilling well of Kunzila exceeded the Ethiopian standard (50 mg/L), that well was determined to fail (detected value: 55.34 mg/L). This test drilling well is located near Lake Tana. It is assumed that the impact of wastewater discharges to Lake Tana is greater than elsewhere. There are no other sites where water quality exceeds Ethiopian standards.

Table 1-28: Result of water quality analysis

No.		Decision criteria		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
ID		Ethiopa standard	WHO guideline (4th edition)	9					10	11	12			14	15	16	-	27	29	
Town				Mertule Maryam					Yetimen	Keranyo	Lumame			Wojel	Sedie	Dibo	Amanuel	Gobeze Maryam	Kunzila	
Water source type				Spring#1	Spring#2	Spring#3	Spring#4	Spring#5	Test well #1	Test well #1	Test well #3	Existing#1	Existing#1	Test well #1	Test well #1	Test well #1	Test well #1	Spring#1	Test well #1	Test well #2
Arsenic	mg/L	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boron	mg/L	0.3	2.5	0.060	0.270	0.130	0.250	0.130	0.040	0.060	0.040	0.180	0.160	0.150	0.050	0.039	0.070	0.200	0.060	0.070
Chrome	mg/L	0.003	0.05	<0.01	<0.01	<0.01	<0.02	<0.01	0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/L	5	1	0.004	0.010	0.010	0.010	0.010	0.010	0.005	0.002	0.010	0.010	0.005	0.010	0.005	Trace	0.004	0.003	0.070
Fluorine	mg/L	3	1.5	0.49	0.50	0.53	0.52	0.54	0.58	0.52	0.63	0.53	0.56	0.73	0.66	0.72	0.45	0.51	0.47	0.69
Manganese	mg/L	0.8	0.1	Trace	Trace	Trace	Trace	Trace	0.05	0.01	Trace	0.01	0.02	Trace	trace	0.05	Trace	0.01	0.03	Trace
Nitrate	mg/L	50	50	5.69	10.27	9.74	5.61	15.21	0.32	22.04	12.91	38.10	0.51	3.65	3.48	9.30	3.84	13.80		1.29
Nitrite	mg/L	6	3	0.01	0.02	0.08	0.02	0.08	0.01	0.06	0.84	0.04	0.12	Trace	0.29	Trace	0.12	0.10	0.01	0.12
Aluminum	mg/L	0.4	0.2	0.030	0.020	0.010	Trace	0.020	0.010	0.010	0.002	0.020	0.030	0.010	trace	0.010	Trace	0.010	0.010	Trace
Ammonia	mg/L	22	1.5	0.31	0.31	0.28	0.29	0.31	0.18	0.31	0.19	0.30	0.28	0.38	0.23	0.15	0.27	0.32	0.28	0.40
Chloride	mg/L	533	250	0.91	2.73	5.46	1.82	5.46	22.75	5.46	10.10	28.21	10.01	10.01	7.28	23.66	3.64	1.82	29.34	13.65
Hardness	mg/L	392	-	66.5	68.4	142.5	104.5	123.5	146.3	123.5	168.3	199.5	11.4	315.1	15.2	89.3	50.0	228.0	259.9	150.1
Iron	mg/L	0.4	0.3	Trace	0.01	Trace	Trace	0.02	0.29	0.01	0.02	0.01	0.02	0.05	0.06	0.07	0.18	0.01	0.01	0.09
ORP *	mv	-	-	254	174	151	134	134	-84	-	250	127	80	-84	55	78	182	158	-84	-84
pH		6.5-8.5	-	6.52	6.89	7.13	7.20	7.20	7.48	6.47	7.29	6.19	8.68	6.94	8.78	7.72	6.30	6.60	6.51	6.82
Sodium	mg/L	358	200	27.0	34.5	13.4	28.5	39.0	41.0	6.2	61.0	13.3	60.0	16.0	86.0	80.0	7.1	18.0	9.9	20.0
Sulfate	mg/L	483	250	0.67	0.48	0.48	0.67	0.29	17.20	1.33	5.42	11.69	6.65	6.27	0.95	24.13	2.85	0.95	0.70	1.62
TDS	mg/L	1776	1000	140	180	200	190	240	302	160	340	280	180	346	220	300	74	320	306	212
Calcium *	mg/L	-	-	19.00	19.00	45.60	31.92	34.20	44.84	31.16	48.62	60.80	2.28	96.60	4.56	22.80	16.80	64.60	56.12	38.00
Alkalinity *	mg/L	-	-	126.0	133.0	176.7	180.0	199.5	197.6	120.0	265.5	140.0	130.0	296.4	178.5	186.0	58.0	280.0	169.1	172.2
Total coliform bacteria		Not detection	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromaticity		22	15	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless
Odor		No smell	-	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless
Taste		Not chill	-	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless
Turbidity	NTU	7	5	Nil	Nil	Nil	Nil	Nil	0.37	Nil	Nil	Nil	Nil	Nil	Nil	Nil	6.5	Nil	Nil	Nil
Temperature *	°C	-	-	-	-	-	-	-	20.57	-	21.3	-	-	19.67	20.17	20.25	21.14	-	23.91	24.9
Electric conductivity *	µS/cm	-	-	234	266	342	325	389	464	253	520	457	266	562	324	486	108	499	473	384

* Reference value

1-3-7 Survey

(1) Objective

In addition, the survey was conducted at every thirteen (13) sites without the result of test drilling with consideration of time constraints, because it has a possibility to design the water facilities as rehabilitation even if the test drilling is failed and it becomes impossible to use groundwater.

(2) Method

Survey was conducted as a line survey at 50 m intervals and plane surveying around existing facilities. Moreover, the existing institutions and geographical features, such as roads, rivers, and farmland, have been grasped, and coordinates information obtained by GPS about the position of construction scheduled institutions or the existing main institutions.

(3) Result

During the survey, it is determined the best locations and routes of reservoir tank, transmission pipes, distribution pipes and water faucet under the master plan which was made by Amhara regional state. None of the sites proved to be a difficulty for design or construction.

