The Federal Republic of Ethiopia

Water Resource Bureau
Southern Nations, Nationalities and
People's Regional State

THE PREPARATORY SURVEY
ON
THE PROJECT FOR WATER SUPPLY DEVELOPMENT TO THE SMALL TOWNS IN RIFT VALLEY BASIN IN SOUTHERN NATIONS, NATIONALITIES AND PEOPLE'S REGIONAL STATE

FINAL REPORT

DECEMBER 2014

Japan International Cooperation Agency (JICA)

Kokusai Kogyo Co., Ltd.

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Summary

1. Outline of the Recipient Country

Southern Nations, Nationalities and People's Regional State (SNNPRS) is located in the southern part of Ethiopia, and neighbors Gambela Region to the northwest, Oromia Region to the north and east, the Republic of Kenya to the south and the Republic of South Sudan to the west. Targeted study area is located about 190km south of Addis Ababa of capital city, and is located in low country separated by a rift formation. This area is called Rift Valley Basin Area because it forms an independent hydrographic basin.

Climate of SNNPRS is categorized into a minor rainy season from February to May, a rainy season from June to September, and a dry season from October to January. Temperature decreases as altitude increases, and rainfall amount also increases with altitude. Average temperature is high from November to March (dry season and minor rainy season) and low from October to November (dry season).

2. Background and Outline of the Project

(1) Overall Goal

The Government of Ethiopia established the UAP (Universal Action Plan, 2005-2012) established on 2005 with the aim of increasing the water coverage ratio in rural areas to 98% by 2012. Their target could not be achieved, therefore a new UAP 2 (2009-2015) was established on 2009 with the aim of increasing the water coverage ratio 100% in urban areas, 98% in rural areas. However, the plan for expansion of water supply facilities has not progressed, the facilities have become older, and the water coverage ratio is 68.0% (2011/12, SNNPRB) in National, rural areas remains low at 50.4%. To solve these issues, the Government of Ethiopia has embarked on a goal of improving the social and sanitary conditions in rural areas.

(2) Current Conditions and Problems

The water supply rate in the rural areas in Ethiopia is 26% (WHO/UNICEF, 2010), which is much lower than the sub-Saharan average of 49%.

The Government of Ethiopia established Water Sector Development Program (WSDP) as national development program covering the entire water sector with the aim of improving conditions of water supply, irrigation and public health, as well as increasing the standard of living of local communities. And Universal Access Program (UAP and UAP 2) as strategy program was established and promoted to aim to increase the ratio of water supply coverage by 98%, however, the progress is far inferior to the target. In addition, water supply program in rural areas are developed by each regional office and Woreda water office as main body of implementation, however, new water supply facilities cannot be constructed sufficiently because the securement of budget in regional governments is not enough.

More than 90% of national population (around 15 million) is living in rural areas. The ratio of water supply coverage in SNNPRS is 51.7% (2011), especially such ratio is 50.4% in rural areas, which is much less than the nationwide average of 68.0%.

The Rift Valley area, the target of the Project, is part of the African Great Rift Valley, which is easily

affected by droughts. Droughts caused serious damage to the area in 2008 and 2011. In addition, existing water source (mainly surface water and shallow groundwater) in a part of target area is not suitable for drinking water because of high contamination of fluorine, therefore there is a major problem for quantity and quality in regard to water source development.

(3) Background and Outline of the Project

The contents of the original request by Water Resource Bureau (WB) of SNNPRS are construction of water supply facilities using deep wells and capacity strengthening of operation and maintenance (technical support) for 19 small towns.

Because much time had passed since the original request in August 2011, the current situation of the requested 19 small towns were confirmed to judge which sites to exclude from the target of the study. Sites with existing new water supply facilities or planned projects, sites categorized as Kebele and not as small towns, and sites difficult to access with heavy equipment were identified for exclusion. Therefore after discussion with the implementation agency, new candidate small towns were listed, and then the 11 small towns shown in the following table were selected as target sites with consideration for construction term and budget. In addition, before commencement of social and natural condition surveys, current water supply conditions in 11 small towns were confirmed.

Table 1: Target site for the study

No.	Zone	Woreda	Small town	Remarks
1	Gurage	Mareqo	Koshe	
2		Sodo	Kela	
3			Tiya	
4	Kembata Timbaro	Kedia Gamela	Adilo	Same as request
5	Sidama	Dara	Teferi Kela	Same as request
6	Silite	Dalocha	Dalocha	
7		Lanifaro	Mito	
8			Tora	Same as request
9		Sankura	Alem Gebeya	
10		Siliti	Kibet	
11	Wolayita	Humbo	Tebela	Same as request

3. Summary of the Survey and Contents of the Project

(1) Summary of the Survey

The scope of assistance in this Project is to provide water supply systems consisting of water supply facilities and public faucets based on the request by Ethiopian side. In ten of the eleven towns, that is not including Tiya, privately funded water supply services with private connections are operating, however, these systems are not covered by this Project. Even if the presence of groundwater has been confirmed, if the water yield is small, such water sources and water supply facilities with hand pumps will not be included in this Project.

In addition, technical assistance to establish a structure of operation and management for water supply facilities by WMOs and Woreda offices will be conducted as part of the Project.

Table 2: Scope of assistance

Item of Cooperation		Scope of Cooperation	
		Target	Not target
Facility Construction	Hand pump type water supply facility		○
	Public faucet type water supply facility	○	
	Each house faucet type water supply facility		○
Equipment Procurement			○
Technical Assistance (Soft Component)		○	

Field survey was conducted during May 2013 to March 2014, and analyzed, designed and calculated Project cost in Japan, explanation of draft final report was conducted on November 2014.

In 11 towns requested by the Ethiopian side, analysis in Japan was conducted based on the data of field surveys in SNNPRS. The towns that fully satisfied the following criteria shown below became target towns for the Project.

Table 3: Criteria for site selection

Item of Evaluation		Criteria of Evaluation	Method of Evaluation
Precondition	Overlapping of Projects	No overlapping plans shall exist in the target towns.	Discussion with and hearing from the recipient
Natural Conditions	Existence of ground water resources	As a result of test well drilling, ground water shall exist.	Field survey, geophysical prospecting, test well drilling, existing water resources survey, discussion with the recipient
	Existence of spring resources	Spring resources, which can be used for this Project, shall exist.	Existing water resources survey, discussion with the recipient
	Water quantity	Yield shall be greater than 2.0 L/s.	Pumping test
	Water quality	Water quality shall satisfy the Ethiopian standard.	Water quality analysis
Social Conditions	Willingness to accept water supply facilities	Residents (water management committee) shall have willingness to accept this Project.	Social condition survey
	Capability to pay water tariff	Residents shall have capability to pay water tariff.	Social condition survey
	Willingness to pay water tariff	Residents shall have willingness to pay water tariff.	Social condition survey

Regarding water quality, Ethiopian Water Quality Standard as requested by SNNPRB, is adopted considering the current water supply situation in 11 towns and the difficulty of groundwater development. Based on the evaluation by the above criteria, site selection and investigation of planning contents were conducted.

In nine towns (Koshe, Kela, Tiya, Adilo, Teferi Kela, Mito, Alem Gebeya, Kibat and Tebela) new water sources by test well drilling were confirmed and in one town (Dalocha) an existing spring was confirmed to have sufficient quantity and quality. Therefore 10 towns were selected as target towns of the Project. However, Tora is excluded from this Project, because it is very difficult to develop a new groundwater source and to convert existing springs in this Project.

This Project is to construct water supply facilities consisting of water source (groundwater or spring), generator house, reservoir, pipeline and public faucet in ten target towns. Overall plan of this Project is as follows.

Table 4: Outline of the Project

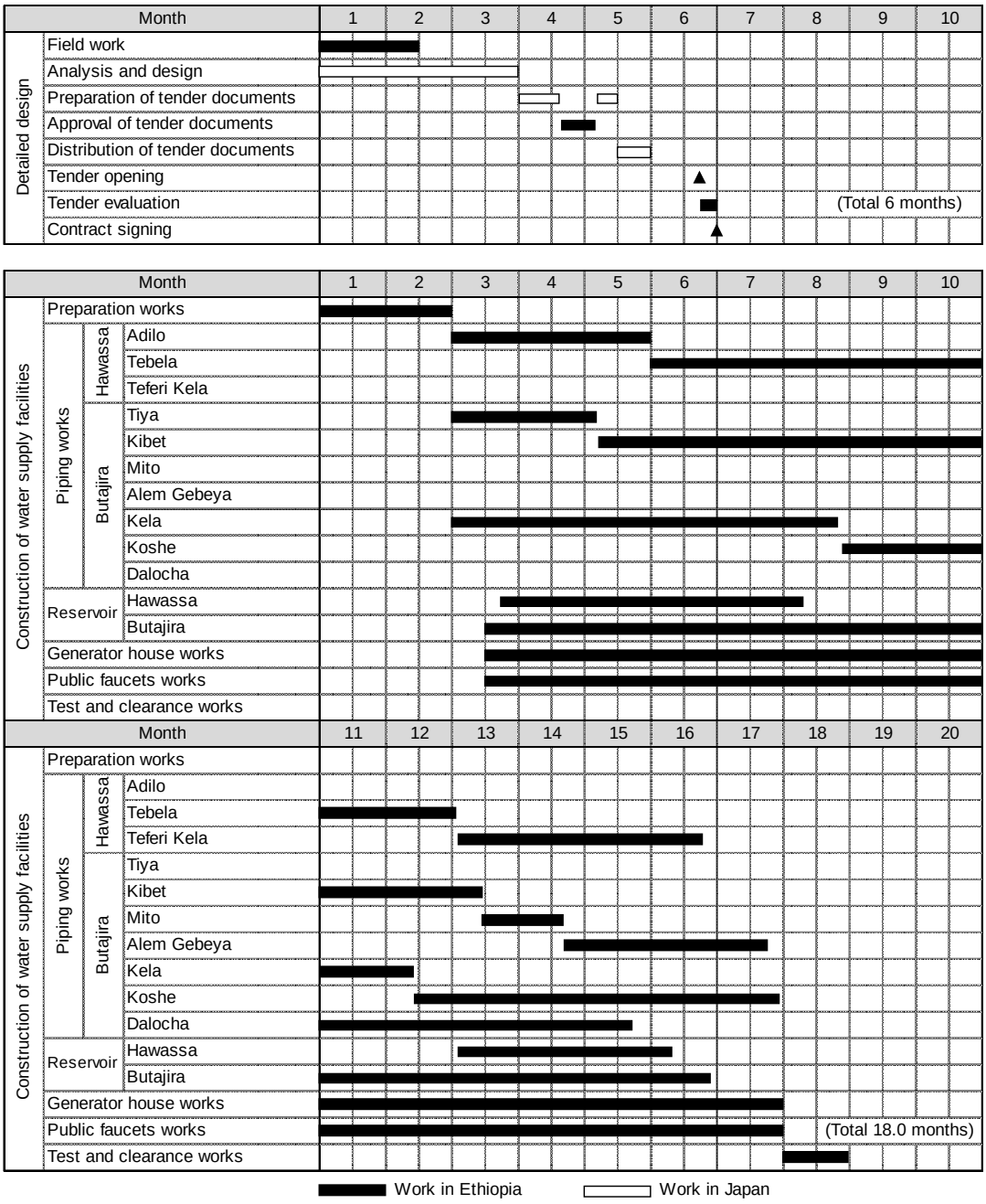
Work type	Specification		Unit	Quantity										Total
				Koshe	Kela	Tiya	Adilo	Teferi Kela	Dalocha	Mito	Alem Gebeya	Kibet	Tebela	
Well points	Existing well		Place			1						1		2
	New well		Place	1	2	1	2	2		1	1	1	1	12
	Sub total		Place	1	2	2	2	2	0	1	1	2	1	14
Generator house	New		Place	1	2	2	2	2		1	1	2	1	14
	Sub total		Place	1	2	2	2	2	0	1	1	2	1	14
Transmission pipe	SGP	φ150mm	m	2,170								4,000	1,430	7,600
		φ100mm	m		5,740		3,080			970	2,010	3,060		14,860
		φ75mm	m			2,610		3,140						5,750
	Sub total		m	2,170	5,740	2,610	3,080	3,140	0	970	2,010	7,060	1,430	28,210
Collection chamber	RC, 60m^3		Place						1					1
	Sub total		Place	0	0	0	0	0	1	0	0	0	0	1
Reservoirs	Ground RC	114.5m^3	Place										1	1
		100.7m^3	Place				1							1
		72.0m^3	Place	1										1
		15.7m^3	Place		1									1
	Elevated Steel	193.7m^3	Place									1		1
		122.0m^3	Place								1			1
		114.8m^3	Place					1						1
		131.2m^3	Place							1				1
		32.8m^3	Place			2								2
	Sub total		Place	1	1	2	1	1	0	1	1	1	1	10
Distribution pipe	SGP	φ150mm	m	1,350					3,640		650	690	530	6,860
		φ100mm	m		920	390	220	1,130	200		1,100	570	70	4,600
		φ75mm	m	1,776	660	1,290	520	590	430	480	770	2,490	2,060	11,066
		φ50mm	m	1,151	150	720	1,460	490	2,470	290	1,570	2,510	3,690	14,501
		φ40mm	m	2,220	6,870	1,590	2,050	2,160	5,500	2,110	2,200	4,250	8,240	37,190
	Sub total		m	6,497	8,600	3,990	4,250	4,370	12,240	2,880	6,290	10,510	14,590	74,217
Public faucets	Renovation		Place	10	9	3	6	10	8	10	8	15	8	87
	New		Place	7	9	5	6	6	10	5	5	8	8	69
	Sub total		Place	17	18	8	12	16	18	15	13	23	16	156

4. Implementation Schedule and Project Cost

(1) Implementation Schedule

Implementation schedule for the Project is shown below.

Table 5: Implementation schedule



(2) Project Cost

In order to implement this Project, the Project cost borne by Ethiopian side is around 3,867,000 Birr.

5. Project Evaluation

(1) Relevance

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 91,688 people of targeted 10 small towns in SNNPRS, a considerable number of whom are in the "worse off" category.
- The inhabitants in the targeted 10 small 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 inhabitants and contribute to improving their lives.
- The Government of Ethiopia aims at "improving living conditions and hygienic conditions in rural areas" as an overall goal. Therefore, implementation of this Project aims to achieve this objective.
- WB and Woreda Offices, as implementing agencies, have enough 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. Therefore, sustainable operation and maintenance by Water Management Organization (WMO) can be expected.
- Water supply facilities to be constructed in this Project are not profit-earning public facilities, therefore those facilities are adapted into the framework of Grant Aid.
- Environment impact as land use and utilization of local resources, soil erosion, air pollution, noise and vibration may be generated by the Project implementation, however, it is evaluated to be able to keep the impacts to the minimum by conducting mitigation measures.

(2) Effectiveness

1) Quantitative Impact

Quantitative impact to be expected by implementation of this Project is shown in following table. WMO records the volume of distribution flow on the management ledger by measuring the flow meter installed at the reservoir tank, therefore, the daily average amount of water supply can be confirmed by accessing the management ledger.

Table 6: Quantitative impact after implementation of this Project

Index	Standard value (Actual values in 2013)	Target value (2020) (After three years of project completion)
Average daily water supply amount	786.72 m^3/day*	2,497.84 m^3/day

* The value calculated on the basis of the Ethiopian Design Standard in existing facilities.