1-3-8 Social Condition Survey

(1) Objective

The objectives of the survey are to obtain the basic data and to figure out the social conditions described below:

- Population and households number in 13 target sites
- Major works of residents
- Residents' water utilization
- Amount of residents' water consumption
- Case of water disease
- Condition of management organization for water supply facilities
- O/M and management system for water supply facilities
- Family budget
- Willingness to pay for water usage charge
- Willingness to accept for residents' responsibility
- Organization and budget condition in Woreda water office
- Current issue for maintenance and management for water supply facilities

(2) Method

The social conditions survey related to water supply situation was made of interview survey by use of structural questionnaire. The survey items are for site survey for administrative organization's representative, for maintenance and management survey for WMO, for household sample survey for ten (10) households in each target town, for water consumption survey for ten (10) households in each target town, and also for water sanitary survey for relevant parties in the health sector.

(3) Result

1) Major works

According to the government printed publication "Household Income, Consumption and Expenditure (HICE) 2004/2005 by CSA", 86.7 % of Amhara regional people are occupied in family based agriculture. The major agriculture products in Amhara regional state are cereal, teff, beans, maize, and wheat. In case of female-led households, it often has the occupations regarding not only agriculture works but vegetable and traditional alcohols sales, cafeteria works. Target towns on this Project are, in majority, the commercial deal place for agriculture products market.

2) Residents' water utilization

Residents in target town are utilizing water supply facilities and primitive water sources full-year. In rainy season, water level at primitive water sources is raising and it makes residents easy to intake the water. In the meanwhile, water level in the underground is drawing down and in drought water level in the well in dry season, and consumer who utilize water supply facilities increases.

Table 1-29: Proportion of water use in rainy and dry seasons

	Water supply facilities			Primitive water source				
	Public faucet	Hand pump	total	Spring water	River	Pond/shallow well	Rain water	total
Rainy season	25.0%	14.3%	39.3%	7.1%	3.6%	39.3%	10.7%	60.7%
Dry Season	38.1%	9.5%	47.6%	14.3%	4.8%	19.0%	14.3%	52.4%

More than half of the people are using primitive water source in not only rainy season but dry season. This indicates the people don't concentrate at same water source, but are scattered and use several water sources.

3) Water disease

According to statistical frequency of Water disease in target sites, the frequency is in the order corresponding to diarrhea, malaria, dysentery, typhoid, and ascaris. And also, according to the data book "Welfare Monitoring Survey 2004 from CSA", based on disease data in Amhara regional state, around half of disease case is water disease (Malaria: 29.4 %, Diarrhea: 11.5 %, Optical disease: 8.4 %, Otolaryngologic disease: 3.1 %).

Few reasons of water disease in high frequency behind this are direct infection by drinking water and indirect infection like malaria at places of water intake and/or on the path to areas far away for fetching water.

Table 1-30: Breakdown of water disease

Zone	ID	Town	Breakdown for water disease (2009/2010)				
			No.1	No.2	No.3	No.4	No.5
East Gojam	9	Mertule Maryam	Diarrhea	Dysentery	Typhoid	Malaria	Ascaris
	10	Yetimen	Diarrhea	Malaria	Dysentery	Typhoid	-
	11	Keranyo	Malaria	Diarrhea	Ascaris	Dysentery	-
	12	Lumame	Diarrhea	Malaria	Scabies	Dysentery	Typhoid
	14	Wojel	Ascaris	diarrhea	Dysentery	Malaria	-
	15	Sedie	Diarrhea	Dysentery	Malaria	-	-
	16	Dibo	Malaria	Dysentery	-	-	-
	-	Amanuel	Diarrhea	Typhoid	Malaria	Dysentery	Ascaris
West Gojam	24	Addisalem	Malaria	Diarrhea	Dysentery	Typhoid	
	26	Kuch	Malaria	Diarrhea	Dysentery	Typhoid	
	27	Gobeze Maryam	Malaria	Diarrhea	Ascaris	Dysentery	Typhoid
	29	Kunzila	Ascaris	Diarrhea	Dysentery	Malaria	
	-	Bikolo	Malaria	Diarrhea	Typhoid	Dysentery	Ascaris

Note: Interview survey from health facilities in each site.

There is at least more than one (1) health facility in every target town. The number of patients who annually come to health facilities with water diseases is more than 37,000 persons in total of thirteen (13) target towns. The proportion of total patients to town population is 46.9 % on town average. This indicates that one (1) of about two (2) persons has been suffering from water disease.

Table 1-31: Number of patients by causing water disease

Zone	ID	Town	Water source	Water supply facilities	No. of the patient by causing water disease	Proportion of patients to town population
East Gojam	9	Mertule Maryam	Spring water	Public faucet	2,634	17.4%
	10	Yetimen	Groundwater	Public faucet	975	29.6%
	11	Keranyo	Groundwater	Public faucet	n.a.	-
	12	Lumame	Groundwater	Public faucet	n.a.	-
	14	Wojel	Groundwater	Shallow well	943	29.6%
	15	Sedie	Groundwater	Public faucet	1,412	42.2%
	16	Dibo	Groundwater	Hand pump	1,824	85.7%
	-	Amanuel	Groundwater	Public faucet	1,576	14.6%
West Gojam	24	Addisalem	Groundwater	Hand pump	5,270	100.4%
	26	Kuch	Groundwater	Public faucet	7,740	112.7%
	27	Gobeze Maryam	Spring water	Public faucet	4,847	82.7%
	29	Kunzila	Groundwater	Public faucet	3,894	67.5%
	-	Bikolo	Groundwater	Public faucet	6,400	129.8%
Total			-	-	37,515	46.9%

4) Household income

According to the data book “Household Income, Consumption and Expenditure (HICE) 2004/2005 from CSA”, 86.7 % of total population in Amhara regional state is occupied in family-operated work. The major agriculture products in Amhara region are cereal, teff, beans, maize, and wheat. Target towns on this Project are, in majority, the commercial deal place for agriculture products market, and are briskly in commercial works of informal sector. This is, in short, that the works makes it easy to make money in petty cash, which allows for a stable household income. The proportion of female-led households in target towns is around 30 % in all, the major works of them for making petty cash revenue are agriculture, vegetable sales, traditional alcohol production and sales, and also cafeteria running.

The survey result of household income in thirteen (13) target sites is 748 Birr on monthly average. This survey was made by randomly selecting ten (10) households, and interviewing them about their household income.