2) Qualitative Impact

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

- Mitigation of workload (time) for fetching water
- Mitigation of water-borne diseases *
- Promotion of the advancement of women into society *

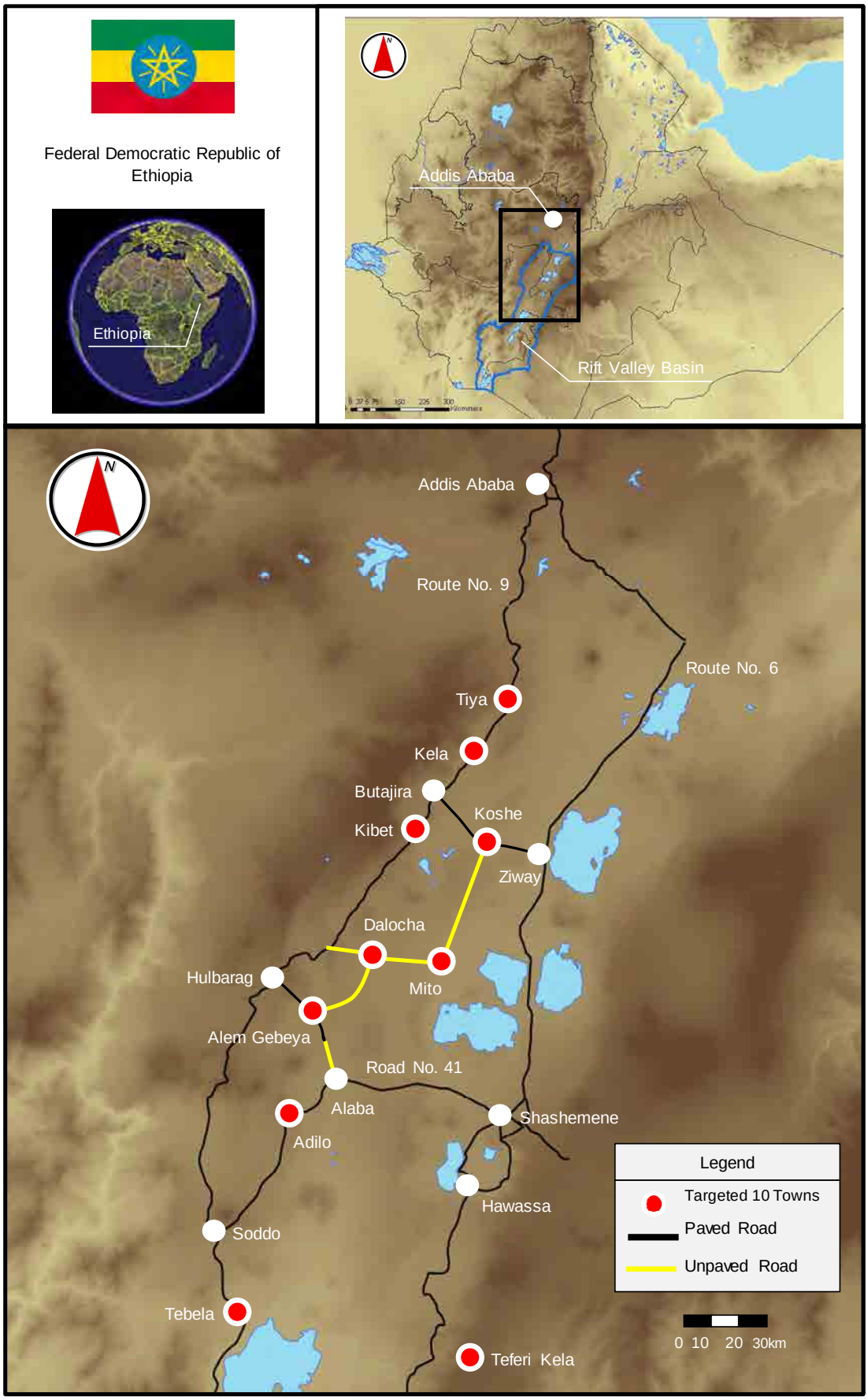
- Improvement of opportunity of school attendance of children *

* These qualitative impacts are expected to generate in this Project, however, it is difficult to measure the accurate impact level because the influence of external conditions have a profound effect.

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

Contents

Location Map



Perspective

Public faucet to be constructed in this Project

List of Figures & Tables

Abbreviations

AfDB	:	African Development Bank
BHN	:	Basic Human Needs
BoFED	:	Bureau of Financial and Economical Development
CSA	:	Central Statistical Agency
DTH	:	Down the Hole Hammer
DWWDA	:	Dalocha Women's Water Development Association
EEPC	:	Ethiopia Electric Power Corporation
EFY	:	Ethiopian Fiscal Year
EIA	:	Environmental Impact Assessment
EPA	:	Environmental Protection Authority
ERA	:	Ethiopian Roads Authority
EWTI	:	Ethiopian Water Technology Institute
GS	:	Galvanized Steel
HEP	:	Horizontal Electric Prospecting
HICE	:	Household Income, Consumption and Expenditure
IEE	:	Initial Environmental Assessment
IMF	:	International Monetary Fund
LAUEPA	:	Land Administration, Uses and Environmental Protection Authority
M/D	:	Minutes of Discussion
MDGs	:	Millennium Development Goals
PA	:	Preliminary Environmental Assessment
PASDEP	:	Plan for Accelerated and Sustained Development to End Poverty
PPP	:	Public Private Partnership
PRSP	:	Poverty Reduction Strategy Paper
SNNPRS	:	Southern Nations, Nationalities and People's Regional State
SDPRP	:	Sustainable Development and Poverty Reduction Program
SGP	:	Steel Galvanized Pipe
SWAps	:	Sector Wide Approach
UAP	:	Universal Access Program
UNICEF	:	United nations Children's Fund
VAT	:	Value Added Tax
VES	:	Vertical Electrical Sounding
WASH	:	Water, Sanitation and Hygiene
WASHCO	:	Water, Sanitation and Hygiene Committee
WB	:	Water Bureau
WHO	:	World Health 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

Chapter 1

Background of the Project

CHAPTER 1 BACKGROUND OF THE PROJECT

1-1 Background and Outline of Grant Aid

The contents of the original request by Water Resource Bureau (WB) of Southern Nations, Nationalities and People's Regional State (SNNPRS) are construction of water supply facilities using deep wells and capacity strengthening of operation and maintenance (technical support) for 19 small towns shown in Table 1-1.

Table 1-1: Original site requested by recipient country

No.	Zone	Woreda	Small town
1	Kembata Timbaro	Kedia Gamela	Adilo
2		Daniboya	Daniboya
3		Anigacha	Anigacha
4	Sidama	Dara	Kebado
5			Teferi Kela
6		Malga	Manicho
7		Goreche	Goreche
8	Silite	Sankura	Mazoria
9		Lanifaro	Tora
10	Wolayita	Sodo Zuria	Dalbo Atowa
11		Humbo	Tebela
12		Damot Pulasa	Shento
13	Hadiya	Misrak Badawocho	Weyira Mazoria
14	Gamo Gofa	Arba Minch Zuria	Lanite
15		Chenicha	Chenicha
16	Gedeo	Kochore	Fiseha Genet
17			Biloya
18		Gedeb	Gedeb
19			Chorso-Mazoria

Because much time had passed since the original request in August 2011, the current situation of the requested 19 small towns were confirmed to judge which sites to exclude from the target of the study. Sites with existing new water supply facilities or planned projects, sites categorized as Kebele and not as small towns, and sites difficult to access with heavy equipment were identified for exclusion. Therefore after discussion with the implementation agency, new candidate small towns were listed, and then the 11 small towns shown in the following table were selected as target sites with consideration for construction term and budget. In addition, before commencement of social and natural condition surveys, current water supply conditions in 11 small towns were confirmed.

Table 1-2: Target site for the study

No.	Zone	Woreda	Small town	Remarks
1	Gurage	Mareqo	Koshe	
2		Sodo	Kela	
3			Tiya	
4	Kembata Timbaro	Kedia Gamela	Adilo	Same as request
5	Sidama	Dara	Teferi Kela	Same as request
6	Silite	Dalocha	Dalocha	
7		Lanifaro	Mito	
8			Tora	Same as request
9		Sankura	Alem Gebeya	
10		Siliti	Kibet	
11	Wolayita	Humbo	Tebela	Same as request

The contents of this Project are construction of water supply facilities and technical support of operation and maintenance for water supply facilities to Water Management Organizations (WMO) and implementation agencies. The sustainable supply of safe water to targeted small towns and improvement of capacity of operation and maintenance for water supply facilities are expected by this Project. The scope of Project is construction of water supply facilities with public faucets and enhancement capacity of operation and maintenance of WMOs and Woreda Offices by soft component. In addition, this Project is part of the Universal Action Plan (UAP).

1-2 Natural Conditions

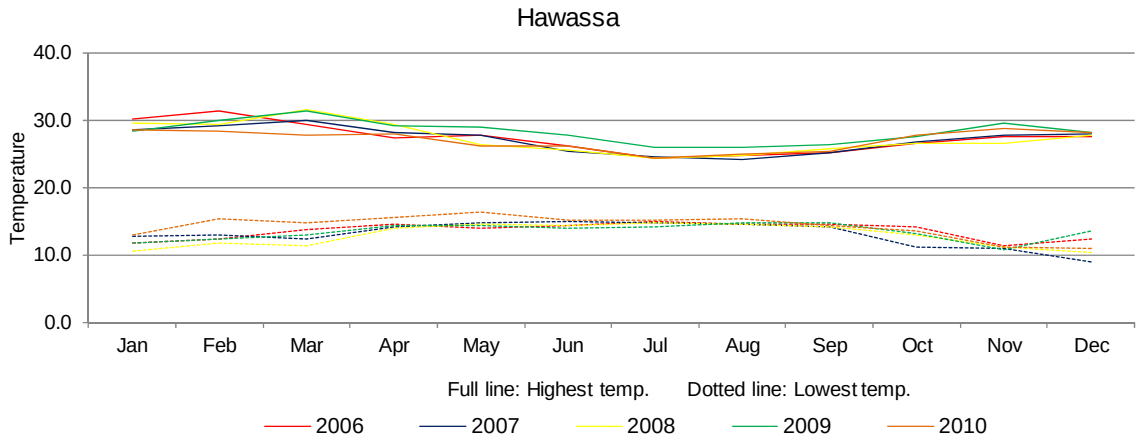
(1) Landscape

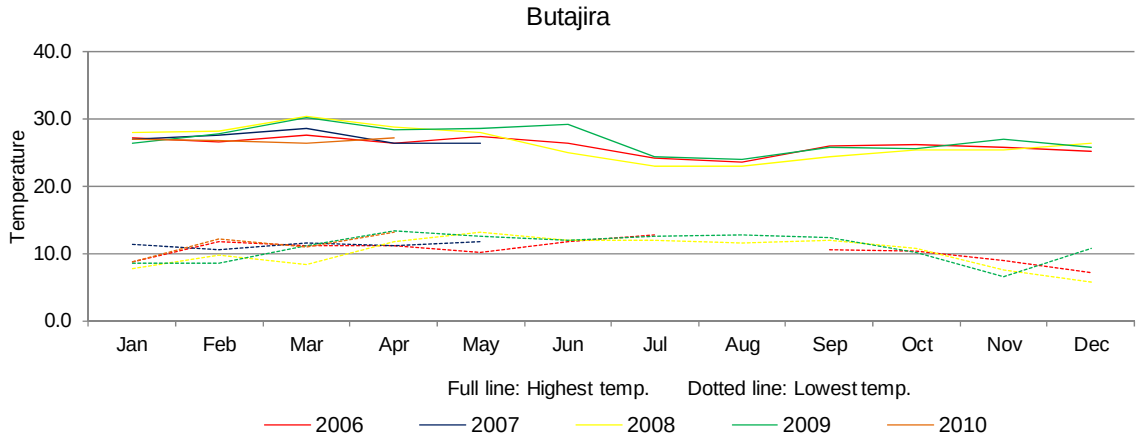
Southern Nations, Nationalities and People's Regional State is located in the southern part of Ethiopia, and neighbors Gambela Region to the northwest, Oromia Region to the north and east, the Republic of Kenya to the south and the Republic of South Sudan to the west. Targeted study area is located about 190km south of Addis Ababa of capital city, and is located in low country separated by a rift formation. This area is called Rift Valley Basin Area because it forms an independent hydrographic basin.

(2) Climate

Average temperature over the 5-year period from 2006 to 2010 at the regional capital Hawassa and the major town of Butajira are shown in Table 1-3. Highest temperature is 27.4°C, lowest is 13.4°C at Hawassa, and highest is 26.5°C, lowest is 10.4°C at Butajira. Climate of SNNPRS is categorized into a minor rainy season from February to May, a rainy season from June to September, and a dry season from October to January. Temperature decreases as altitude increases, and rainfall amount also increases with altitude. Average temperature is high from February to June (minor rainy season and rainy season) and low from October to November (dry season).

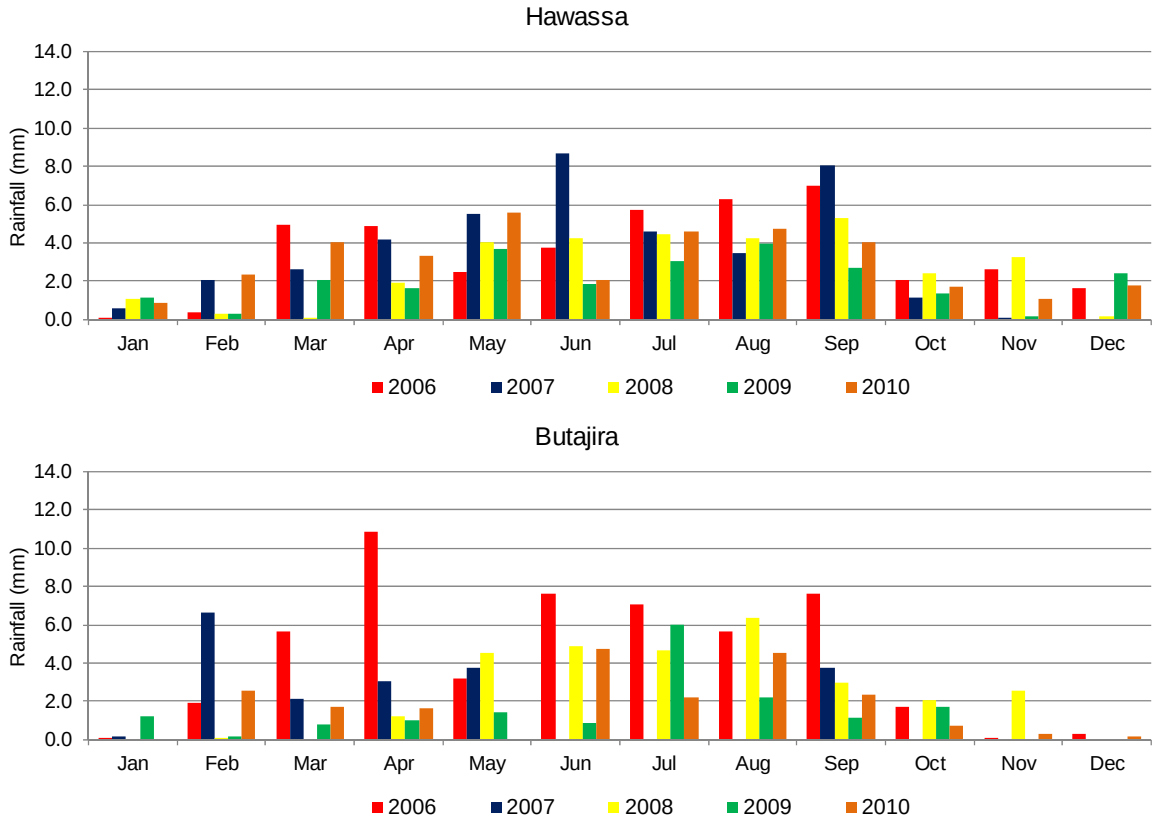
Table 1-3: Average temperature from 2006 to 2010





Rainfall statistics over the 5-year period from 2006 to 2010 is 1,002.6 mm/year at Hawassa and 832.4 mm/year at Butajira shown in Table 1-4, rain concentrates on April to September (small rainy season and rainy season).

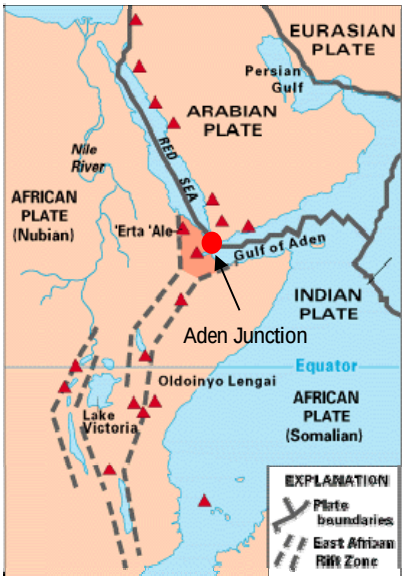
Table 1-4: Rainfall amount from 2006 to 2010



(3) Physiography

The study area is within the African Rift. The African Rift runs from Aden Junction and continues in a SW-SSW traverse longitudinally through eastern African countries such as the Republic of Djibouti, the State of Eritrea, the Republic of Kenya, the Republic of Uganda and the Republic of Tanzania.

Generally the valley is characterized by the geological occurrence of active faults, active volcanoes and hot springs, which indicates it is a geothermal area. Geophysical and petrological data show lithosphere is thinning by intrusion of hot mantle below the valley. The valley is considered to be a separation boundary of the African Plate. The eastern plate is called the Somalian Plate and the western the Nubian Plate. The two plates are separating at a speed of 5 mm/year (Stamps et al, 2008).



Source: http://people.dbq.edu/faculty/deasley/Essays/EastAfricanRift.html

Figure 1-1: Distribution of African Rift Valley

(4) Regional Geological Setting

The study area belongs to central-southern part of the Main Ethiopian Rift (MER). MER developed over a span from the Oligocene to the Quaternary. During that period, major volcanic episodes are

recognized in Oligocene, middle Miocene, late Miocene, early-middle Pleistocene and Holocene (WoldeGabriel et al. 1990).

The oldest volcanic activities are basalt and rhyolite flows in Oligocene, exposed in and around the rift margins (e.g. Blue Nile gorge), which formed lava plateau in the surrounding area. By middle Miocene, the rift was formed in some parts with containment basaltic flows. In Pliocene, a huge pyroclastic flow covered the northern part of study area. This characteristic pyroclastic flow deposit is currently observed at a depth of around 2,100m in the basin floor by geothermal well, indicates a minimum of 2km of downthrown in the rift basin since its eruption (WoldeGabriel et al. 1990).

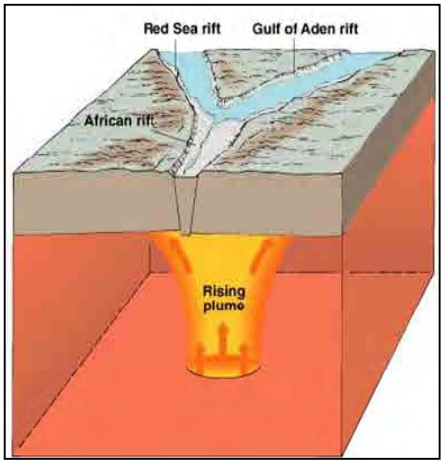
In Pleistocene, Wonji Fault Belt (WFB), which is the main spreading axis of MER, is formed at the rift floor, and floor basalt and rhyolite are erupted along WFB. The volcanic activities are characterized by peralkaline fissure basaltic eruptions and rhyolitic eruptions which make volcanoes and calderas. MER was formed as symmetrical depression zone in this period and many lakes appeared and disappeared by obstruction of volcanic deposit and/or climate change.

(5) Regional tectonic setting

The MER was created by a complex of NE-SW trending system of tensional faults, cut by a more recent system of NNE-SSW trending faults known as the Wonji Fault Belt.

The rift starts with the Afar Depression in the north, and continues as symmetrical grabens in the center. The continuation of the rift is distinctive near the border between Ethiopia and Republic of Kenya, were small asymmetrical basins are formed instead, and finally the rift is connected to the Kenya Rift which has a direction of N-S.

The initial stage of MER formation is closely related to that of the Red Sea and Aden Sea. In Mesozoic time, north-central MER was bulged. That is deduced by the existence of thick Mesozoic sediments in Kella horst (North of Butajira) and the Blue Nile gorge.



Source: http://www3.interscience.wiley.com:8100/legacy/college/levin/0470000201/chap_tutorial/ch07/chapter07-1.html

Figure 1-2: Schematic diagram

In Oligocene, large and huge volcanic activity created a lava plateau. In early Miocene, three radial rifts might have been formed in the plateau. After that, two rifts spread open and were downthrown to the sea, which became the Red Sea and Aden Sea. Another rift, which was not spread well, became the MER. Such kind of tectonic activity is considered to have occurred in the initial stage when the continent started splitting, and caused by rising of hot plume from the mantle. Structural and stratigraphic relations of volcanic rocks along both rift escarpments of MER indicate a two-stage rift development. The early phase started during late Oligocene-early Miocene and was characterized by a series of alternating and opposed half grabens. The half-grabens evolved into a symmetrical rift during the late Miocene. The area also was characterized by active rifting during Plio-Pleistocene, around 2,000m of subsidence was estimated (WoldeGabriel et al, 1990, WoldeGabriel et al, 2000).

1-3 Result of Field Survey

1-3-1 Geophysical Prospecting

(1) Objectives

In the target 10 small towns where water supply plans utilizing groundwater are to be designed (Dalocha is designed by utilizing an existing spring), geophysical prospecting was carried out in order to select the point and depth of test well drilling.

(2) Methods

Geophysical prospecting was conducted by a local contractor. Number, depth and point of survey were determined based on collection and analysis of existing data, interview on geological condition to hydrogeological engineer of implementation agency and classifying lithofacies properly In order to create a cross-sectional view of a plurality of directions, Horizontal Electrical Prospecting (HEP) was carried out first and rough indication of the investigation point was made, vertical electrical sounding (VES) was carried out.

The average depth of test well drilling was 150m; therefore the depth for geophysical prospecting was set as 200m. Discussions were held with hydrogeologist of SNNPRB before the geophysical prospecting to ensure it would be implemented with due regard to the actual natural conditions.

(3) Results

Geophysical prospecting was carried out at 240 points, and the results were utilized for deciding on the location and depth of test well drilling points.

Table 1-5: Result of geophysical prospecting

Small town	Priority	Area	UTM		Expected aquuifer (m)	Expected drilling depth (m)
			E	N		
Koshe	1	South	447458	886442	30-40	300
	2	South	447215	886262	30-40	300
Kela	1	South	444228	911393	40-50	150
	2	North	444906	911931	40-50	150
Tiya	1	North	456148	931758	60-100	200
	2	South	457376	931153	60-100	200
Adilo	1	North	388581	797812	80-90	200
	2	West	387406	796573	80-90	200
Teferl Kela	1	South	433699	718162	15-20	200
	2	North	433128	718853	15-20	200
Mito	1	North	428396	849238	70-90	150
	2	South	428297	848715	70-90	150
Tora	1	South	436407	866097	40-90	250
	2	North	435460	869224	90-120	250
Alem Gebeya	1	South	408329	835572	30-40	150
	2	North	409636	837853	30-40	150
Kibet	1	North	427039	888093	10-30	300
	2	North	426997	888415	10-30	250
Tebela	1	West	363147	740684	30-60	200
	2	South	364768	739821	30-60	200

1-3-1-2 Test Well Drilling

(1) Objectives

In the target 10 small towns where water supply plans utilizing groundwater are to be designed, test well drilling was conducted with consideration of conversion to production wells if it was evaluated as having sufficient quantity and quality of water for groundwater development under Ethiopian Standards.

(2) Methods

Test well drilling was conducted by a local contractor. Non-resistance sectional view suggested hydrogeological conditions was created based on the result of geophysical prospecting mentioned above, then drilling points were selected with consideration of the following conditions.

- To be existed target aquifer to fetch water by the development planning depth (shallower than 200m)
- To be accessible by heavy equipment such as drilling rigs
- To be secured sufficient work spaces for drilling
- To be less possibility to occur the problem against land use and drilling works with local residents
- To be located drilling points not to interfere existing wells by water pumping

Average drilling depth was 150m, then casing diameter was selected 8" with consideration of installation for submersible pump which has large outer diameter because assumption of poor ground water existence. Materials of casing and screen were selected steel, and then open ratio of screen was more than 5% with consideration of effective water intake. Structure of test well is shown in Figure 1-3.

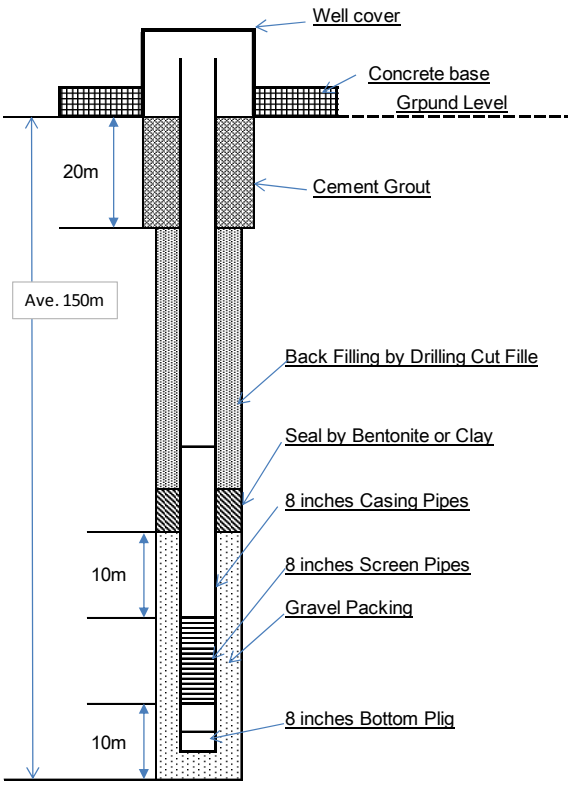


Figure 1-3: Structure of test well (Standard)

Drilling method was selected mud water circulation drilling method at soft rock layer, down the hole hummer (DTH) drilling method or air pressure drilling method at hard rock layer and lithology layer with many cavities with consideration of condition of lithology and capacity of local contractors. To ensure the success of drilling, effort was made to secure enough materials and equipment at drilling sites, to conduct prompt measures in case of a collapse in the hole, to install work casings to protect the surface disintegrative hole wall. Sample (shaving by drilling) was collected at each 1m, drilling operation was conducted by Japanese expert with confirmation of geology conditions. At the well which confirmed existence of groundwater, well logging was conducted promptly after drilling, screen position was decided based on the results of observation of collected samples and evaluation of hydrogeological condition around the drilling point.

Test well drilling was conducted at least 1 well. In case the first test well was unsuccessful, whether to drill a second test well in the same small town was judged based on the result of first test well drilling and in consideration of summary of terrain (interpretation of lineament) and study of existing data. In addition, the criteria for evaluating whether a well is successful or not were cases of no groundwater (dry hole) and case whereby the water yield was less than 2 L/s with consideration of intake efficiency and cost-effectiveness, etc.

(3) Results

The result of test well drilling is shown in Table 1-6. At the 12 wells that were evaluated as successful, the wells which evaluated having sufficient quantity and quality of water by pumping test and water quality analysis will be converted to production wells.

Table 1-6: Result of test well drilling

Small town	No.	Drilling method	Drilling depth (m)	Total casing length (m)	Total screen length (m)	Result
Koshe	#1	Mud	200.00	164.00	36.00	Success
Kela	#1	Mud	99.00	81.00	18.00	Success
	#2	Mud	100.00	76.00	24.00	Success
Tiya	#1	DTH	180.00	150.00	30.00	Success
	#2	DTH	180.00	Dry Well		Failure
Adilo	#1	Mud/DTH	244.00	226.00	18.00	Success
	#2	DTH	260.00	230.00	30.00	Success
Teferi Kela	#1	Mud	120.00	96.00	24.00	Success
	#2	Mud/DTH	168.00	136.00	30.00	Success
Mito	#1	Mud	101.00	83.00	18.00	Success
Tora	#1	Mud/DTH	222.00	Dry Well		Failure
	#2	DTH	250.00	Dry Well		Failure
Alem Gebeya	#1	Mud	176.00	152.00	24.00	Success
	#2	Mud	120.00	96.00	24.00	Failure
Kibet	#1	Mud/DTH	147.00	123.00	24.00	Success
	#2	Mud	177.00	Dry Well		Failure
Tebela	#1	DTH	86.00	68.00	18.00	Success
Total			2,830.00	1,681.00	318.00	

Successful ratio of test well drilling was 70.6% because 5 points (Tiya #2, Tora #1 & #2, Alem

Gebeya #2 and Kibet #2) were evaluated as unsuccessful. The reasons to be evaluated as unsuccessful are as follows.

a. Tiya #2

- Drilling site is located about 1 km south from existing wells, in the gentle slope of south of the small town. The catchment area behind the aquifer is small, small river is flowing down along the northeast-southwest direction of lineament.
- Since the drilling site is located slightly lower than the existing wells (depth 184m), if aquifer of test well is the same aquifer with existing wells, test well should have already reached the expected depth, however, groundwater was not confirmed. In addition, the amount of water from the aquifer of existing wells is 1.2 L/s, which is not so much.
- Basalt that is considered as a good aquifer compared with Anchor Basalt has been confirmed at a depth of 40 to 80m. Volcanic gravel has been confirmed at a depth of 80 to 140 m. Ignimbrite that are considered aquifer of existing wells has been confirmed at a depth of 140 to 180m. Ignimbrite is considered a good aquifer in Rift Valley region, but the development of cracks is moderate, and groundwater could not be confirmed.
- From the results of geophysical survey, the value of resistivity in the vicinity of 160 to 180m depth (unstable resistivity) is confirmed. The team determined that is the cracks of Ignimbrite, however, groundwater could not be confirmed. In the depth of 180m or more, unstable resistivity of the specific resistance value is not observed. Therefore, it was determined that the possibility of groundwater is low.

Therefore, Tiya # 2 is determined as dry well at the time that was drilled to 180m.

b. Tora #1

- Drilling site is located in the gentle slope of the south of the small town on the plateau. It has been assumed that the catchment area behind the aquifer is small, or bedrock zone is shallow.
- Since drilling site is located about 30 to 40m higher elevation than the existing wells (depth 251m), if aquifer of test well is the same aquifer with existing wells, test well should be drilled to about 300m. However, the amount of water of existing wells is 3.2 L/s, it is not so much.
- Pyroclastic deposits – which included a 2 to 4m layer of weathered gravel and volcanic sand – were found at a depth near 100m, for. This was considered as a target water source, but sufficient water was not obtained. Also 200m or deeper was assumed that the dense tuff is continuous to a significant depth.

Therefore, Tora # 1 is determined as dry well at the time that was drilled to 222m.

c. Tora #2

- Drilling site is located about 1 km north from existing wells, in the gentle slope of northwest of the small town. It has been assumed that the catchment area behind the aquifer is small, or bedrock zone is shallow.
- Since drilling site is located at approximately the same elevation as the existing wells (depth 251m),

if aquifer of test well is the same aquifer with existing wells, test well should have already reached the expected depth, however, groundwater was not confirmed.

- From the results of geophysical survey, the same value of specific resistance (100Ω-m) was found at a depth of 200 to 400m. From drilling results up to 250m, this specific resistance was determined as gravel layer containing no groundwater.

Therefore, Tora # 2 was determined as the dry well when it was drilled to 250m.

In addition, although both of the two test wells has been determined to be the dry well in Tora, there are no areas in the small town that have the potential of groundwater. Moreover, there is no water source that satisfies the amount of water and water quality in the small town (groundwater or spring water, etc.), and there are no alternative water sources for the project. Therefore, Tora was excluded from the Project.

d. Alem Gebeya #2

- Volcanic gravel layer is distributed at a depth of 40 to 80m, groundwater has been confirmed. Ignimbrite that develop moderate cracks were confirmed at a depth of 86 to 100m. Distribution of gravel layer made of volcanic deposits containing volcanic sand is confirmed to a depth of 86 to 120m, increasing of the groundwater level was observed.
- From the results of geophysical survey, there was a tendency that the specific resistance is high around the depth of 120m, it was determined the possibility of the existence of groundwater is low.

In Alem Gebeya #2, since the groundwater is confirmed at a depth of 120m, drilling was stopped from the reasons described above. However, as a result of simple pumping test, since the pumping discharge was reduced to 0.5 L/s, this test well was determined as dry well from the viewpoint of cost-effectiveness, etc.

e. Kibet #2

- Drilling site is located approximately 2km south of existing well, gentle slope of south of small town. Basalt and Ignimbrite are found along the river around a valid aquifer.
- Since drilling site is located at a slightly higher elevation than the existing wells (depth 119m), if aquifer of test well is the same aquifer with existing wells, test well should have already reached the expected depth, however, groundwater was not confirmed. In addition, the amount of water from the aquifer of existing wells is 3.6 L/s, it is not so much.
- Basalt was confirmed to the depth of 22 to 52m, rhyolite develop moderate cracks were confirmed at a depth of 52 to 100m, the gravel layer made of volcanic deposits containing volcanic sand was confirmed at a depth of 100 to 177m. Despite the basalt and gravel layers are considered good aquifer, groundwater was not confirmed.
- From the results of geophysical survey, the value of resistivity in the vicinity of 150 to 160m depth is determined to be the gravel layer, however, ground water was not confirmed. There is no response of the specific resistance at 180m or deeper, possibility of the presence of groundwater has been determined to be low.

Therefore, Kibet #2 was determined as the dry well when it was drilled to 177m.

1-3-1-3 Pumping Test

(1) Objectives

In order to confirm the amount of water of test wells which groundwater has been confirmed by test well drilling, pumping test was conducted.

(2) Method

Pumping test was included in the contract of test well drilling, it was conducted by the local contractors. In successful wells of the test well drilling, the following four tests were conducted.

a. Preliminary Pumping Test

To determine the pumping discharge in each stage, preliminary pumping test was conducted for four hours or more.

b. Step Drawdown Test

In order to determine the pumping discharge in the continuous pumping test, step drawdown test was conducted. Initially, it was planned to pump each step 2 hours forward five stages and return four steps, but based on the results of preliminary pumping tests, the number of steps for each test was determined based on the following reasons.

- Maximum and minimum pumping discharges are different for each point.
- There is the point where the water level drops more than 30m.
- If a pump is operated at about 40% below its maximum capacity, there is a high possibility that an accident/breakdown will occur because of the increased load on the pump.
- Five or more stages of pumping is not expected at all points

c. Continuous Test

To determine the coefficients of the aquifer, continuous test was conducted. Jacob linear methods and Thies curve method which is generally used was adopted for the analysis. The thickness of the aquifer in the analysis was adopted the total length of the inserted screen.

d. Recovery Test

Recovery test was conducted in order to determine the recovery capability of the well. The test was conducted immediately after the continuous pumping test, the end was set as 97% of the recovery or 12 hours measurement in principle.

(3) Results

Result of the pumping test at 12 places is shown in the following table, the water can be converted to the Project was confirmed in all 12 sites. Therefore, there is no problem that the test wells convert to production wells with regard to the water quantity. Also, In the same 12 points, water quality analysis is carried out, and if sufficient water quality is found for the Project, test well is converted to the production well.