Table 1-32: Household income in target towns

Unit: Birr

Zone	ID	Town	Household monthly revenue		
			Average	Maximum	Minimum
East Gojam	9	Mertule Maryam	1,505	7,000	100
	10	Yetimen	1,250	8,000	0
	11	Keranyo	336	1,269	30
	12	Lumame	860	1,500	0
	14	Wojel	575	1,500	100
	15	Sedie	215	400	0
	16	Dibo	387	1,000	50
	-	Amanuel	469	2,000	50
West Gojam	24	Addisalem	950	3,970	0
	26	Kuch	519	1,792	0
	27	Gobeze Maryam	881	2,500	50
	29	Kunzila	326	2,000	30
	-	Bikolo	1,451	6,000	50
Average			748	-	-

According to the data book HICE 2004/2005, monthly expenditure per household in Amhara regional state is 684 Birr on average. General households in developing countries have a low rate of savings. In other words, this expenditure almost means disposable income (i.e.; consumption expenditure + savings). Accordingly, supposed that the income per household is 684 Birr on average, average income in thirteen (13) target towns is higher than Amhara regional state's average one.

5) Current condition of water utilization

The survey to know amount of household water consumptions as current condition of water utilization in thirteen (13) target sites is conducted for few days. The sample number of surveying household is ten (10) and the households are selected at random. The survey result is that amount of water consumption is 15.74 Liter per person per day as average of thirteen (13) target towns, and the site to show lowest amount of water consumption is Amanuel, the amount is 8.00 Liter per person per day. However, WSDP's targeted standard of setup amount in water supply basic unit is 20 Liter per person per day, current condition of target sites hasn't been achieved yet.

Number of times for fetching water per day is 2.9 times on average of target sites. Fetching water work is, in majority, in the responsibility of woman and girls. Time spent to move to water supply facilities for fetching is around 15 minutes per one-way, the distance to water supply facilities for access is 740.8 meter on target sites' average. However, WSDP's targeted standard of access distance to water supply facilities is 500 meter, in other words, it shows the number of water supply facilities is insufficient in current condition.

Table 1-33: Current condition of water utilization

Zone	ID	Town	Water supply facilities	Water used amount	Times of fetching water	Time spent to move for fetching water	Access distance to water supply facilities *
East Gojam	9	Mertule Maryam	Public faucet	14.40	3.5	1.0	50.0
	10	Yetimen	Public faucet	15.10	3.1	1.0	50.0
	11	Keranyo	Public faucet	12.90	2.7	12.6	630.0
	12	Lumame	Public faucet	9.00	1.9	10.1	505.0
	14	Wojel	Shallow well	13.60	2.6	14.8	740.0
	15	Sedie	Public faucet	21.90	2.6	30.0	1,500.0
	16	Dibo	Hand pump	14.40	2.7	15.1	755.0
	-	Amanuel	Public faucet	8.00	3.2	4.0	200.0
West Gojam	24	Addisalem	Hand pump	31.80	3.2	39.0	1,950.0
	26	Kuch	Public faucet	10.90	2.0	16.8	840.0
	27	Gobeze Maryam	Public faucet	15.50	3.2	15.7	785.0
	29	Kunzila	Public faucet	16.60	3.0	9.1	455.0
	-	Bikolo	Public faucet	20.50	3.7	23.4	1,170.0
Average in sites			-	15.74	2.9	14.8	740.8

Note: Moving distance per minute calculated in 50 meter.

6) The proportion of household expenditure for water usage

The monthly expenditure for purchase of water per household is 22.58 Birr on average of target towns, the percentage of water fee for household monthly expenditure is 3.0 %. The targeted expenditure percentage per household for purchase of water is generally approx. 5 %. Specifically, the expenditure percentage in few target towns; Keranyo, Sedie, and Kunzila, shows 6.0 % to 8.6 %, and it is slightly higher than the targeted percentage.

Table 1-34: Monthly expenditure and proportion of water usage

Unit: Birr

Zone	ID	Town	Water supply facilities	Monthly overall expenditure on average per HH	Monthly expenditure for water usage per HH	Percentage of expenditure
East Gojam	9	Mertule Maryam	Public faucet	1,505	23.00	1.5%
	10	Yetimen	Public faucet	1,250	14.00	1.1%
	11	Keranyo	Public faucet	336	20.00	6.0%
	12	Lumame	Public faucet	860	22.00	2.6%
	14	Wojel	Shallow well	575	30.00	5.2%
	15	Sedie	Public faucet	215	18.00	8.4%
	16	Dibo	Hand pump	387	2.00	0.5%
	-	Amanuel	Public faucet	469	25.50	5.4%
West Gojam	24	Addisalem	Hand pump	950	27.00	2.8%
	26	Kuch	Public faucet	519	17.00	3.3%
	27	Gobeze Maryam	Public faucet	881	24.00	2.7%
	29	Kunzila	Public faucet	326	28.00	8.6%
	-	Bikolo	Public faucet	1,451	43.00	3.0%
Average in sites			-	748	22.58	3.0%

7) Willingness to pay for water charge

When new water supply facilities is equipped in the future, the way to pay for water fee is requested month by month for charge collection. This request means that the facilities user hopes to keep stable water charge in an even proportion and that they hope to have stable water supply full-year.

The range to amount of willingness to pay in case of monthly charge is 2.5 Birr to 30.0 Birr, and the range in case of water fee per jerry can is 0.05 Birr to 0.3 Birr. Many of target towns are acceptable for the more or same amount of expenditure for water fee as current amount of it.

Table 1-35: Willingness to pay for water charge

Unit: Birr

Zone	ID	Town	Current expenditure per m^3	Monthly payment		Payment per jerry can	
				Per HH	m3 *	Per 20 liter	m3 *
East Gojam	9	Mertule Maryam	1.38	2.50	1.38	0.05	2.50
	10	Yetimen	0.53	6.00	3.15	0.20	10.00
	11	Keranyo	10.00	6.00	3.69	0.20	10.00
	12	Lumame	5.29	6.00	5.29	0.20	10.00
	14	Wojel	15.00	8.00	4.67	0.30	15.00
	15	Sedie	6.50	4.50	1.63	0.15	7.50
	16	Dibo	0.55	12.00	6.61	0.30	15.00
	-	Amanuel	12.50	25.50	25.30	0.25	12.50
West Gojam	24	Addisalem	50.00	6.00	1.50	0.20	10.00
	26	Kuch	12.50	7.00	5.10	0.25	12.50
	27	Gobeze Maryam	10.00	6.00	3.07	0.20	10.00
	29	Kunzila	10.00	5.00	2.39	0.20	10.00
	-	Bikolo	5.00	30.00	11.61	0.10	5.00

Note: A conversion based on the amount of current condition in each site.