Table 1-7: Result of pumping test

Small town	No.	Drilling depth (m)	Pumping discharge (L/s)	Static water level (m)	Dynamic water level (m)	Assumed pump position (m)
Koshe	#1	200.00	36.50	14.80	33.97	112.00
Kela	#1	99.00	5.20	17.07	42.77	65.00
	#2	100.00	5.00	5.97	52.83	60.00
Tiya	#1	180.00	2.00	69.50	123.10	150.00
Adilo	#1	244.00	5.00	193.80	194.40	216.00
	#2	260.00	5.00	197.70	198.00	220.00
Teferi Kela	#1	120.00	5.00	11.28	47.57	68.00
	#2	168.00	4.00	16.60	99.90	130.00
Mito	#1	101.00	14.28	29.30	36.34	60.00
Alem Gebeya	#1	176.00	9.70	110.80	122.10	155.00
Kibet	#1	147.00	13.10	78.00	87.00	118.00
Tebela	#1	86.00	35.57	11.08	34.45	60.00

1-3-1-4 Existing Water Source survey

Nine small towns out of eleven (Koshe, Kela, Tiya, Adilo, Teferi Kela, Mito, Tora, Alem Gebeya, Kibet) are using the groundwater, while the other two small towns (Dalocha, Tebela) are using the spring water as water source. In Dalocha, it was confirmed that current amount of spring water can cover the required amount of water in the Project in 2020 as target year. Therefore, in the Dalocha, new water source was not developed by test well drilling, water supply plan was considered to utilize the existing water source. Other 10 small towns, because it is impossible to secure the necessary amount of water only by the existing water sources, water supply plan was considered by developing the groundwater.

In addition, water quality testing of existing water sources result, in the three small towns (Koshe, Tora, Alem Gebeya), the value of the fluorine had exceeded the WHO standard (1.5 mg/L), however, it was under the Ethiopian Standard (3.0 mg/L).

Table 1-8: Existing water source in 11 small towns

Small town	Groundwater			Spring, others	
	Quantity (8 hours/day)		Quality (Fluorine)	Quantity	Quality (Fluorine)
	L/s	m^3/day	mg/L	m^3/day	mg/L
Koshe	8.00 2.00	288.00	1.77 1.24	***	***
Kela	1.70	48.90	0.51	***	***
Tiya	2.00	57.60	0.63	***	***
Adilo	3.90	112.32	0.65	***	***
Teferi Kela	6.00	172.80	0.86	***	***
Dalocha	***	***	***	691.20	1.45
Mito	1.60	46.08	0.74	***	***
Tora	7.00 2.00	259.20	1.64 1.63	***	***
Alem Gebeya	2.05	59.04	1.63	***	***
Kibet	3.60 3.20	195.84	0.59 0.63	***	***
Tebela	***	***	***	397.40	0.52

Note: Red-letters of water quality means the value exceeds the value of WHO guideline (1.5mg/L)

1-3-2 Water Quality Analysis

(1) Objectives

Water quality analysis was conducted in order to check the groundwater quality of well drilled by test well drilling for drinking. In addition, water quality analysis was carried out not only for the new water sources developed in test well drilling, but also for every existing groundwater and spring water, etc. that are currently in use in each of the small towns.

(2) Methods

Water quality analysis was conducted by the local contractors. Water was sampled just before continuous pumping test is completed. In compliance with water quality standards of Ethiopia (Ethiopian Guidelines - Specification for Drinking Water Quality; September 2002), water quality was analyzed in 30 items. Two items (arsenic, E. coli) were measured in the field by the portable instrument, and the other 28 items were measured in the water testing laboratory.

(3) Results

Water quality analysis was conducted at fifteen existing water sources and fourteen test wells; namely at a total of twenty nine locations Among the new water source (test wells), iron in Teferi Kela (Fe), and fluorine (F) in Mito and Alem Gebeya exceeded the WHO standard, but it was within the Ethiopian water quality standards. In addition, fluorine has been retested at two small cities exceeding the WHO standard, both values were within WHO standard. This means, although the initial test exceeded the standard value because the well was not washed enough for sampling water, since the water was stabilized by continuous pumping, good results were achieved when retesting was conducted. Other items did not exceed both WHO and Ethiopian water quality standards. Therefore, there is no problem to convert the test drilling wells to production wells.

Standard value of water quality used in the survey is shown in Table 1-9. Survey results are shown in Table 1-10 and Table 1-11.

Table 1-9: Water quality standard value

Inspection item		WHO guideline		Ethiopian Standard		Remarks
		Guideline value	Acceptable value	Harmful substances to health	Level of complaint	
Colour	Colour	***	15 TCU	***	22 TCU	
Odor	Odor	***	***	***	No smell	
Taste	Taste	***	***	***	Offenseless	
Turbidity	Turbidity	***	5 NTU	***	7 NTU	
Total Solids	Total Solids	***	***	***	***	Reference
Total Dissoolved Solid	TDS	***	1000 mg/L	***	1776 mg/L	
Electrical Conductivity	EC	***	***	***	***	Reference
pH	pH	***	6.5-8.5	***	6.5-8.5	
Ammonia	NH3	***	1.5 mg/L	***	2 mg/L	
Sodium	Na	***	200 mg/L	***	358 mg/L	
Potassium	K	***	***	***	***	Reference
Total Hardness	Total Hardness	***	500 mg/L	***	392 mg/L	
Calcium	Ca	***	***	***	***	Reference
Magnesium	Mg	***	***	***	***	Reference
Total Iron	Fe	***	0.3 mg/L	***	0.4 mg/L	
Manganese	Mn	***	0.4 mg/L	0.13 mg/L	***	
Fluoride	F	1.5 mg/L	***	3.0 mg/L	***	
Chloride	Cl	***	250 mg/L	***	533 mg/L	
Nitrite	NO2	3 mg/L	***	6 mg/L	***	
Nitrate	NO3	50 mg/L	***	50 mg/L	***	
Alkalinty	CaCO3	***	***	***	***	Reference
Carbonate	CO3	***	***	***	***	Reference
Bicarbonate	HCO3	***	***	***	***	Reference
Sulphate	SO4	***	250 mg/L	***	483 mg/L	
Phoaphate	PO4	***	***	***	***	Reference
Copper	Cu	2 mg/L	***	5 mg/L	***	
Alminium	Al	***	0.2 mg/L	***	0.4 mg/L	
Chromium	Cr	0.05 mg/L	***	0.1 mg/L	***	
Boron	B	2.4 mg/L	***	0.3 mg/L	***	
Zinc	Zn	***	4 mg/L	***	***	
Arsenic	As	0.01 mg/L	***	0.01 mg/L	***	
Coliform Bacterium	Bacteria	0	***	0	***	

Table 1-10: Result of water quality analysis (Existing water source)

Small Town	Point	Colour (app)	Odor	Taste	Turbidity (NTU)	Total Solids (mg/L)	TDS (mg/L)	EC (µS/cm)	pH	NH3 (mg/L)	Na (mg/L)	K (mg/L)	Total Hardness (mg/L)	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	Mn (mg/L)
WHO guideline		15	***	***	5	***	1000	***	6.5-8.5	1.5	200	***	500	***	***	0.3	0.4
Ethiopian Standard		22	Odourless	Tasteless	7	***	1776	***	6.5-8.5	2	358	***	392	***	***	0.4	0.13
Koshe	Well-1	Colourless	Odourless	Tasteless	0.37	432	420	732	7.48	0.14	136	17	70	20	4.8	0.03	0.03
	Well-2	Colourless	Odourless	Tasteless	Nill	464	460	772	7.08	0.18	113	13.5	170	54.4	8.16	0.03	0.01
Kela	Well	Colourless	Odourless	Tasteless	Nill	386	380	573	6.4	0.19	18.5	4.7	250	81.6	11.04	0.03	0.04
Tiya	Well	Colourless	Odourless	Tasteless	0.37	212	200	354	6.6	0.2	11.5	7.7	160	47.2	10.08	0.05	0.01
Adilo	Well	Colourless	Odourless	Tasteless	0.37	190	180	313	6.95	0.14	32	9.9	92	20	10.08	0.03	0.02
Teferi Kela	Well	Colourless	Odourless	Tasteless	0.37	230	220	381	7.36	0.16	52	3.9	74	18.4	6.72	0.03	0.02
Dalocha	Spring	Colourless	Odourless	Tasteless	0.4	220	210	358	6.83	0.12	49	9.4	62	18.4	3.84	0.03	0.01
Mito	Well	Colourless	Odourless	Tasteless	Nill	278	270	429	7.09	0.19	58	10	126	28	13.44	0.03	0.03
Tora	Well-1	Colourless	Odourless	Tasteless	0.37	612	600	971	7.19	0.15	180	22	130	48	2.4	0.03	0.04
	Well-2	Colourless	Odourless	Tasteless	0.37	628	620	1002	7.48	0.17	166	21	122	46.4	1.44	0.03	0.03
Alem Gebeya	Well	Colourless	Odourless	Tasteless	0.4	408	400	640	7.82	0.15	105	13	136	44	6.24	0.03	0.04
Kibet	Well-1	Colourless	Odourless	Tasteless	0.37	316	300	486	6.5	0.15	41	10.1	176	62.4	4.8	0.03	0.03
	Well-2	Colourless	Odourless	Tasteless	Nill	266	260	455	6.65	0.19	33.5	9.3	166	49.6	10.08	0.04	0.01
Lake Hare Shetan	Lake	Colourless	Odourless	Tasteless	0.73	300	280	438	8.56	0.19	47	12	150	33.6	15.84	0.04	0.02
Tebela	Spring	Colourless	Odourless	Tasteless	0.37	172	160	260	6.9	0.14	15	4.9	104	29.6	7.2	0.03	0.02

Small Town	Point	F (mg/L)	Cl (mg/L)	NO2 (mg/L)	NO3 (mg/L)	CaCO3 (mg/L)	CO3 (mg/L)	HCO3 (mg/L)	SO4 (mg/L)	PO4 (mg/L)	Cu (mg/L)	Al (mg/L)	Cr (mg/L)	B (mg/L)	Zn (mg/L)	As (mg/L)	Bacteria
WHO guideline		1.5	250	3	50	***	***	***	250	***	2	0.2	0.05	2.4	4	0.01	0
Ethiopian Standard		3	533	6	50	***	***	***	483	***	5	0.4	0.1	0.3	***	0.01	0
Koshe	Well-1	1.77	10.01	0.01	0.57	370	Nil	451.4	3.54	–	0.001	0.006	0.002	0.114	Nil	Nil	Low
	Well-2	1.24	16.38	0.02	2.57	378	Nil	461.16	15.06	–	0.006	0.002	0.001	0.007	Nil	Nil	–
Kela	Well	0.51	10.92	0.01	12.42	160	Nil	195.2	133.23	–	0.008	0.002	0.005	0.057	Nil	Nil	Low
Tiya	Well	0.63	5.46	0.01	0.67	184	Nil	224.48	0.33	–	0.006	0.002	0.001	0.107	Nil	Nil	Low
Adilo	Well	0.65	3.64	0.01	0.78	160	Nil	195.2	0.22	–	0.004	0.002	0.006	0.079	Nil	Nil	–
Teferi Kela	Well	0.86	3.64	0.01	0.4	201	Nil	248.88	0.11	–	0.005	0.002	0.002	0.007	Nil	Nil	–
Dalocha	Spring	1.45	5.46	0.02	0.91	180	Nil	219.6	0.22	–	0.002	0.002	0.001	0.086	Nil	Nil	–
Mito	Well	0.74	7.28	0.01	3.31	226	Nil	275.72	0.89	–	0.004	0.002	0.005	0.064	Nil	Nil	Low
Tora	Well-1	1.64	23.66	0.01	1.18	474	Nil	578.28	36.55	–	0.001	0.002	0.004	0.129	Nil	Nil	Low
	Well-2	1.63	28.21	0.02	0.8	456	Nil	556.32	51.94	–	0.005	0.006	0.007	0.15	Nil	Nil	Low
Alem Gebeya	Well	1.63	5.46	0.02	0.44	338	Nil	412.36	0.22	–	0.005	0.002	0.004	0.114	Nil	Nil	Low
Kibet	Well-1	0.59	7.28	0.02	12.25	226	Nil	275.72	4.87	–	0.005	0.002	0.001	0.114	Nil	Nil	Low
	Well-2	0.63	6.37	0.02	6.01	222	Nil	270.84	1.77	–	0.004	0.002	0.006	0.007	Nil	Nil	High
Lake Hare Shetan	Lake	0.55	10.01	0.02	0.46	236	36	214.72	0.29	–	0.005	0.004	0.002	0.007	Nil	Nil	V. High
Tebela	Spring	0.52	2.73	0.01	2.17	138	Nil	168.36	0.22	–	0.001	0.002	0.002	0.1	Nil	Nil	–

* More than the WHO standard, the Ethiopian standard or less More than the the Ethiopian standard

Table 1-11: Result of water quality analysis (Test well drilling)

Small Town	Point	Colour (app)	Odor	Taste	Turbidity (NTU)	Total Solids (mg/L)	TDS (mg/L)	EC (µS/cm)	pH	NH3 (mg/L)	Na (mg/L)	K (mg/L)	Total Hardness (mg/L)	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	Mn (mg/L)
WHO guideline		15	***	***	5	***	1000	***	6.5-8.5	1.5	200	***	500	***	***	0.3	0.4
Ethiopian Standard		22	Odourless	Tasteless	7	***	1776	***	6.5-8.5	2	358	***	392	***	***	0.4	0.13
Koshe	Well-1	Colourless	Odorless	Tasteless	Trace	470.00	460.00	750.00	7.97	1.53	138.00	8.60	70.00	16.80	6.72	0.17	0.06
Kela	Well-1	Colourless	Odorless	Tasteless	Trace	388.00	380.00	570.00	7.12	0.24	21.50	7.00	264.00	84.00	12.96	0.10	Trace
	Well-2	Colourless	Odorless	Tasteless	Trace	288.00	280.00	422.00	6.57	0.16	33.00	5.50	164.00	47.20	11.04	0.07	0.01
Tiya	Well-1	Colourless	Odorless	Tasteless	Trace	244.00	240.00	398.00	7.60	0.29	25.00	7.90	172.00	44.00	14.88	0.07	0.03
Adilo	Well-1	Colourless	Odorless	Tasteless	Trace	196.00	186.00	289.00	6.72	0.15	33.50	9.80	86.00	23.20	6.72	0.06	Trace
	Well-2	Colourless	Odorless	Tasteless	Trace	198.00	190.00	295.00	6.75	0.21	36.50	10.10	92.00	24.00	7.68	0.11	Trace
Teferi Kela	Well-1	Colourless	Odorless	Tasteless	2.92	216.00	200.00	302.00	6.97	0.16	51.50	8.30	50.00	12.80	4.32	0.32	0.01
	Well-2	Colourless	Odorless	Tasteless	Trace	248.00	240.00	396.00	7.64	0.32	63.00	4.00	66.00	16.80	5.76	0.02	Trace
Mito	Well-1-1	Colourless	Odorless	Tasteless	Trace	272.00	260.00	430.00	7.56	0.15	53.00	10.00	118.00	22.40	14.88	0.04	Trace
	Well-1-2	Colourless	Odorless	Tasteless	Trace	270.00	260.00	420.00	7.33	0.11	46.50	9.60	132.00	33.60	11.52	0.04	0.01
Alem Gebeya	Well-1-1	Colourless	Odorless	Tasteless	Trace	472.00	460.00	706.00	7.10	0.12	109.00	11.90	160.00	45.60	11.04	0.16	0.09
	Well-1-2	Colourless	Odorless	Tasteless	Trace	468.00	460.00	723.00	7.27	0.34	113.00	12.90	160.00	51.20	7.68	0.01	0.00
	Well-1-3	Colourless	Odorless	Tasteless	Trace	490.00	480.00	737.00	7.20	0.32	112.00	16.00	180.00	56.00	9.60	0.07	0.00
Kibet	Well-1	Colourless	Odorless	Tasteless	Trace	312.00	300.00	467.00	6.69	0.21	33.00	8.70	184.00	63.20	6.24	0.02	0.06
Tebela	Well-1	Colourless	Odorless	Tasteless	Trace	216.00	210.00	352.00	6.88	0.14	35.50	8.90	108.00	27.20	9.60	0.03	Trace

Small Town	Point	F (mg/L)	Cl (mg/L)	NO2 (mg/L)	NO3 (mg/L)	CaCO3 (mg/L)	CO3 (mg/L)	HCO3 (mg/L)	SO4 (mg/L)	PO4 (mg/L)	Cu (mg/L)	Al (mg/L)	Cr (mg/L)	B (mg/L)	Zn (mg/L)	As (mg/L)	Bacteria
WHO guideline		1.5	250	3	50	***	***	***	250	***	2	0.2	0.05	2.4	4	0.01	0
Ethiopian Standard		3	533	6	50	***	***	***	483	***	5	0.4	0.1	0.3	***	0.01	0
Koshe	Well-1	1.14	5.46	Trace	0.08	410.00	Nil	500.20	0.33	0.49	Trace	0.012	0.002	0.063	–	Nil	–
Kela	Well-1	0.61	3.64	Trace	1.73	212.00	Nil	258.64	114.90	–	0.033	Trace	0.001	0.065	–	Nil	–
	Well-2	1.06	7.28	0.02	1.01	180.00	Nil	219.60	44.54	0.24	0.020	0.008	0.006	0.006	–	Nil	–
Tiya	Well-1	0.86	6.37	0.04	0.74	214.00	Nil	261.08	0.22	–	0.005	0.008	Trace	0.072	–	Nil	–
Adilo	Well-1	0.71	8.19	0.01	0.36	150.00	Nil	183.00	0.19	0.65	0.013	0.014	0.007	0.042	–	Nil	–
	Well-2	0.70	6.37	0.01	0.42	156.00	Nil	190.32	0.19	0.27	0.020	0.018	0.009	0.004	–	Nil	–
Teferi Kela	Well-1	0.70	5.46	0.13	4.66	158.00	Nil	192.76	0.78	0.26	0.050	Trace	0.011	Trace	–	Nil	–
	Well-2	1.38	10.01	0.01	0.45	198.00	Nil	241.56	0.33	0.19	0.040	0.002	Trace	0.119	–	Nil	–
Mito	Well-1-1	1.96	7.28	0.02	4.14	214.00	Nil	261.08	0.33	0.26	0.007	Trace	Trace	0.240	–	Nil	–
	Well-1-2	1.12	4.55	0.01	3.07	210.00	Nil	256.20	0.22	0.17	0.026	0.006	0.007	0.051	–	Nil	–
Alem Gebeya	Well-1-1	2.04	5.46	0.05	0.25	384.00	Nil	468.48	0.44	0.12	0.040	0.010	0.004	0.025	–	Nil	–
	Well-1-2	1.57	5.46	0.01	1.17	386.00	Nil	470.92	0.19	0.27	0.033	0.006	Trace	0.004	0.128	Nil	–
	Well-1-3	1.36	6.37	0.09	2.33	390.00	Nil	475.80	0.19	0.21	0.013	0.014	Trace	0.003	0.115	Nil	–
Kibet	Well-1	0.58	6.37	0.06	19.12	230.00	Nil	280.60	2.77	0.19	0.020	Trace	0.010	0.233	–	Nil	–
Tebela	Well-1	0.58	3.64	0.02	0.74	180.00	Nil	219.60	0.22	0.22	Trace	0.002	0.001	0.120	–	Nil	–

* More than the WHO standard, the Ethiopian standard or less More than the the Ethiopian standard

1-3-3 Exploration of Ground

(1) Objectives

Exploration of ground has been carried out to determine whether the ground can withstand the load of the structure. Since investigation point is the planned construction site for reservoir and collection chamber, in the position not to build a new structure was not conducted the exploration of ground.

(2) Methods

Exploration of ground was conducted by the local contractors. In planned construction site of the structure of each of the small towns consultant has indicated, standard penetration test has been carried out and laboratory test was performed by taking samples of the soil. In laboratory tests, uniaxial compression test, pH, chloride content and sulfate content was confirmed.

(3) Results

The results of the survey found no places had problems with the ground. And it was confirmed that the ground strength is enough to construct the structure.

1-3-4 Survey Work

(1) Objectives

The survey work was conducted for base data of site decision of water sources, transmission lines, distribution lines and reservoirs in the target small towns. Longitudinal survey was conducted along the route, and topographical survey such as water sources and structures related facilities design has been carried out at the same time to investigate pipe length and vertical interval of envisioned transmission line and distribution line. Moreover, due to time constraint, surveys were conducted in all 11 small towns without waiting for the results of drilling surveys despite the possibility that the drilling survey might determine the well to be unsuccessful and groundwater cannot be extracted, because there is the possibility of using the existing facilities by rehabilitation.

(2) Methods

Survey work was conducted by the local contractors. Longitudinal survey has been conducted at 50 meter intervals, and plane survey around existing facilities has been conducted at the same time. For surveying work in the field, first, longitudinal survey and plane survey of the planned reservoir point to distribution line was conducted. And after the result of the physical exploration and drilling location has been determined, longitudinal survey of transmission from the water source to reservoir has been conducted.

(3) Results

Survey routes that the reservoir, transmission line, distribution line, and public faucets from water source can be laid in the optimum location was determined by following the existing master plan that the SNNPRS has created. In all sites, there are no locations that are difficult to design and construct the

water facilities.

1-3-5 Social Condition Survey

(1) Objective

The objectives of the survey are to obtain the basic data for planning of O/M and management system for water supply facilities and for the assessment of the Project by comprehending circumstantially the actual state of water use in target 11 small towns.

(2) Method

The social conditions survey related to water supply situation was made of interview survey as follows by use of structural questionnaire. The survey was conducted to obtain the information from the administrative level (water supplier's side such as municipalities and water management organizations of 11 small towns) and residential level (user side) and also to comprehend the situation of water disease.

- Interview to administrative organization's representative for comprehending the actual social condition.
- Interview to water management organization for investigating an actual O/M and management system for water supply facilities.
- Interview to medical institution (hospital, clinic) to comprehend hygienic conditions.
- Household survey for obtaining a general information about residents, water usage, willingness to pay for water charge.
- Interview to the residents for investigating actual water use at the public water point.

(3) Results

1) Number of Households

The average number of people per household was calculated by the data of 10 households which were selected randomly. The average number of household in overall target 11 small towns was 5.39 people. Meanwhile, the number of households of each town was the value obtained by dividing the population of each year (2013 and 2020) by the average household size. The population in 2020 was calculated by multiplying the annual population growth rate of 2013 (4.8 %/year).The result is as follows.

Table 1-12: Number of households

Small town	Population		Average household population	Number of household	
	2013	2020		2013	2020
Koshe	9,882	13,721	5.30	1,865	2,589
Kela	5,054	7,017	5.15	981	1,363
Tiya	2,782	3,863	5.05	551	765
Adilo	6,693	9,293	6.53	1,025	1,423
Teferi Kela	4,778	6,634	5.45	877	1,217
Dalocha	9,756	13,546	5.78	1,688	2,344
Mito	4,711	6,541	4.37	1,078	1,497
Tora	13,165	18,279	5.35	2,461	3,417
Alem Gebeya	5,251	7,291	5.13	1,024	1,421
Kibet	8,155	11,323	5.72	1,426	1,980
Tebela	8,973	12,459	5.45	1,646	2,286
Total	79,200	109,967	5.39	14,622	20,302

2) Major Works

According to the government printed publication “Household Income, Consumption and Expenditure (HICE) 2004/2005 by CSA”, 82.7% of SNNPRS’s people are occupied in family based agriculture, hunting or fishing. The major agricultural and livestock products in 11 target small towns are maize, cereal, teff, coffee, cows, sheeps, goats and chickens. And more than 40% of workers are engaged in agriculture. Men have a high percentage who is engaged in agriculture, livestock and day labor. On the other hand, main activities of women are traditional alcohol sales, retail trade and cafeteria work.

3) Household Income

According to the forgoing HICE 2004/2005 from CSA, the average annual gross expenditure per person in SNNPRS was 1,589.84 Birr. No.1 spending item is "food and beverage", which accounts for about half of the total expenditure, the second place is "water and fuel" which accounts for one-fifth of the total expenditure.

The survey was conducted by randomly selecting ten (10) households, and interviewing them about their household income with the consideration of value of HICE 2004/5. As a result, the average annual income per household was 11,362 Birr. 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). From this point of view, it is close to the average value of SNNPRS if the average annual expenditure is taken as the average annual income (2,107.97 Birr) per person of the target small towns.

Table 1-13: Household income

Unit: Birr

Small town	Annual household income (Disposable income)			Monthly income
	Maximum	Minimum	Average	Average
Koshe	32,256	3,408	8,312	693
Kela	20,400	1,560	10,757	896
Tiya	26,400	525	12,997	1,083
Adilo	20,500	4,600	10,790	899
Teferi Kela	22,200	5,500	13,391	1,116
Dalocha	22,400	800	8,873	739
Mito	40,560	2,400	14,901	1,242
Tora	33,600	3,140	9,704	809
Alem Gebeya	27,600	6,500	16,243	1,354
Kibet	22,800	400	9,716	810
Tebela	54,000	2,490	9,300	775
Average per household	***	***	11,362	947

4) Sharing of Roles of Fetching Water

Ratio of male to female of sharing of roles of fetching water in the household is 65.1% of women against 30.3% of men, the percentage of women is large. In addition, 64.9% are adults, but 30.5% are children (both boys and girls) under 15 years old. On the other hand, there are some households who buy water without having to fetch it. Especially Teferi Kela relies a lot on the purchase of water because the existing water supply facilities are small compared to other small towns.

Table 1-14: Sharing of roles of fetching water

Small town	Male			Female			Buy the water
	Adult	Young	Total	Adult	Young	Total	
Koshe	27.8%	11.1%	38.9%	38.9%	22.2%	61.1%	0.0%
Kela	15.0%	5.0%	20.0%	50.0%	25.0%	75.0%	5.0%
Tiya	15.8%	15.8%	31.6%	47.4%	21.1%	68.4%	0.0%
Adilo	17.6%	5.9%	23.5%	52.9%	23.5%	76.5%	0.0%
Teferi Kela	6.3%	18.8%	25.0%	18.8%	18.8%	37.5%	37.5%
Dalocha	25.0%	0.0%	25.0%	66.7%	8.3%	75.0%	0.0%
Mito	23.1%	23.1%	46.2%	23.1%	23.1%	46.2%	7.7%
Tora	14.3%	14.3%	28.6%	57.1%	14.3%	71.4%	0.0%
Alem Gebeya	18.2%	0.0%	18.2%	81.8%	0.0%	81.8%	0.0%
Kibet	17.4%	17.4%	34.8%	39.1%	26.1%	65.2%	0.0%
Tebela	26.3%	15.8%	42.1%	31.6%	26.3%	57.9%	0.0%
Sex ratio	***	Male	30.3%	***	Female	65.1%	4.6%
Age ratio	***	Adult	64.9%	***	Young	30.5%	4.6%

5) Circumstance of Employment

As employment rate in households, 90.3% of men and 50.8% of women are working. There are also households where women are supporting the household income. The main employment of men is agriculture, civil engineering work or day labor work like common labor. Meanwhile the women's work is agriculture or light work such as sales of vegetables and livestock. The reason for the low employment rate of women is conceivable that there are fewer jobs for women in rural small towns. In addition,

women who do not have a job do the cooking, cleaning and laundry in the home, fetch water, and raise their children.

Table 1-15: Employment rate

Small town	Male	Female
Koshe	90.0%	40.0%
Kela	90.9%	36.4%
Tiya	72.7%	72.7%
Adilo	90.0%	40.0%
Teferi Kela	90.0%	50.0%
Dalocha	90.0%	70.0%
Mito	90.0%	60.0%
Tora	100.0%	30.0%
Alem Gebeya	100.0%	40.0%
Kibet	90.0%	60.0%
Tebela	90.0%	60.0%
Average	90.3%	50.8%

6) Residents' Water Utilization

Public faucets and private connections are in place in 10 small towns with the exception of Tiya. However, in addition to public faucets and private connections, many households are using more than one water source such as buying commercial water and using rainwater, fetching water from rivers or ponds. Therefore, it is difficult to grasp the use state of the public faucets and private connections from interview data. Therefore, the water supply amounts by the public faucets and private connections were calculated based on the amounts of revenue from water rate listed in accounting book administered by the water management organization of the small town.

a. Current condition of water utilization of public faucets

In collection amount of Water tariffs (past 3 years) based on account book, with regard to setting the water supply amounts, it is calculated by dividing a highest monthly revenue of Water tariffs using the public faucets by unit water price fixed by each small town.

Table 1-16: Water supply amounts of public faucets

Small town	Public faucets		
	Water income*1	Unit price*2	Supplied amount
	Birr/month	Birr/m^3	m^3/month
Koshe	3,659.25	7.50	487.90
Kela	1,317.90	10.00	131.79
Tiya	8,000.00	15.00	533.33
Adilo	24,282.00	20.00	1,214.10
Teferi Kela	2,263.59	10.00	226.36
Dalocha	8,079.99	12.50	646.40
Mito	5,958.33	7.50	794.44
Tora	22,610.42	25.00	904.42
Alem Gebeya	9,425.00	7.50	1,256.67
Kibet	4,257.98	7.50	567.73
Tebela	2,041.67	10.00	204.17

*1 Record of ledger of each water management organization

*2 Unit price per 20L (1 Jeri can) has been converted per cubic meters

b. Current condition of water utilization of private connection

In the 10 small towns with the exception of Tiya, all households are receiving water supply and have connected, at their own expense, to the tertiary piping and installed water meters. In the same way as the water supply amounts were calculated for the public faucets, the water supply amounts of private connections were calculated by dividing the highest monthly revenue water charge of each household faucets by the unit price of each small town.

Table 1-17: Water supply amounts of private connection

Small town	Private connection		
	Water income*	Unit price	Supplied amount
	Birr/month	Birr/m^3	m^3/month
Koshe	16,903.50	5.00	3,380.70
Kela	14,795.00	7.00	2,113.57
Tiya	***	***	***
Adilo	14,346.00	18.00	797.00
Teferi Kela	5,999.00	4.00	1,499.75
Dalocha	14,073.00	4.50	3,127.33
Mito	20,665.57	7.50	2,755.41
Tora	49,073.67	12.00	4,089.47
Alem Gebeya	10,461.67	5.00	2,092.33
Kibet	22,172.67	3.50	6,335.05
Tebela	9,000.00	2.00	4,500.00

* Record of ledger of each water management organization

c. Current condition of water consumption

Current water consumption per person calculated from the above analysis is shown in Table 1-18.

Table 1-18: Current condition of water consumption

Small town	Supplied amount					Population (2013)	Current water usage per capita
	Public faucets		Private connection		Total		
	m^3/month	m^3/day	m^3/month	m^3/day	m^3/day	capita	L/capita/day
Koshe	487.90	16.26	3,380.70	112.69	128.95	9,882	13.05
Kela	131.79	4.39	2,113.57	70.45	74.84	5,054	14.81
Tiya	533.33	17.78	***	***	17.78	2,782	6.39
Adilo	1,214.10	40.47	797.00	26.57	67.04	6,693	10.02
Teferi Kela	226.36	7.55	1,499.75	49.99	57.54	4,778	12.04
Dalocha	646.40	21.55	3,127.33	104.24	125.79	9,756	12.89
Mito	794.44	26.48	2,755.41	91.85	118.33	4,711	25.12
Tora	904.42	30.15	4,089.47	136.32	166.47	13,165	12.64
Alem Gebeya	1,256.67	41.89	2,092.33	69.74	111.63	5,251	21.26
Kibet	567.73	18.92	6,335.05	211.17	230.09	8,155	28.21
Tebela	204.17	6.81	4,500.00	150.00	156.81	8,973	17.48

7) Expenditure of Water Tariffs

Current expenditure of Water tariffs per household in each town was calculated by dividing total amount of income from public faucets and private connection by number of households in each town.

Table 1-19: Expenditure of water tariffs per household

Small town	Water income			Number of household			Current water expenditure
	Public faucets	Private connection	Total	Public faucets*1	Private connection*2	Total	
	Birr/month	Birr/month	Birr/month	HH	HH	HH	Birr/HH/month
Koshe	3,659.25	16,903.50	20,562.75	1,408	457	1,865	11.03
Kela	1,317.90	14,795.00	16,112.90	528	453	981	16.42
Tiya	8,000.00	***	8,000.00	551	0	551	14.52
Adilo	24,282.00	14,346.00	38,628.00	884	141	1,025	37.69
Teferi Kela	2,263.59	5,999.00	8,262.59	730	147	877	9.42
Dalocha	8,079.99	14,073.00	22,152.99	1,217	471	1,688	13.12
Mito	5,958.33	20,665.57	26,623.90	717	361	1,078	24.70
Tora	22,610.42	49,073.67	71,684.09	1,683	778	2,461	29.13
Alem Gebeya	9,425.00	10,461.67	19,886.67	744	280	1,024	19.42
Kibet	4,257.98	22,172.67	26,430.65	401	1,025	1,426	18.53
Tebela	2,041.67	9,000.00	11,041.67	296	1,350	1,646	6.71

*1 Number of HH that are calculated to take number of HH of private connection from total number of HH

*2 Number of HH that are registered in water management organization in August 2014

8) Willingness to pay for Water tariffs

Payment for using public faucets is per Jerry can (20L) as defined by each small town (water management organization) and is paid each time. On the other hand, in the case of private connection, the water meter installed in each user household is measured monthly, is employed a method to pay the water management organization monthly on the basis of the measured value.

As a result of household surveys, it was confirmed that residents want to pay monthly the amount shown on their water meter as a payment method used when a new water supply facilities with pubic faucet have been introduced. Willingness to pay per household in water usage of current situation is as shown in Table 1-20.

Table 1-20: Preference of the method of pay by residents

Small town	Number of sampling H.H	Time of payments		Mode of payment	
		Monthly*1	PAYG*2	Meterd rate*3	Flat rate pricing
Koshe	10	100%	0%	100%	0%
Kela	12	100%	0%	100%	0%
Tiya	11	100%	0%	100%	0%
Adilo	6	100%	0%	100%	0%
Teferi Kela	5	100%	0%	100%	0%
Dalocha	10	100%	0%	100%	0%
Mito	9	100%	0%	100%	0%
Tora	9	100%	0%	100%	0%
Alem Gebeya	9	100%	0%	100%	0%
Kibet	11	100%	0%	100%	0%
Tebela	8	100%	0%	100%	0%
Total	100	***	***	***	***

*1 Pay totally at the end of the month

*2 Pay-as-you-go

*3 Current way of payment (by Jeri can)

Willingness to pay per household in water usage of current situation is as shown in Table 1-21.