8) Willingness to accept for residents' responsibility

At all thirteen (13) target towns, each WMO is confirmed that there is willingness to accept the granted project implemented by Japan Government, and willingness to provide labor force and stretch budget, construction material.

As for hearing investigation to Water management organizations, land owner is verified together with Woreda water office staff in all target towns. The target towns for site acquisition for water supply facilities are public land in national or regional property.

Table 1-36: Willingness to accept for residents' responsibility for each target site

Zone	ID	Town	Willingness to accept	Labor force service	funding	Purchase of material	Food service at const. site	Land provided
East Gojam	9	Mertule Maryam	○	○	○	○		○
	10	Yetimen	○		○	○		
	11	Keranyo	○	○	○			
	12	Lumame	○	○	○		○	
	14	Wojel	○	○	○			
	15	Sedie	○	○		○	○	
	16	Dibo	○	○	○	○		
	-	Amanuel	○	○	○	○	○	○
West Gojam	24	Addisalem	○	○	○	○	○	
	26	Kuch	○	○	○			
	27	Gobeze Maryam	○	○		○	○	
	29	Kunzila	○	○	○	○		
	-	Bikolo	○	○	○			
Percentage			100.0%	92.3%	84.6%	61.5%	38.5%	15.4%

1-4 Social and Environmental Consideration

1-4-1 Social and Environmental Consideration

The water supply amount of the facilities planned in this Project turned out to be less than 500 m^3/day capacities for all sites in water supply demand. Therefore, it is not necessary to carry out an Initial Environmental Examination (IEE) procedures according to the criteria of Environmental Impact Assessment Procedural Guideline in Amhara regional state. And also, as the result of evaluation of environmental condition of the target sites based on this guideline, there would be negligible environmental and social impacts from the Project.

1-4-2 Social Condition

Construction location of reservoir tanks planned in this Project is inside the public areas for Sedie, Dibo, Gobeze Maryam and Bikolo. No negative impact from the site acquisition is expected. As for the other facilities, they are planned to be constructed inside the existing facilities area. Therefore, no negative impact is expected. On the other hand, there would be negligible impact concerning the installation of distribution pipes and public faucets because they are planned to be placed along public roads. In order to make sure of this assessment, the details of the pipeline construction need to be verified with related organizations after the exact construction routes are determined.

In the case of land acquisition, it should be implemented in accordance with the guideline "The Revised Amhara National Regional State Rural Land Administration and Use Proclamation", and in the case of demolishing of existing facilities for site clearance, it should be implemented in accordance with the guideline "Solid Waste Management Proclamation".

1-4-3 Environmental Condition

It was confirmed that a group of Ardeidae (Latin name: Ciconia Ciconia) inhabit one of target sites, Kuch. But, this species is classified as "least concern" in accordance with IUCN Red List of Threatened Species. Therefore it is identified that this species is not of serious concern. Thus, it is judged that there is no negative impact to the ecosystem in the environmental assessment for the target sites including Kuch. As for the water facilities development in this Project, wells that satisfy criteria based on the results of pumping test and water quality analysis will be used as production wells. Based on the screening with these tests, it is identified that there is no negative impact in terms of water quality and quantity.

Ardeidae in Kuch

Chapter 2

Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Over Goal and Project Goal

(1) Over Goal

The Government of Ethiopia established Universal Action Plan (UAP, 2005-2012) in order to elevate water coverage ratio in rural areas up to 98 %. This target could be not achieved, therefore UAP2 (2009-2015) was established aiming to elevate water coverage ratio. However, the plan for expansion of water supply facilities was not preceded and the facilities are becoming older, water coverage ratio in rural area is still 53 % (2008).

To solve these conditions, the Government of Ethiopia is settled to improve the social and sanitary conditions in small towns as an overall goal. In this situation, this Project targets to construct water supply facilities and improve the ratio of water coverage in small town of southern part of the Amhara regional state.

(2) Project Goal

This Project targets to provide safe water sustainably and improve the ratio of water coverage to inhabitants in small towns of southern part of the Amhara regional state through the construction of water supply facilities in order to achieve the overall goal. This Project is a part of UAP.

2-1-2 Project Summary

The Project is not only construction of water supply facilities with public faucets in the target area, but also conducting of soft component in order to elevate the capability of Water Management Organization (WMO) for operation and maintenance to achieve the overall goal.

The Project implementation aims to enable the sustainable to supply of safe water and expects to elevate capability for operation and maintenance for water supply facilities.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

(1) Selection Criteria

In the thirteen (13) sites requested by the Ethiopian side, the sites that have satisfied all criteria shown below will be selected as the Project candidate sites for water supply scheme by public faucets. The water source for water supply facility is groundwater or spring water based on the result of test well drilling and existing water source survey. Water supply facility by hand pump will not be planned in this Project.

Table 2-1: Criteria for candidate for the Project

Evaluation Item		Criteria	Evaluation Method
Precondition	Overlap of other project	There is overlap project in the target site or not.	Discussion and hearing from AWRDB
Natural condition	Existence of water source	Ground water or spring is existing in the target site or not.	Geophisical survey, test well drilling survey, existing source survey and discussion
	Water source potential (quantity)	Water quantity is more than 2.0 L/sec. or not.	Pumping test
	Water source potential (quality)	Water quality is satisfied Ethiopian water quality standard or not.	Water quality analysis
Social condition	Willingness to accept water supply facility	Residents are willing to accept water supply facility or not.	Social condition survey
	Ability to pay water fee	Residents have the ability to pay water fee or not.	Social condition survey
	Willingness to form WMO	Residents are willing to form WMO or not.	Social condition survey

(2) Project Target Year

Project target year is year 2016 confirmed on the inception report discussion.