Table 1-21: Comparison between the current expenditure and the willingness to pay water tariffs

Small town	Current water usage		Current water expenditure	Intention of water expenditure
	L/c/d	m^3/HH/month	Birr/HH/month	Birr/HH/month
Koshe	13.05	2.07	11.03	52.75
Kela	14.81	2.29	16.42	33.75
Tiya	6.39	0.97	14.52	50.45
Adilo	10.02	1.96	37.69	33.00
Teferi Kela	12.04	1.97	9.42	26.00
Dalocha	12.89	2.24	13.12	38.50
Mito	25.12	3.29	24.70	53.25
Tora	12.64	2.03	29.13	31.00
Alem Gebeya	21.26	3.27	19.42	34.50
Kibet	28.21	4.84	18.53	52.77
Tebela	17.48	2.86	6.71	30.20
Average	15.81	2.53	18.24	39.65

Nine small towns except Adilo, recognize the need to pay more than the current water fee amount so that the residents can continuously use safe water and increase water consumption by improving the current situation. On the other hand, the amount of current water expenditure of Adilo is high even through the current water usage is almost the same as the other small towns. It is caused by the water tariff of Adilo which is fixed higher than the other towns making it more expensive. In the Table 1-21, just the amount of intention of water expenditure of Adilo is less than the current water expenditure, but it is not that the intention of water expenditure of Adilo is notably small in comparison with the other towns. In consideration of current straitened circumstances, it is considered that the modification of water tariff will be revised in Adilo.

9) Available spending Amount for Water Use

According to the World Bank, the target expenditure percentage per household for purchase of water is approx. 4%. On the other hand, the expenditure percentage per household for purchase of water is generally approx. 5% in Sub-Saharan Africa. In this survey, 5% of disposable income was calculated as shown in Table 1-22. As a result, the available spending amounts for water use in all small towns are higher than current expenditure of Water tariffs.

Table 1-22: Available spending amount for water use

Small town	Average monthly income	Current water usage	Current water expenditure	Possible water expenditure (5% of monthly income)
	Birr/HH/month	L/c/d	Birr/HH/month	Birr/HH/month
	a			b=a×5%
Koshe	692.60	13.05	11.03	34.63
Kela	896.40	14.81	16.42	44.82
Tiya	1,083.10	6.39	14.52	54.16
Adilo	899.20	10.02	37.69	44.96
Teferi Kela	1,115.90	12.04	9.42	55.80
Dalocha	739.40	12.89	13.12	36.97
Mito	1,241.80	25.12	24.70	62.09
Tora	808.70	12.64	29.13	40.44
Alem Gebeya	1,353.60	21.26	19.42	67.68
Kibet	809.70	28.21	18.53	40.49
Tebela	775.00	17.48	6.71	38.75
Average	946.9	15.81	18.24	47.34

10) Willingness to accept for Residents' Responsibility

Each administrative organization, WMO and residents at all target towns are confirmed that there is willingness to accept the Project, and willingness to provide labor, budget and construction materials. Meanwhile, planned construction sites in this Project are public land which belongs to the nation, however there is a possibility that the project will have to use land that is rented/leased, namely that someone has land use rights to. However, it was confirmed in a meeting with the heads of municipalities and WMOs that if the project has to use the land that someone holds the right to use, the municipalities intend to appropriate and provide alternative land.

Table 1-23: Willingness of residents to accept their responsibilities

Small town	No. of sampling HH	Acceptance intention	Project participants intention	Provide labor	Funding	Materials purchase	Donation of private land
Koshe	10	100%	100%	100%	90%	10%	0%
Kela	12	100%	100%	100%	83%	0%	0%
Tiya	11	100%	100%	82%	91%	9%	9%
Adilo	10	100%	100%	100%	90%	10%	0%
Teferi Kela	10	100%	90%	90%	100%	30%	0%
Dalocha	10	100%	100%	100%	80%	0%	10%
Mito	10	100%	100%	90%	90%	0%	0%
Tora	10	100%	90%	60%	90%	10%	0%
Alem Gebeya	10	100%	90%	70%	90%	20%	0%
Kibet	11	100%	91%	73%	73%	9%	0%
Tebela	10	100%	100%	100%	90%	0%	0%
Average	***	100%	96%	88%	88%	9%	2%

As shown by Table 1-23 residents were cooperative about the acceptance intention, project participants intention, provide labor and the funding if these do not affect the household budgets. At the same time, the willingness about the materials purchase and donation of private land was not obtained by most of the residents because of the difficulty in assumption of quantity or dimension. However, it was confirmed the intention to donate private land by the residents for the new water supply during the residents meeting at the “Social and Environmental Considerations survey”. And also, it was confirmed the intention of financial support by the municipalities on the discussion with them if the residents cannot defray the heavy financial burden for the construction of stockade fencing, among others.

11) Water-borne Diseases

According to statistical frequency of waterborne diseases in target sites, the frequency is in the order corresponding to typhoid, diarrhea, helminthiasis, dysentery. The water supply facilities are constructed in all small towns, but in fact, the residents living in remote areas away from the center of small towns are utilizing primitive water sources because they could not easily access the water supply facilities. However, households that don’t use the toilet even now so there is a possibility of water pollution of the river and by underground seepage of sewage swamp. The proportion and water-borne diseases and the number of patients per year by data and the result of interview from the health center in each small town are shown in Table 1-24.

Table 1-24: Ratio of water-borne diseases

Unit: person/%

Small town	Population	Water-born Disease									
		No.1		No.2		No.3		No.4		No.5	
Koshe	9,882	Diarrhea		Dermatosis		Acute gastroenteritis		Dysentery			
		919	9.3%	932	9.4%	753	7.6%	736	7.4%	***	***
Kela	5,054	Typhoid		Acute gastroenteritis		Parasitosis		Diarrhea			
		2,284	45.2%	1,395	27.6%	503	10.0%	349	6.9%	***	***
Tiya	2,782	Typhoid		Acute gastroenteritis		Helminthiasis		Dermatosis		Diarrhea	
		473	17.0%	331	11.9%	181	6.5%	151	5.4%	87	3.1%
Adilo	6,693	Typhoid		Acute gastroenteritis		Helminthiasis		Dermatosis			
		620	9.3%	287	4.3%	275	4.1%	115	1.7%	***	***
Teferi Kela	4,778	Diarrhea		Helminthiasis		Typhoid		Dermatosis			
		792	16.6%	563	11.8%	417	8.7%	140	2.9%	***	***
Dalocha	9,756	Diarrhea		Typhoid		Helminthiasis		Dermatosis			
		2,652	27.2%	2,417	24.8%	504	5.2%	165	1.7%	***	***
Mito	4,711	Typhoid		Epidemic typhus		Dermatosis		Intestinal parasite			
		1,570	33.3%	502	10.7%	471	10.0%	430	9.1%	***	***
Alem Gebeya	5,251	Diarrhea		Helminthiasis		Typhoid		Dermatosis			
		1,201	22.9%	874	16.6%	271	5.2%	149	2.8%	***	***
Kibet	8,155	Acute gastroenteritis		Dysentery		Dermatosis		Epidemic typhus			
		2,408	29.5%	1,836	22.5%	1,066	13.1%	777	9.5%	***	***
Tebela	8,973	Typhoid		Diarrhea		Dermatosis					
		1,873	20.9%	299	3.3%	281	3.1%	***	***	***	***

* %: Total prevalence for the population

1-4 Social and Environmental Considerations

1-4-1 Environmental and Social Considerations

1-4-1-1 Components of the Project which have a Negative Environmental Impact

This Project consisted by Boreholes, Transmission & Distribution pipes, Reservoir tanks, Generator houses, Public faucets to provide safe water sustainably and to improve the ratio of water coverage to inhabitants through the construction of water supply facilities.

Because of the environmental impact of acquiring rural land currently used by farmers, this Project is classified as Category B on “JICA investigation of environmental and social guidelines (April 2010)”. On this occasion, the items mentioned below are confirmed about Environment and Social Conditions.

For this reason, the environmental and social considerations survey was conducted in the 10 target towns where water sources have been secured, and the contents of monitoring and mitigation measures for the major environmental and social impact items were examined.

1-4-1-2 The Environmental and Social Conditions around the Project Sites

(1) Natural Environment

A characteristic of topography of the Southern Nations, Nationalities and People’s Regional State (SNNPRS) area, which forms a portion of Great Rift Valley, is a typical gently-sloped valley with a flat

plain in the middle. The surface water (river) does not reach the ocean, but evaporates in the basin, leading to the accumulation of inorganic salts. As a result, poisonous substances such as fluorides are widely distributed in the lakes, surface water and groundwater of the basin. Many of the residents have no other choice but to drink the poisonous water, so there is a significant demand for a safe drinking water supply.

As a result of land use development for agriculture or for grazing, most of the area has already lost its original plants and animals. In Tiya, there is a stone monument registered as a World Heritage by UNESCO in 1980, however, the Project will have no negative impact on the site. This is because the site is protected by a gate and it is located far from the project site.

(2) Social Economy

There are various ethnic groups in SNNPRS with varying languages and cultures. Political boundaries, such as Zone and Woreda, roughly depict their living areas. More than 90% of town residents have the same religious faith with the exception of Koshe. Main industries are agriculture (cereals, coffee, teff, maize, etc.), livestock farming (cattle, sheep, goats, chickens), trading of agricultural and livestock products, commerce and about 40% of workers are engaged in agriculture.

1-4-1-3 System and Organization of Social Environmental Consideration in Ethiopia

(1) Environmental Legislation and Standard

The Environmental Protection Authority (EPA) of Ethiopia was established by a proclamation in 1995, which is now the main administrative body for EIA (Environmental Impact Assessment) in Ethiopia. The enabling legislation for EIA in Ethiopia is the EIA proclamation of 2002 (Environmental Impact Assessment Proclamation, Proclamation No.299/2002). EIA has been run by the Environmental Protection Authority (EPA) in accordance with Environmental Impact Assessment Procedural Guidelines 2003.

(2) Environmental Institutions

Final approval of the environmental impact assessment has been carried out by Land Administration, Uses and Environmental Protection Authority (LAUPA) in SNNPRS. After consultation with LAUPA and Regional Water Resource Bureau (RWRB), the Project had been classified as rural water supply of “Schedule 2” in Environmental Impact Assessment Procedural Guidelines. On the other hand, it has been confirmed that it does not need a full EIA because the facilities are small scale. But it was confirmed that necessity of the execution of a Preliminary Environmental Assessment (PA), which is equivalent to IEE (Initial Environmental Examination) level of JICA. Relevant organizations on environmental and social considerations in SNNPRS are as in the following figure.

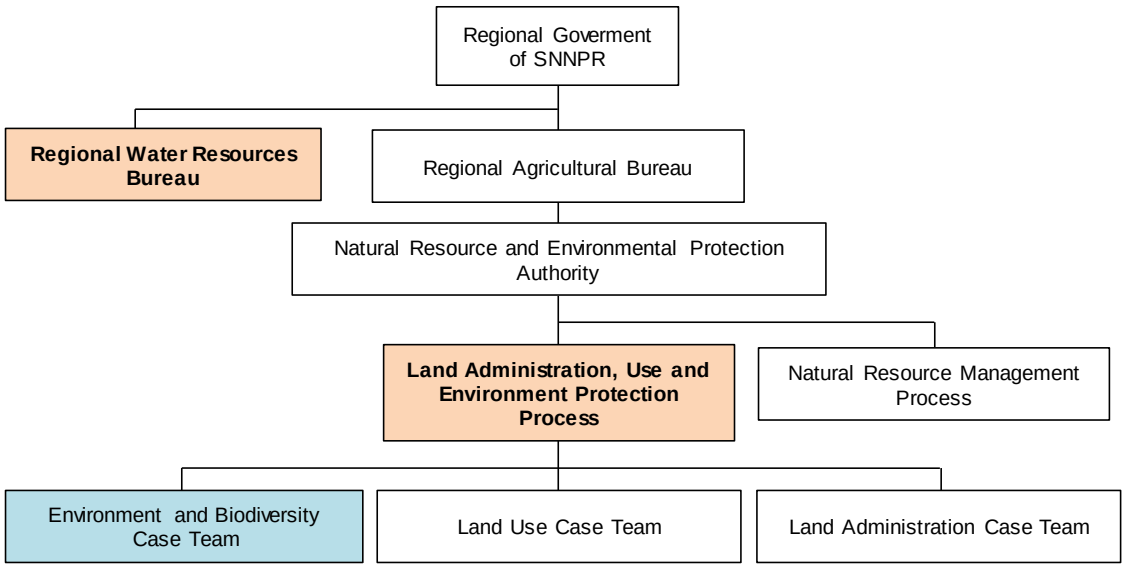


Table 1-25: Organization chart of LAUEPA

1-4-1-4 Comparative Examination of Alternative Plans

Comparison table of the case of implementing the project and the zero option (non-implementation) of the construction is as in the following table. By carrying out the Project, environmental impacts such as a land acquisition, air pollution by the exhaust gas, noise and dust during construction will occur, and also the Project will incur a financial cost. However, implementation of this Project is recommended as the most suitable plan, because it was confirmed that the contribution to the residents is large by the construction of the water supply facilities.

Table 1-26: Comparison of the case of implementing the Project and the zero option

	Item	Zero Option	Implementation of the Project
Supply facility	Public W.P	87 points	156 points（Increase of 69）
Environmental and social conciderations	Social environment	・By the lack or inadequacy of water supply facilities, it is difficult to supply enough of a stable water. ・By the lack of number of facilities and the shortage of water supply , is taken a lot of time to fetching water.	・There is a possibility of land acquisition for the laying of the pipeline, but substitute land or compensation has been guaranteed by the municipality. ・For the facilities is not constructed in the residential area, involuntary resettlement will not occur. ・By the increase of water supply facilities, the time of fetching water of women and children is shortened.
	Natural environment	・Most of the land as grazing land and farmland been pioneered already, wild animal is not inhabited.	・Since facilities will be built outside the range of animal sanctuaries and nature reserves, the natural environment is not impacted.
	Pollution	・When the bus, cars and trucks travels unpaved road, exhaust gas and dust are confirmed on a daily basis.	・Exhaust gases and dust by construction vehicle including a heavy machine are generated. But its value does not exceed greater than the daily levels, because of for a short period. ・The noise is assumed during the construction, but each project sites are planned away from residential area, so there will be no direct impact on the residents.
Recommended proposal and reason		Deprecated ・In the current situation, the amount of the water supply for the residents is very few and fetching water takes much time.	Recommended as optimal proposal ・Project cost consuming but abundant water supply than the current can be obtained, is also facilitated access to public faucets. Therefore this proposal gives large contribution to the residents.

1-4-1-5 Result of the “Study on Groundwater Resources Assessment”

On the basis of “Study on Groundwater Resources Assessment in the Rift Valley Lakes Basin in Ethiopia” from 2010 to 2012, 30 scoping items of environmental influence have been extracted, and the environmental impact such "Local conflict" in service of water supply was predicted. In addition, analysis of the water quality of groundwater has been carried out as a note item.