(3) Planned Coverage Population

Planned coverage population is calculated to multiply annual population increasing ratio in rural area (4.2 %) using the Amhara regional state up to year 2016 to the latest population data by CSA (year 2011). In Dibo there is no population data, the population is calculated by abstracting the number of residential buildings from satellite imagery then multiplying the number of people in an average household (4.2 person per household).

(4) Water Supply Unit

Water supply unit will be 20 liter capita per day same value as WSDP in Ethiopia.

2-2-1-2 Policy of Natural Conditions

Precipitation in the Survey area is concentrated in the rainy season from May to October. The dry

season runs from November to March and has almost no rain. Roads other than Route No. 3 that extends from the capital Addis Ababa to Bahir Dar are not paved. Since the majority of the target sites are located on the highway, therefore, the access to the target sites is possible even in the rainy season. However, it may be difficult to access to the construction sites. Therefore, the construction plan has to take into account the weather conditions as well.

2-2-1-3 Policy of Social Conditions

Although the existing water supply facilities and water source are managed by WMOs in the target sites, their experience of operation and maintenance is scarce. In addition to that cash is limited and access to safe water is limited. Therefore, they have insufficient knowledge and awareness of water and sanitation environment. To improve the sustainability of the Project, it is important to increase the awareness of participation in the Project of the inhabitants, hygiene awareness and appropriate technology of operation and maintenance. Therefore, by implementing the soft component, the ability of operation and maintenance of WMO and inhabitants may be elevated.

2-2-1-4 Policy of Construction Conditions

(1) Permit Approval

So as not to interfere with the smooth implementation of the Project, it has been confirmed that the Ethiopian side will take care of issues such as water rights, the right to possession of land, import customs clearance, and tax exemption.

(2) Electricity

From a lack of capacity of the two (2) substations in the Amhara regional state, the target sites have an unstable power supply and failures occur sporadically. From the viewpoint of the operation and maintenance, commercial power is planned for power source for water supply facilities. However, the installation of generator is also planned in order to operate a sustainable water supply facility. Further, when the power is stable, so that commercial power can be used, the switching device between the generator and commercial power is set up on the control panel.

2-2-1-5 Policy of Utilization of Local Contractor

In Ethiopia, the local contractor is obliged to register, and are graded by the number of employers and holding equipment into nine (9) grades. The local contractor graded specify, has enough technology and experience of facility construction. In this Project, the planning and cost estimation are carried out with the assumption of using of the local contractors that have higher grades specify.

2-2-1-6 Policy of Operation and Maintenance

Water supply facilities to be constructed in this Project will be operated and maintained by WMOs and Woreda offices. At present, the structure of operation and maintenance is mainly the role of

WMOs and the government. The method and ability of operation and maintenance of water supply facility are not enough. Therefore, in order to improve the capacity of WMOs and Woreda offices, soft component is conducted.

In order to achieve operation and maintenance by WMO, Ethiopian side (especially Woreda office) has to support. Therefore, the operating budget (transportation, per diem, etc.) of Ethiopian side is necessary to build the structure of operation and maintenance.

2-2-1-7 Policy of Facility Design

(1) Planning Condition

The specification of the structure is planned in order to minimize operation and maintenance cost, and to refer to the specifications employed by the other grant aid projects, the other donors and AWRDB.

And the design criteria is to comply with Ethiopian standards. The other design conditions are applied the calculated number and method based on the actual situation.

Table 2-2: Planning condition for the Project

Item		Planning condition
Effective water	Water supply unit for living	20 liter per capita per day
	Water supply unit for school	5 liter per capita per day
	Water supply unit for hospital	25 liter per bed per day
	Water supply unit for health center	25 liter per bed per day
Leaked water		15 % of effective water
Max. water supply amount per day		Average water supply amount x 1.2
Max. water supply amount per hour		Max. water supply amount x 2.0
Effective water head		5 m in principle
Open hour of public faucet		3 hours in AM, 3 hours in PM, total 6 hours
Operation hour of motorized pump		8 hours
Capacity of reservoir tank		12 hours for average water supply amount per day (more than 10,000 peoples) 15 hours for average water supply amount per day (less than 10,000 peoples)
Hydrologic accounting formula for pipes		Hazen Williams formula
Flow coefficient		C: 110

(2) Water Consumption Amount for Planning Purposes

Water consumption for planning is multiplied by the population served water consumption per person per day, and the water consumption for hospitals and schools are also added. However, if the amount does not satisfy the 100 % supply for the water supply plan, the water for life is prioritized. The amount of water for livestock is not covered in this Project.

2-2-2 Basic Plan (Construction Plan)

2-2-2-1 Overall Plan

Field survey in Ethiopia and analysis in Japan were conducted for thirteen (13) sites requested by the Ethiopian side. The thirteen (13) sites were evaluated by the criteria as previously mentioned, the candidate sites that were evaluated as suitable sites for the Project were selected. The flow of selection for candidate site and the result of selection of candidate site are as follows:

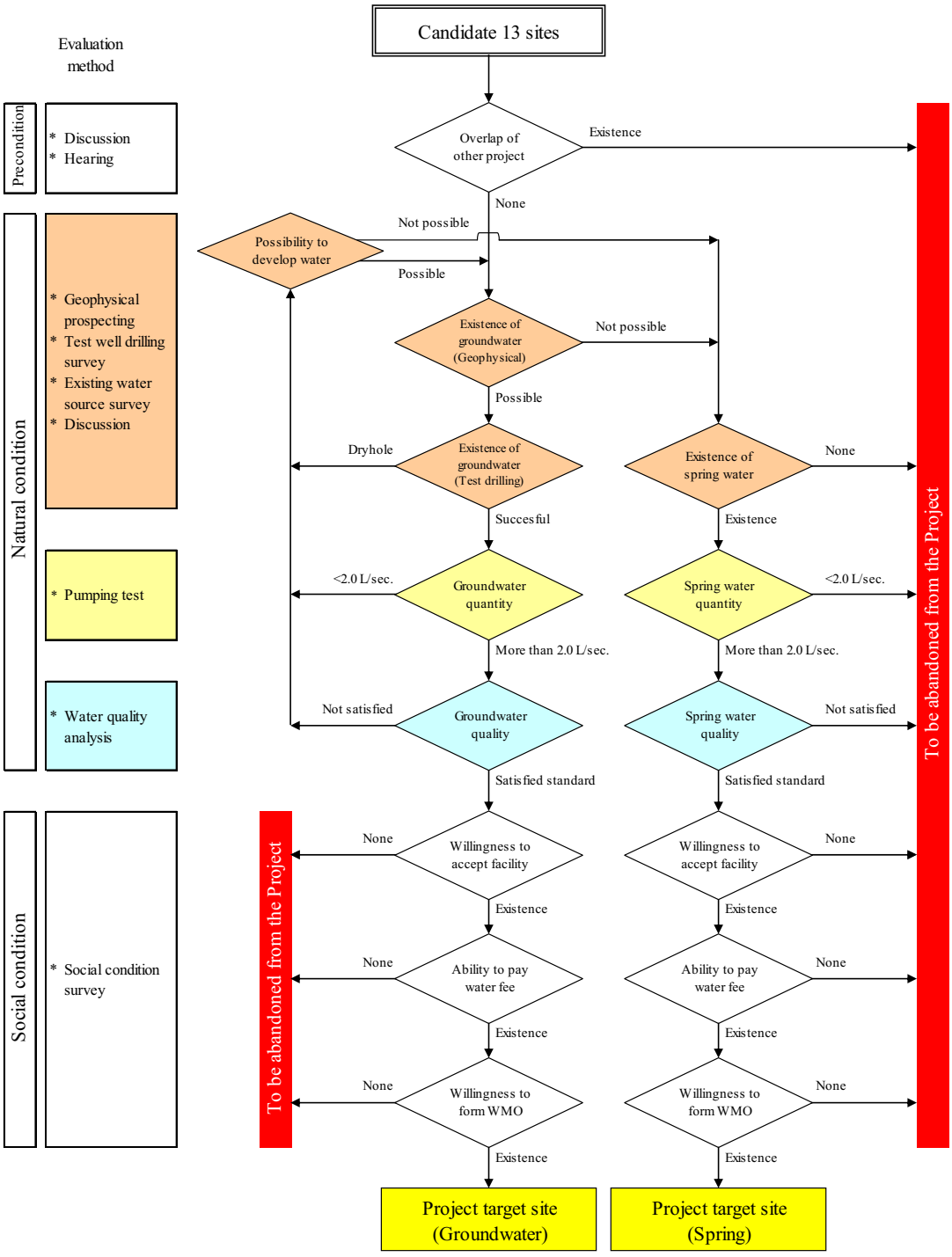


Figure 2-1: Flow of selection of the candidate sites

Table 2-3: The result of selection of candidate sites

Zone	ID	Town	Precondition	Natural condition				Social condition			Result of selection
			Overlap of other project	Existence of water source		Water source potential		Willingness to accept water supply facility	Ability to pay water fee	Willingness to form WMO	
				Groundwater	Spring	Quantity	Quality				
East Gojam	9	Mertule Maryam	None	None	5 points	11.42 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	10	Yetimen	None	Existence	—	8.70 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	11	Keranyo	None	None	None	—	—	—	—	—	To be abandoned
	12	Lumame	None	Existence	—	8.86 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	14	Wojel	None	Existence	—	7.80 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	15	Sedie	None	Existence	—	8.90 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	16	Dibo	None	Existence	—	8.90 L/sec	Satisfied	Existence	Existence	Existence	Project target site
	-	Amanuel	None	Existence	—	3.00 L/sec	Satisfied	Existence	Existence	Existence	Project target site
West Gojam	24	Addisalem	None	None	None	—	—	—	—	—	To be abandoned
	26	Kuch	None	None	None	—	—	—	—	—	To be abandoned
	27	Gobeze Maryam	None	None	1 point	3.96 L./sec	Satisfied	Existence	Existence	Existence	Project target site
	29	Kunzila	None	None	None	—	—	—	—	—	To be abandoned
	-	Bikolo	None	Existence	—	14.00 L/sec	Satisfied	Existence	Existence	Existence	Project target site

Criteria:	Precondition	Overlap of other project	There is overlap project in the target site or not.
	Natural condition	Existence of groundwater source	Groundwater is existing in the target site or not.
		Existence of spring water source	Spring is existing in the target site or not.
		Water source potential (quantity)	Water quantity is more than 2.0 L/sec. or not.
		Water source potential (quality)	Water quality is satisfied Ethiopian water quality standard or not.
	Social condition	Willingness to accept water supply facility	Residents are willing to accept water supply facility or not.
		Ability to pay water fee	Residents have the ability to pay water fee or not.
		Willingness to form WMO	Residents are willing to form WMO or not.

Based on the result of field survey in Ethiopia and analysis in Japan, four (4) sites; Keranyo, Addisalem, Kuch and Kunzila were evaluated to be abandoned from the Project, because of difficulty of development of water source at these sites.

Therefore, the number of candidate sites for the Project is totally nine (9); seven (7) sites will planned by groundwater source, two (2) sites will be planned by spring water source as mentioned below:

Table 2-4: Candidate sites for the Project

	Sites	Name
The site to be planned water supply facility by groundwater	7	Yetimen, Lumame, Wojel, Sedie, Dibo, Amanuel, Bikolo
The site to be planned water supply facility by spring	2	Mertule Maryam, Gobeze Maryam
Target site	9	
The site to be abandoned	4	Keranyo, Addisalem, Kuch, Kunzila
Total	13	

The outline of the Project is as follows:

Table 2-5: Outline of the Project

Item	Contents and activity
Facility construction	[Water supply] Construction of water supply facilities with public faucets and rehabilitation of existing facilities ・ Water supply facilities by groundwater: 7 sites ・ Water supply facilities by spring: 2 sites ・ Elevated reservoir tank: 3 ・ Ground reservoir tank: 6 ・ Generator house: 11 ・ Public faucet: 86/90 (new/existing exchange) ・ Transmission pipe: 23.843 km ・ Distribution pipe: 37.497 km
Soft component	[Water supply] Support to strengthen of capability of O&M by WMO and Woreda water office

2-2-2-2 Water Supply Facility Plan

(1) Water Supply System

1) The Points of Water Supply Facility Plan

Water supply facility plan in the Project are referred to existing water supply facility plan and are designed simply in order to operate and maintain easily by WMO. The points of water supply facility plan are as follows:

- To minimize the cost of operation and maintenance, water supply system is not planned to have

large power consumption.