Table 1-27: Result of the environmental impact assessment of "Study"

	No.	Impacts	Evaluation		Description
			Const-ruction	Opera-tion	
Social Environment	1	Involuntary Resettlement	D	D	The water supply facilities will be construced out of residential area. And the sizes of water supply facilities are small and their position can be adjusted easily sothe resettlement of residents will not occur.
	2	Local economy such as employment and livelihood	D	D	There would be some job opportunity provided to locals by water users' groups; they rather have positive impacts on local economy.
	3	Land use and utilization of local resources	D	D	No adverse impact is expected on land use and utilization of local resources, but positive impacts by installation of water supply facility such as increasing of the land value are expected.
	4	Local communities and decision-making institutions	D	D	No negative impact is expected on local society; however, new water supply facility is going to give good and profound impacts to the local community since securing water is one of the most significant needs in their community.
	5	Existing infrastructures and services	D	D	There would be little interference with construction vehicles and obstruction of traffic in case pipes would be laid crossing village road. However, since there are almost no paved roads in the rural area, the burying work of a pipe crossing the road will finish within an hour.
	6	The poor/ indigenous/ ethnic minority/ women/ children	D	D	Highly positive impacts are expected for women and children by saving their time for water fetching and spend the time for other productive work.
	7	Misdistribution of benefit and social cost	D	D	The same with above "4".
	8	Historical/ cultural heritage	D	D	The sizes of water supply facilities are small; and, it is movable in proximity area so it does not interfere with historical/cultural heritage.
	9	Local conflict of interests	D	C	There are various kinds of peoples and tribes especially in SNNPR, in which autonomous governing body, Special Woreda, exist. If there are hostile tribes exist at upstream and down stream of the catchment area, installation of the water supply facility may affect their relationships. Further social survey of the villages is essential.
	10	Water usage, Water rights, Communal rights	D	D	Since water supply facility will provide water, there would be highly positive impact on water usage of the community. The facility will contribute to the respective village as a whole because the distribution is managed by village water committee or water users group.
	11	Sanitation	D	D	The facility allows amount of water supply for sanitation use. It gives highly positive impact to the community health.
	12	Health Hazards/Risk, Infectious Diseases such as HIV/AIDS	D	D	Public health and sanitation condition will be improved by improving accessibility to clean water. HIV/AIDS problem will not occur at water facility installation work.
Natural Environment	13	Important/ valuable geographical and geological features/ resources	D	D	There is no such place in the Regions. No impact is expected.
	14	Soil erosion	D	D	No soil erosion is expected by installation and use of water supply facility.
	15	Amount and quality of groundwater	D	D	There would be no negative impact on quality of groundwater by installation and operation of the facility. Since the facility will be built at the site only with sufficient amount of ground water, depletion of water is not expected in short-term period. However, quantity of ground water may decrease accordance with the draw down amount from the well.
	16	Amount of natural reservoir/ flow	D	D	Extracting deep ground water has almost no impact on the flow rate of river at the surface.
	17	Coastal zone	D	D	There is no coastal area in the target Regions.
	18	Flora, Fauna, Biodiversity	D	D	Game Reserve or Forest Reserve is excluded from the project area.
	19	Meteorology/ climate	D	D	There is no plan of large scale construction or facility as to give negative impact on the climate.
	20	Aesthetic landscape	D	D	There will be no large scale facility that may affect surrounding landscape. Surge tank of Level-2 facility may change the surrounding view; however, it is not much impact.
	21	Global warming	D	D	Diesel motor pumps emit CO2; however, there would be no large scale generators to be installed as to give negative impact on global warming.
Pollution	22	Air pollution	D	D	There will be some exhaust emission from trucks and machineries during the construction work, and diesel generator of Level-2 facility emits exhaust gas, which contain SOX and NOX gases, but the size is small and operation period is short. Therefore impact on air is negligible.
	23	Water pollution	D	D	Ground water in large portion of the target area are highly contaminated by fluoride. In order to avoid providing contaminated water by new water supply facilities, wells that indicate high fluoride values will be disregarded as project well. Other remedies such as 1) installation of long extension pipes from low fluoride wells at distant hillside area, 2) installation of defluoridation plant or promoting/local remedies, and 3) rain harvesting. Water pollution during construction phase is easily avoidable with the proper supervision of work. There is no waste water discharge from the facilities during operation.
	24	Soil contamination	D	D	Falling down of some oil droplets from heavy machineries is expected in during construction phase, which is negligible impact; and there is no soil contamination occurs during operation phase either.
	25	Solid waste amount increase	D	D	Excavated soil is properly disposed in routine manner. There is no solid waste produced by water supply facility during operation phase.
	26	Increase of noise and vibration	D	D	Since heavy machineries will be operated during construction phase, noise and vibration will occur; however, the duration is limited.
	27	Ground level subsidence	D	D	The capacities of pump motors are extremely smaller, compare to those causes ground subsidence.
	28	Offensive odor	D	D	There would be no source of odor at the water supply facility.
	29	Sedimentation	D	D	There is no sedimentation on river bed or reservoir bed occurred by installation of the water supply facility.
	30	Increase of Accidents	D	D	There is no circumstances provoke accidents, by installation of the facilities.

1-4-1-6 Scoping and TOR with regards to Environmental and Social Considerations

Through the survey, it was considered appropriate to select items of impact assessment as follow.

1. Land acquisition and resettlement
2. Erosion of the land
3. Air pollution / Dust damage
4. Noise

In the consultation with the Regional water resource bureau and LAUEPA in SNNPRS, it was decided that the environmental impact assessment will be carried out in the PA level for this Project. Therefore, in accordance with the following TOR, it was confirmed about 30 items of environmental influence with site survey and through interviews with the town government office and town water management organization.

Table 1-28: Rating of impact assessment

Rating	Criteria
A	Serious impact(s) is (are) expected
B	Less serious impact(s) is (are) expected
C	Impact not known without further research
D	Negligible impacts are expected or no impact is expected

Table 1-29: TOR

Impact item	Survey item	Survey method
Land acquisition・Involuntary resettlement	・Confirmation for the scale of land acquisition and involuntary resettlement ・Compensation method in the case of resettlement occurs or land acquisition	・Related law and cases ・Confirmation of type of the existing building around of the small towns by site reconnaissance ・Confirmation of land use around the small towns by interviews of site reconnaissance
Local conflict	・Disputes relating to water acquisition in small towns	・Interview with water management organization, municipality and residents of each small towns.
Soil erosion	・Current status of soil conditions	・investigation of the soil situation at the site
Air and dust pollution	・Understanding of traffic situation surrounding planning land ・Confirmation of existing residence, school, hospital around the project sites. ・Impact during construction	・Prediction of impact based on the survey of traffic situation ・Field survey and interviews ・Confirmation about contents of work, period, and vehicle
Water pollution	・Quality of the river water ・Situation of use of river water	・Result of the exploratory drilling survey ・Field survey and interviews to neighborhood of target small towns.
Noise and vibration	・Distance from construction site to residential area, hospital, the school ・Impact during construction	・Field survey and interviews ・Content of construction, method, period, location, range, types of construction machinery, operating location, operating period, the number of construction vehicle, confirmation of the road route
Historical/cultural heritage	・Impact of this project against the World Heritage Site of Tiya	・Field survey and interviews

1-4-1-7 Result of Preliminary Environmental Impact Study

Interviews were held with water management organizations and the town municipalities in each town as to the environmental impact of 30 scoping items. It was found that currently four of the scoping items are thought to have an environmental impact, as shown in Table 1-30.

Table 1-30: Result of preliminary environmental impact study

	No.	Impacts	Evaluation		Description
			Const-ruction	Opera-tion	
Social Environment	1	Involuntary Resettlement	D	D	The sizes of water supply facilities are small and their position can be adjusted easily so the resettlement of residents will not occur.
	2	Local economy such as employment and livelihood	D	D	They have positive Impacts on local economy as a creation of employment by the water management organization Since private water seller does not exist, there is no negative impact.
	3	Land use and utilization of local resources	B-	D	Water supply facilities will be constructed at the land of existing facilities or the land away from the residential area, therefore, basically land acquisition does not occur. However, there is a possibility of utilizing a part of the farm land for pipe installation.
	4	Local communities and decision-making institutions	D	D	No negative impact is expected on local society; however, new water supply facility is going to give good and profound impacts to the local community since securing water is one of the most significant needs in their community.
	5	Existing infrastructures and services	D	D	There are almost no paved roads in the rural area, there would be no negative impact during the burying work of a pipe crossing the road.
	6	The poor/ indigenous/ ethnic minority/ women/ children	D	D	By Highly positive impacts are expected for women and children by saving their time for water fetching and spend the time for other productive work.
	7	Misdistribution of benefit and social cost	D	D	The same with above "4".
	8	Historical/ cultural heritage	D	D	There is a world heritage. But there is no influence because the facilities will construct far from Tiya town. And also the heritage is surrounded by a fence and construction vehicles and workers is impossible to enter.
	9	Local conflict of interests	D	D	The residents in small towns are composed with the same ethnic group.Percentage of the religious population also normaly 90% is a Christ Orthodox, and 10 % is a Muslim. (Koshe is contrary) There was no conflict from several decades. So the trouble between residents over the water will be judged as less to occur.
	10	Water usage, Water rights, Communal rights	D	D	Water supply facilities will be operated by the water management committee, so It will also benefit for residents of the town.
	11	Sanitation	D	D	The facility allows amount of water supply for sanitation use. It gives highly positive impact to the community health.
	12	Health Hazards/Risk, Infectious Diseases such as HIV/AIDS	D	D	Public health and sanitation condition will be improved by improving accessibility to clean water. HIV/AIDS problem will not occur at water facility installation work.
Natural Environment	13	Important/ valuable geographical and geological features/ resources	D	D	There is no such place in the small towns. No impact is expected.
	14	Soil erosion	B-	D	There is a possibility that the soil is eroded by earthworks.
	15	Amount and quality of groundwater	D	D	Location of pump and pumping capacity were decided based on the results of the pumping test by calculating datas of the appropriate water level and pumping amount. For this reason, reduction of underground water source by the Project does not occur.
	16	Amount of natural reservoir/ flow	D	D	Since using the extracting deep ground water, no give an impact on the flow rate of river.
	17	Coastal zone	D	D	There is no coastal area in the target Regions.
	18	Flora, Fauna, Biodiversity	D	D	There is no Game Reserve or Forest Reserve around the project area.
	19	Meteorology/ climate	D	D	There is no plan of large scale construction or facility as to give negative impact on the climate.
	20	Aesthetic landscape	D	D	There will be no large scale facility that may affect surrounding landscape.
	21	Global warming	D	D	There would be no large scale generators to be installed as to give negative impact on global warming.
Pollution	22	Air pollution	B-	D	Almost no effect on the atmosphere under the construction, however, exhaust gas from heavy equipment and trucks, etc. and dust during construction are generated.
	23	Water pollution	D	D	Water source for the Project are guaranteed safe water by water quality test. Under the guidance of the RWRB, water quality test is also carried out in the small towns. So the quality of groundwater are always confirm.
	24	Soil contamination	D	D	Since heavy machineries will be operated during construction phase, noise and vibration will occur; however, the duration is limited.
	25	Solid waste amount increase	D	D	Waste occured by this Project are the waste soil and removal buried object (piping, etc.), and they are treated properly. Therefore, waste during the construction will not make an impact.
	26	Increase of noise and vibration	B-	D	Since heavy machineries will be operated during construction phase, noise and vibration will occur. Although construction site is away from residential areas, noise caused by the generator is expected after the commencement of service.
	27	Ground level subsidence	D	D	The capacities of pump motors are extremely smaller, compare to those causes ground subsidence.
	28	Offensive odor	D	D	There would be no source of odor at the water supply facility.
	29	Sedimentation	D	D	There is no sedimentation on river bed or reservoir bed occurred by installation of the water supply facility.
	30	Increase of Accidents	D	D	There is no circumstances provoke accidents, by installation of the facilities.

1-4-1-8 Impact Assessment

Based on the TOR, the 7 scoping items, as per the following table, of the 30 impact items including 4 preliminary environmental impact items was assessed. In addition, countermeasures for the impact items were considered.

Table 1-31: Impact assessment based on results of preliminary environmental impact study

No.	Impacts	Evaluation		Description
		Const-ruction	Opera-tion	
3	Land use and utilization of local resources	B-	D	The center of the small town is a residential area, but the around area are spread cereal farmland and pastures. In this plan, there is a possibility of passing through the farmland in use (grain fields, etc.) upon the laying of the pipeline. But total area in all farmlands that is subject is less than one hectare.It is easy to provide the substituted land instead of a land acquisition since there is a vast land around the small town. Water supply facilities will be constructed at the land of existing facilities or the land away from the residential area, therefore, basically land acquisition does not occur. However, there is a possibility of utilizing a part of the farm land for pipe installation. By the interview, it was confirmed that the residents are willing tp provide their farmland in order to obtain clean water.
8	Historical/ cultural heritage	D	D	There is a world heritage inTiya town. But there is no influence because the facilities will construct far from heritage. And also the heritage is surrounded by a fence and construction vehicles and workers is impossible to enter.
9	Local conflict of interests	D	D	There are various kinds of peoples and tribes especially in SNNPR, but the residents in small towns are composed with the same ethnic group. Percentage of the religious population also normaly 90% is a Christ Orthodox, and 10 % is a Muslim. (Koshe is contrary) There was no conflict from several decades. So the trouble between residents over the water will be judged as less to occur. Dispute between residents is due mostly personal reasons, not religious. According to the opinion of water management organization and municipality, the water supply facilities is a major boon to small town, so it will not to occur dispute concerning water supply.
14	Soil erosion	B-	D	In the current small city, erosion and weathering can be confirmed in a part of the unpaved road and slope. Therefore, there is a possibility that the soil is eroded by earthworks.
22	Air pollution	B-	D	There is some environmental impact by the exhaust gas from heavy equipment and trucks, etc. and dust during construction.
23	Water pollution	D	D	In the exploratory drilling survey, the water quality of 3 small towns (Koshe, Tora, Alem Gebeya) in 10 small towns has been detected fluorine and the level were above the WHO criteria (1.5mg / L or less) .However it was less than the Ethiopian country standards (3.0mg · L).RWRB of SNNPR had asked to adopt the Ethiopian country standards for the reasons of the lack of water in rural area and the difficulty of developing new groundwater, so it was decided to adopt the Ethiopian country standards.Although not periodic, water quality test has been performed under the guidance of the RWRB.Hence, it is necessary to teach the regular water quality grasp by the soft component.
26	Increase of noise and vibration	B-	D	Since heavy machineries will be operated during construction phase, noise and vibration will occur. Although construction site is away from residential areas, noise caused by the generator is expected after the commencement of service.

However, four items that are shown in the following table were re-evaluated and the potential environmental impact was assessed to be “B-” after reviewing the results of the field surveys. For this reason, the impact assessment and future measures to counter these four items were examined.

Table 1-32: Environmental social impact assessment

No.	Impact items	Evaluation		Reason
		Const-ruction	Opera-tion	
3	Land use and utilization of local resources	B-	D	Well, generator room, water supply facilities, public faucets, will be placed far from the residential areas or at the current position. So the land acquisition will not occur. However it is possible to utilize part of the land for laying the pipeline.
14	Soil erosion	B-	D	Possibility of erosion of soil by soil work is considered.
22	Air pollution	B-	D	There will be some exhaust emission from trucks and machineries and the dust by the construction during the work.
26	Increase of noise and vibration	B-	D	It is possible the pipe laying work at the center of the small town by considering the construction time, though temporary noise and vibration are assumed. Since the generator used as a standby power supply is separated far from the residential area, so not caused complaints by noise.

1-4-1-9 Mitigation Measures and Cost for Implementation

Mitigation measures for 4 items potential environmental impact is expected, is listed in the following table. All the affect items are also able to be resolved sufficiently by the water management organizations, Woreda water office and Japanese contractor.

Table 1-33: Mitigation measures

Impact items No.	Items	Mitigation measures	Responsible agencies	Finance
Before and during construction				
3	Land use and utilization of local resources	・ Executing the field survey sufficiently in the stage of detailed design ・ Piping work in the agricultural off-season	・ Japanese constructor	Including in the construction costs
		・ Compensation as an substitute of land acquisition will be paid by municipality of each small town (per unit price). ・ The procedures for payment of substituted land or compensation.(by municipality) ・ The mediation to the municipality of the description and explanation to the residents of small town. (Water management organization)	・ Municipality of the small towns ・ Water management organisation	See a clause 1-3-2-8. Financial resources and cost
14	Soil erosion	・ At the time of the construction and backfilling piping work, pressurizing rolling compaction including periphery. ・ Consider the replacement of new soil if current soil can not be used for backfilling because of the quality.	・ Japanese constructor	Including in the construction costs
22	Air pollution	・ In the time of work, avoid the the non-necessary operation and rewing. ・ Performs watering to minimize the scattering of dust. ・ The guidance for the field worker and drivers bcome thorough , and mitigation for influence of environment is conducted strictly.	・ Japanese constructor	Including in the construction costs
26	Increase of noise and vibration	・ Prohibition of work at early morning and night . (Japan contractor) ・ Performs a sufficient explanation to the residents before start of construction and during construction, to obtain a pre-understanding. (Water management organization)	・ Japanese constructor ・ Water management organisation	Including in the construction costs

1-4-1-10 Monitoring Plan

The monitoring plan is as follows based on the results of environmental impact assessment and

mitigation measure.

Table 1-34: Monitoring plan

Impacts	Item	Monitoring point	Frequency	Responsible agencies
Soil erosion	Check the degree of erosion by visual	Each sites of the small towns	1 time/month	Japanese constructor
Air pollution	The exhaust gas by visual inspection, Check the degree of dust		1 time/month	
Increase of noise and vibration	Confirmation of noise by hearing		1 time/month	

1-4-1-11 Consultant Meeting with Stakeholder

As mentioned above, procedures of the Environmental Impact Assessment of projects in SNNPRS have been implemented by Land Administration and Use, the Environmental Protection Agency (LAUEPA), and a final decision of the Implementation of Project has been decided by Regional Water Resources Bureau. Then, consultation on the 30 items of the environmental impact was carried out to the town government office heads and water management organization managers from 13 to 20 February 2014 in each target town. The result of environmental impact assessment in each town is reported to LAUEPA, the research report has been received. The research report accepted by LAUPA has been presented to the regional water resource bureau, and was reported the implementation of the PA process about the Project. The opinions in the discussion at the towns are as follows,

- Due to an increase in water supply, the conflict over water does not occur. Also there were no disputes occurred in the town until now. (There are small quarrels frequently of the individual, but they are resolved by themselves.)
- The land is belonged to the nation, but the town municipality will pay the compensation with the responsibility as indemnification or substitute land when the farmland and residential areas to be utilized for the construction of water supply facilities.
- The amount of the water supply to the town residents will be increased by the construction of water supply facilities. The amount of the water supply to the town residents will be increased by the construction of water supply facilities. Since residents have used the river water during insufficient of water, they have suffered sometimes with disease. So the provision of safe water will be a change for the good for the future health of residents.
- The disposable time for women and children will be increased with the shortening of fetching water, furthermore, the enrollment rate of children will be increased.
- Increase of the amount of water supply will lead to the development of the town.