- To enable easy operation and maintenance by WMO, a complex water supply system and high-performance features are not planned.
- To reduce initial investment (construction cost), equipment to be procured, the construction methods and the secondary products (elevated tank etc.) are to be those that are common in Ethiopia.

2) Water Supply System by Groundwater #1

This water supply system is planned at four (4) sites, Yetimen, Wojel, Sedie and Bikolo. This system is composed one groundwater source developed in the Project, motorized pump, reservoir and public faucets etc. The elevation of construction land of reservoir is higher than the elevation of construction land of public faucets, the ground reservoir tank is planned. The water is distributed from reservoir to public faucets by gravity.

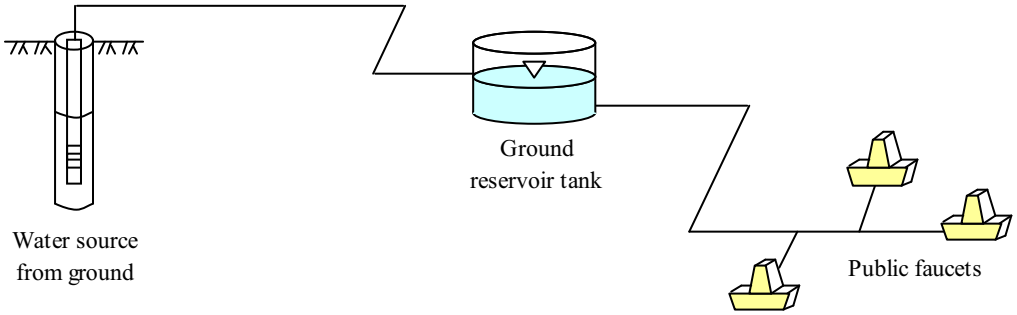


Figure 2-2: Concept of water supply system by groundwater #1

3) Water Supply System by Groundwater #2

This water supply system is planned at three (3) sites, Lumame, Dibo and Amanuel. This system is almost same composition as water supply system #1 mentioned above, groundwater source developed in the Project. The elevation of construction land of reservoir is lower than the elevation of construction land of public faucets, the elevated reservoir tank is planned. The water head is secured in order to distribute until the end of public faucets.

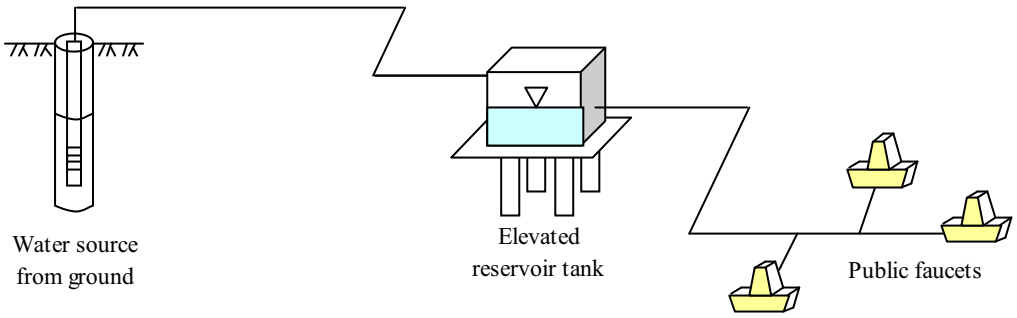


Figure 2-3: Concept of water supply system by groundwater #2

4) Water Supply System by Spring Water

This water supply system is planned at two (2) sites, Mertule Maryam and Gobeze Maryam. This system is composed one unit including water source by spring confirmed sufficient water quantity and quality in the Survey, motorized pump, pump pit, reservoir and public faucets etc. The water is distributed to reservoir by motorized pump after collecting once in pump pit. The elevation of construction land of reservoir is higher than the elevation of construction land of public faucets, the ground reservoir tank is planned. The water is distributed from reservoir to public faucets by gravity.

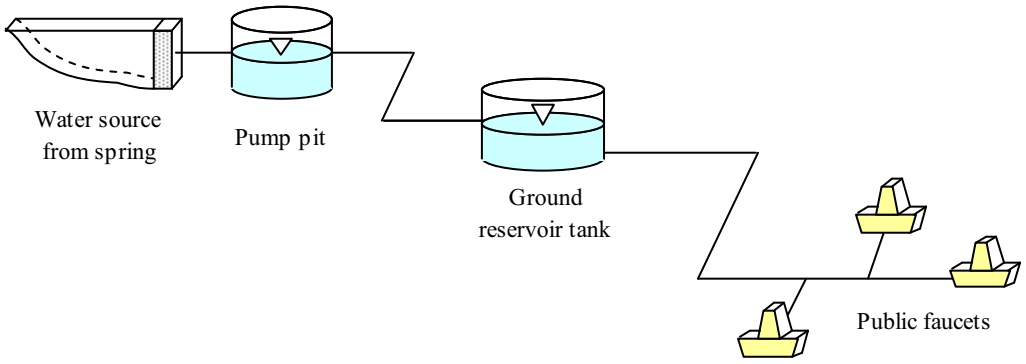


Figure 2-4: Concept of water supply system by spring water

(2) Water Source

In the seven sites where test drilling was successful, this project will convert test drilling wells into production wells. In addition, in two (2) sites where test drilling was unsuccessful but sufficient quantity and quality of spring water was ensured, this Project takes advantage of those springs as alternative water sources. It is planned to select the submersible pump in consideration of ease of procurement of the pump main unit and spare parts.

(3) Reservoir Tank

In this Project ground type or elevated type of reservoir tank will be selected according to the terrain conditions of each site. Consideration of structure and specifications of each type of reservoir tank will focus on safety and durability of structures for ground type, and on ease of construction and versatility for elevated type. The structure and capacity of reservoirs planned in this Project are as follows:

Table 2-6: Reservoir tank to be planned

Zone	ID	Town	Reservoir tank	
East Gojam	9	Mertule Maryam	Ground RC made	30 m^3
	10	Yetimen	Ground RC made	70 m^3
	12	Lumame	Elevated Steel made	120 m^3
	14	Wojel	Ground RC made	70 m^3
	15	Sedie	Ground RC made	70 m^3
	16	Dibo	Elevated Steel made	50 m^3
	-	Amanuel	Elevated Steel made	120 m^3
West Gojam	27	Gobeze Maryam	Ground RC made	100 m^3
	-	Bikolo	Ground RC made	100 m^3

(4) Transmission Pipe and Distribution Pipe

Design of transmission pipe (from water source to reservoir tank) and distribution pipe (from reservoir tank to water faucet) will, in principle, be based on the design standards of Ethiopia. Items that are not specified in Ethiopian design standards will adopt Japanese design standards.

With regard to the design of transmission and distribution pipes, existing pipes are diverted in seven (7) sites except Wojel and Dibo. About several zones where it is necessary to change the diameter of pipe, where existing pipes are exposed by the scouring of rain and where there are no existing pipes, it is planned to replace pipes or lay new pipes. Although there are existing pipes in Wojel, all water facilities are abandoned in Wojel and since the situation of existing pipes cannot be confirmed, new pipes are set in total area. And at Dibo, only hand pumps are used until now, so all water facilities will be newly constructed.

Galvanized steel pipes are selected in Amhara regional state as transmission and distribution pipes. In this Project, type of pipe is selected by considering the ease of procurement, price increase in recent years, strength, and cost savings. However, in some areas, where water pressure (combined static head and water hammer pressure) is over 1.0 Mpa, galvanized steel pipe is selected.

The minimum earth covering for newly laid pipe is about 80 cm (width of earthwork is about 50 cm to 70 cm), because there is little traffic of heavy vehicles in target sites. However, because the black cotton soil is present in part of target sites, pipe is protected by sand.

After this Project, although there is the possibility that the water supply will be expanded to connect residents directly to main pipes by counterparts in future, pipelines are planned to be designed for public faucet in this Project. In this case, minimum diameter of pipe is planned to be about 40 mm. This size is required to avoid the pipe being blocked by deposition of dust, sand, etc., since the pipeline is a core infrastructure. By making the minimum diameter 40 mm, if, in future, the water supply is extended to individual houses, this pipe will be able to be used to a certain extent. Therefore, this Project doesn't plan to connect individual houses.

The following tables show the total length (proposed) of transmission and distribution pipelines planned by this Project. Total length of transmission pipeline to be laid by this Project is from water sources, which were confirmed to have sufficient quantity of water by this study, to reservoir tanks; while the total length of distribution pipeline is from reservoir tank to each public faucet.

Table 2-7: Transmission pipe to be planned

Zone	ID	Town	Transmission pipe (m)			
			100A	80A	40A	Total
East Gojam	9	Mertule Maryam	0.00	1,230.00	3,015.40	4,245.40
	10	Yetimen	0.00	1,241.19	0.00	1,241.19
	12	Lumame	1,225.48	3,402.36	0.00	4,627.84
	14	Wojel	0.00	990.29	0.00	990.29
	15	Sedie	0.00	1,455.27	0.00	1,455.27
	16	Dibo	0.00	2,071.06	0.00	2,071.06
	-	Amanuel	0.00	2,386.25	0.00	2,386.25
West Gojam	27	Gobeze Maryam	0.00	1,304.06	0.00	1,304.06
	-	Bikolo	5,521.82	0.00	0.00	5,521.82
Total			6,747.30	14,080.48	3,015.40	23,843.18

Table 2-8: Distribution pipe to be planned

Zone	ID	Town	Distribution pipe (m)				
			100A	80A	50A	40A	Total
East Gojam	9	Mertule Maryam	738.59	3,118.17	1,380.37	4,528.97	9,766.10
	10	Yetimen	0.00	357.42	0.00	2,261.84	2,619.26
	12	Lumame	186.71	573.29	554.36	2,280.90	3,595.26
	14	Wojel	0.00	497.83	271.77	4,478.42	5,248.02
	15	Sedie	0.00	408.67	393.53	1,532.28	2,334.48
	16	Dibo	0.00	0.00	1,458.01	2,400.22	3,858.23
	-	Amanuel	93.54	1,019.94	580.24	1,659.22	3,352.94
West Gojam	27	Gobeze Maryam	0.00	906.33	390.15	3,416.11	4,712.59
	-	Bikolo	823.89	296.95	0.00	889.64	2,010.48
Total			1,842.73	7,178.60	5,028.43	23,447.60	37,497.36

(5) Drain Valve, Air Valve and Gate Valve

In a pipeline, in order to discharge mud, drain valves are installed in relatively low sections of pipe, and in order to prevent restricted flows caused by air in the pipe and broken pipes caused by water hammer, air valves are installed in relatively high sections of pipe. Moreover, in order to make repairs of broken or leaking pipes easier, gate valves are installed every 1 to 2 km.

(6) Public Faucet

Although various types of public water faucet are used in Amhara regional state, their height is planned so that people can easily fill jerry cans or water containers. Apron and drain are also planned around public faucets, and a water meter is installed in the inflow part to public faucet. Moreover, the existing public faucets that are currently abandoned are also exchanged.

About the setting position of a public faucet, existing public faucet is considered to set as present position, new public faucet is planned based on a request of local residents and the end pipeline extended in this Project. In addition, all land in Ethiopia is government owned under Ethiopian law, so there is no obstacle in establishment of public faucets; moreover, the construction sites have already been checked with the water management organization and local residents. However, in order to avoid problems of eminent domain at the time of construction, documentation to this effect will be obtained

from the Ethiopian side.

The public faucets planned in this Project are as follows:

Table 2-9: Public faucets to be planned

Zone	ID	Town	New	Exchange existing
East Gojam	9	Mertule Maryam	25	17
	10	Yetimen	5	11
	12	Lumame	10	11
	14	Wojel	12	8
	15	Sedie	7	6
	16	Dibo	6	0
	-	Amanuel	6	18
West Gojam	27	Gobeze Maryam	11	12
	-	Bikolo	4	7
Total			86	90