1-4-2 Land Acquisition, Resettlement

1-4-2-1 Necessity of Land Acquisition and Resettlement

The problem of involuntary resettlement will not occur in this project, because the project does not

use on the premises. Further, the impact of the existing structure will not occur because the laying pipeline has been selected so as not to affect such structures. But the environmental impact of "Land acquisition" will occur according to the necessity of laying the pipeline under the farmland.

Impact Area	Farmland of the town
Initial alternative design	Not laying in pipeline to the farmland
Method of land acquisition minimal	Laying the pipeline avoiding the farmland

1-4-2-2 Legal Framework in accordance to the Land Acquisition

Land ownership is legally vested in the Ethiopian state and public in the ordinance. Then, people are getting the holding right to use the land by having to pay rent to the country based on the use of the land, (Council of Ministers Regulations No.135./2007 Payment of Compensation for Property Situated on Landholdings Expropriated for Public Purposes).

On the other hand, at the time of the construction of public facilities, if the nation has the necessity to use the land where the peoples have the holding right, the nation has an obligation to provide alternative land or compensation corresponding to the area to be acquired. Compensation relating to land acquisition in the region is determined at the regional level. The amount of compensation and substitute land has been determined by the town municipality on a case-by-case basis.

Holding right of farmland is showed in the Annunciation 89/1997 (Proclamation No. 89/1997 Federal Rural Land Administration). Compensation to be paid if the nation has the necessity to use the land where the peoples have the holding right is provided by the ordinance 135/2007 (Council of Ministers Regulation No.135/2007 Payment of compensation for property situated on landholding expropriated for public purposes).

Table 1-35: Land rental duration by plot size and agricultural activity

Unit: Year

Plot size	Rental period (rain fed agriculture)		Rental period (irrigated agriculture)		Mixed agriculture and forestry	Livestock farming	Others
	Perennial crops	Seasonal crops	Perennial crops	Seasonal crops			
Bellow 200	35	30	40	35	35	25	45
200-500	40	35	45	40	40	30	45
Over 500	45	40	50	45	45	35	45

Table 1-36: Land rental price by grade in SNNPRS

No.	Zone	Town	Price (Birr/hectare/year)	
			1st grade land	2nd Grade land
2	Sidama	Teferi Kela	117	71
4	Wolayita	Tebela	78	47
7	Gurage	Koshe, Kela, Tiya	105	64
10	Kenbata-Tenbaro	Adilo	100	61
11	Silte	Dalocha, Mito, Alem Gebeya, Kibat	105	64

1-4-2-3 Scale and Range of Land Acquisition

In the basic design, the pipeline is designed by avoiding land that is currently used. However, there is the possibility that the pipeline will be laid under some farmland (less than 1ha in all 10 towns). Plumbing on plan will be carried out avoiding the farming season. On the other hand, there is no possibility of involuntary resettlement by the pipe laying.

Total area of land acquisition for all target towns	Less than 1.167ha
Dimension of the small town	0.022-0.466ha
Current usage condition	Farmland：Farm (Teff, Maize, etc.)

The number of households which are affected land acquisition is envisaged in this project as follow. Affected households were set to 1 compartment per household as a farmland on the pipe laying route. On the other hand, farmland for which compartments could not be determined is also numerous. The rental unit for farmland in Ethiopia is 1 hectare, so the division of 1 household was set as 1 hectare each. Assuming to 1 hectare as the land of 100m × 100m, the number of household was calculated by the value obtained by dividing the 100m distance of the pipe laying route.

Table 1-37: Number of households which are affected by land acquisition

Small town	Affected households		Total No.of household
	Compartmentalized farmland	Farmland by 1ha	
Koshe	18	8	26
Kela	***	3	3
Tiya	8	2	10
Adilo	9	3	12
Teferi Kela	15	32	47
Dalocha	47	***	47
Mito	***	3	3
Alem Gebeya	8	***	8
Kibet	4	11	15
Tebela	5	***	5
Total	114	62	176

1-4-2-4 Concrete Measures of Compensation and Support

In SNNPRS, rental period and rental fee has been set by the purpose of usage of land (Farming, Residence, Commerce, Industry etc.). Compensation for exploitation of land and felling of trees and crops for the construction of public facilities will be paid from the town municipality. Compensation will be paid according to the criteria of Ethiopia as follows. “Compensation that is corresponding to the unit or area”, “Compensation that is corresponding to amount of harvest” and/or “Compensation that is taking into account the growth amount in the case of perennial plants”.

Table 1-38: Entitlement matrix

No.	Loss	Beneficiaries	Contents of compensation	Responsible agencies
1	Farmland	Farmers	Compensation or alternative land is paid based on each rental fee under the judgment of municipality of each small towns.	Regional goverment Implementation agency : Municipality
2	Crops			

Reference : Council of Ministers Regulation No.135/2007 Payment of compensation for property situated on landholding expropriated for public purposes

1-4-2-5 Mechanism of the Complaints Processing

Opinions and complaints from residents relating to water supply facilities are processing by the water management organization and the town municipality in each town. The town has held a residents meeting if necessary. From the advantage of facility, reliability and convenience for the residents, water management organization will be the point of contact for complaints. On the other hand, the specific procedures to deal with complaints such as payment of the compensation will be implemented by the town municipality.

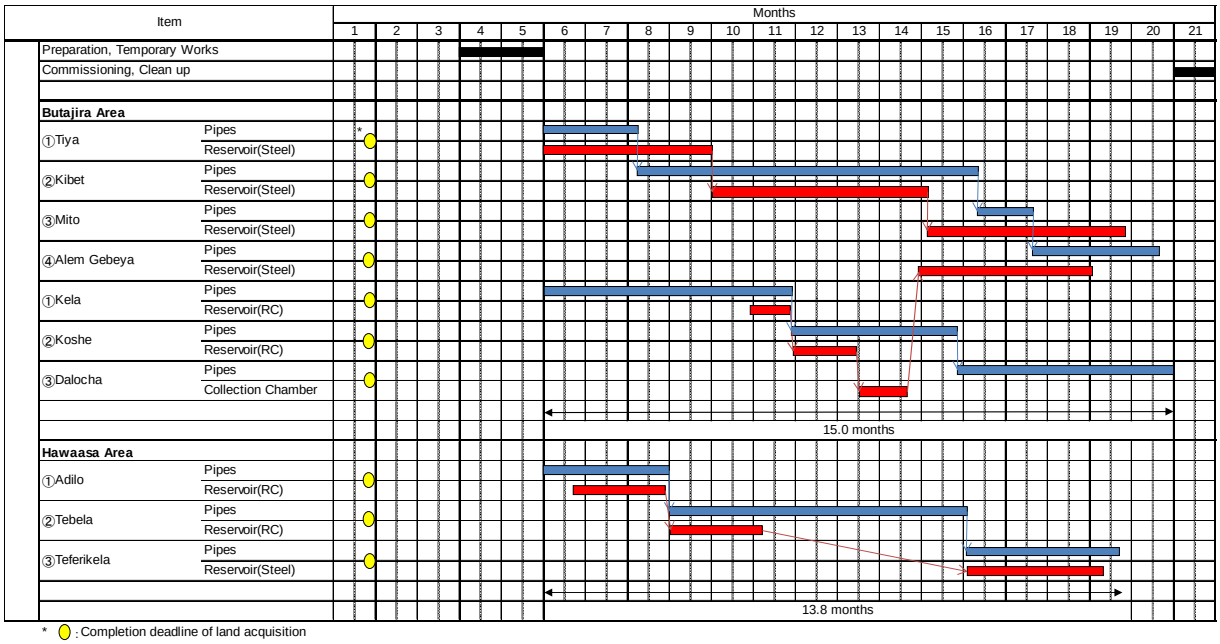
1-4-2-6 Executive System

The operation and maintenance (O&M) of water supply facilities, is implemented by town water management organization. Therefore, the procedure of the land acquisition is represented by the water management organization. Water management organization of the project target town, is composed by members of 4 to 11 persons in each town, and the survey of land acquisition is carried out under the guidance of the head of the organization.

1-4-2-7 Implementation Schedule

Procedure of the land acquisition such as a description to the target residents, site inspections of the land and the residents meetings are better to be finished 4 months before the start of the construction. Implementation schedule in this process is as follows.

Table 1-39: Implementation schedule



1-4-2-8 Financial Resources and Cost

Under the constitution of the Federal Democratic Republic of Ethiopia, land is the sole property of the State. Urban and rural land is available for investment and residents on lease-hold and rental basis. Period and rental rates of land will be determined in each state, it is managed by the town municipality. Therefore, the amount of compensation or substitute land for land acquisition in this time are decided and are paid for by the town municipality by using the national budget. Provision of the land acquisition for rural land in the SNNPRS is as follows.

Table 1-40: Cost of compensation and financial resources (Rural areas)

Rental price*	Total componsation (Land rental fee and Relocation expenses)	Financial resources of compensation costs
78-117 Birr/ha/year	Municipality of the small town decide finally for the compensation. The total borrowed years, the existing of current harvestable crops and the distance etc is considered.	Regional Government of SNNPRS

* Rental price in each small town

Table 1-41: Amount of compensation for land acquisition

Small town	Distance	Wide	Area		Compensation*	Componsation	
	m	m	m^2	ha	Birr/ha	Birr	Yen
Koshe	1,775	1.0	1,775	0.178	105.0	18.6	100
Kela	300	1.0	300	0.030	105.0	3.2	17
Tiya	1,030	1.0	1,030	0.103	105.0	10.8	58
Adilo	950	1.0	950	0.095	100.0	9.5	51
Teferi Kela	220	1.0	220	0.022	117.0	2.6	14
Dalocha	4,655	1.0	4,655	0.466	105.0	48.9	263
Mito	300	1.0	300	0.030	105.0	3.2	17
Alem Gebeya	800	1.0	800	0.080	105.0	8.4	45
Kibet	1,280	1.0	1,280	0.128	105.0	13.4	72
Tebela	360	1.0	360	0.036	78.0	2.8	15
Total	11,670	***	11,670	1.167	***	121.4	654

* Rental price in each small town

Besides the land as compensation, the compensation for the crops or trees etc. are added. In the survey, project land had been determined but the cultivated trees and crops were not determined. Then, by multiplying the average annual income amount of farmer and the ratio coefficient of total area which is a possibility of land acquisition, and the maximum area of land acquisition in this Project, the compensation for the cultivated trees/crops will be calculated.

Table 1-42: Amount of compensation for crops, trees and fruits

Small town	Affected houshold	Total incomes of farmers	The total land area of the affected farmers	Area of land acquisition		Distance	Wide	Ratio of acquired land	Compon-sation
	HH	Birr/year	ha	m^2	ha	m	m		Birr
	a	b=a×8770 Birr*	c	d=f×g	e=d÷10000	f	g	h=e÷c	i=b×h
Koshe	26	228,020	22.60	1,775	0.178	1,775	1.0	0.008	1,790.87
Kela	3	26,310	7.50	300	0.030	300	1.0	0.004	105.24
Tiya	10	87,700	9.44	1,030	0.103	1,030	1.0	0.011	956.90
Adilo	12	105,240	8.81	950	0.095	950	1.0	0.011	1,134.82
Teferi Kela	3	26,310	1.72	220	0.022	220	1.0	0.013	336.52
Dalocha	47	412,190	39.11	4,655	0.466	4,655	1.0	0.012	4,906.02
Mito	3	26,310	3.00	300	0.030	300	1.0	0.010	263.10
Alem Gebeya	8	70,160	6.18	800	0.080	800	1.0	0.013	908.96
Kibet	15	131,550	12.00	1,280	0.128	1,280	1.0	0.011	1,403.20
Tebela	5	43,850	3.58	360	0.036	360	1.0	0.010	440.95
Total	132	1,157,640	113.94	11,670	1.167	11,670	***	***	12,246.57

* Average annual income of full-time farmers by social survey

1-4-2-9 Monitoring System by Implementing Agencies and Monitoring Form

Even after the compensation has been granted, whether the current dissatisfaction of the beneficiaries exists should be confirmed by the water management organization. Monitoring will be carried out on the public water point users and the private connection user by the water management organization. The water management organization responds to everyday complaints. However in cases where it is difficult to find a settlement in discussions, the solution will be sought based on advice from Woreda, Zone, and the Regional water resource bureau.

Table 1-43: Monitoring form

Name of farmer	Adress	Componsation	Scale of substitute land	Comments (complaints)
Before moving				
After moving				

1-4-2-10 Residents Meeting

In the field survey related to environmental and social considerations, the discussion about the compensation and substituted land for the land acquisition were carried out with water management organization and municipality. As a result, the compensation or substitute land for land acquisition will be paid by the finance of the government in the case of land acquisition and the explanation about the compensation to the residents (including farmers) by the municipality was made a definite promise. As a result, it was confirmed that the compensation or substitute land for the land acquisition will be paid by the finance of government in the case of land acquisition. And the holding of resident meetings before the Project to explain about the compensation by the municipality was promised.

On the other hand, in the interviews with farmers who have a possibility of being subjected to land acquisition, it was confirmed that the supply of clean water has been desired for a long time, so it was confirmed that the provision of other farmland is allowable. Also, there were no dissenting opinions against the construction of water supply facilities during spot interviews with residents.

In future, water management organization will play a central role, to perform a summary description of the construction work for the residents. Completion of the land acquisition procedure is desirable to (up to 4 months) before the start of construction. In particular, after the affected residents are determined, it is necessary to provide adequate description about the compensation policy for the loss of property in providing the information.

Chapter 2

Contents of the Project

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Basic Concept of the Project

2-1-1 Overall Goal and Project Goal

(1) Overall Goal

The Government of Ethiopia established the UAP (Universal Action Plan, 2005-2012) established on 2005 with the aim of increasing the water coverage ratio in rural areas to 98% by 2012. Their target could not be achieved, therefore a new UAP 2 (2009-2015) was established on 2009 with the aim of increasing the water coverage ratio 100% in urban areas, 98% in rural areas. However, the plan for expansion of water supply facilities has not progressed, the facilities have become older, and the water coverage ratio is 68.0% (2011/12, SNNPRB) in National, rural areas remains low at 50.4%. To solve these issues, the Government of Ethiopia has embarked on a goal of improving the social and sanitary conditions in rural areas.

(2) Project Goal

In this situation, this Project targets to construct water supply facilities and provide safe drinking water, then to improve the ratio of water coverage in small towns of rural areas of SNNPR.

2-1-2 Project Summary

This plan is to construct water supply facilities, and also to conduct technical assistance support to Water Management Organizations (WMOs) and Implementation Agency for operation and maintenance of water supply facilities in order to achieve the above goals. By implementing these planned activities it is hoped that a sustainable and safe water supply and an increase in the capability for operation and maintenance of the water supply facilities will be attained. The targeted Project for cooperation is to construct water supply facilities with public faucets in 10 small towns, and to strengthen the capacity of WMOs and Woreda Offices for operation and maintenance. Moreover, this Project is placed as a part of UAP.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

(1) Scope of Assistance

The scope of assistance in this Project is to provide water supply systems consisting of water supply facilities and public faucets based on the request by Ethiopian side. In ten of the eleven towns, that is not including Tiya, privately funded water supply services with private connections are operating, however, these systems are not covered by this Project. Even if the presence of groundwater has been confirmed, if

the water yield is small, such water sources and water supply facilities with hand pumps will not be included in this Project.

In addition, technical assistance to establish a structure of operation and management for water supply facilities by WMOs and Woreda offices will be conducted as part of the Project.

Table 2-1: Scope of assistance

Item of Cooperation		Scope of Cooperation	
		Target	Not target
Facility Construction	Hand pump type water supply facility		○
	Public faucet type water supply facility	○	
	Each house faucet type water supply facility		○
Equipment Procurement			○
Technical Assistance (Soft Component)		○	

(2) Site Selection

In 11 towns requested by the Ethiopian side, analysis in Japan was conducted based on the data of field surveys in SNNPR. The towns that fully satisfied the following criteria shown on Table 2-2 became target towns for the Project.

Table 2-2: Criteria for site selection

Item of Evaluation		Criteria of Evaluation	Method of Evaluation
Precondition	Overlapping of Projects	No overlapping plans shall exist in the target towns.	Discussion with and hearing from the recipient
Natural Conditions	Existence of ground water resources	As a result of test well drilling, ground water shall exist.	Field survey, geophysical prospecting, test well drilling, existing water resources survey, discussion with the recipient
	Existence of spring resources	Spring resources, which can be used for this Project, shall exist.	Existing water resources survey, discussion with the recipient
	Water quantity	Yield shall be greater than 2.0 L/s.	Pumping test
	Water quality	Water quality shall satisfy the Ethiopian standard.	Water quality analysis
Social Conditions	Willingness to accept water supply facilities	Residents (water management committee) shall have willingness to accept this Project.	Social condition survey
	Capability to pay water tariff	Residents shall have capability to pay water tariff.	Social condition survey
	Willingness to pay water tariff	Residents shall have willingness to pay water tariff.	Social condition survey

Regarding water quality, Ethiopian Water Quality Standard (refer to Table 1-9) as requested by SNNPRB, is adopted considering the current water supply situation in 11 towns and the difficulty of groundwater development. Based on the evaluation by the above criteria, site selection and investigation of planning contents were conducted according to the following flow diagram.

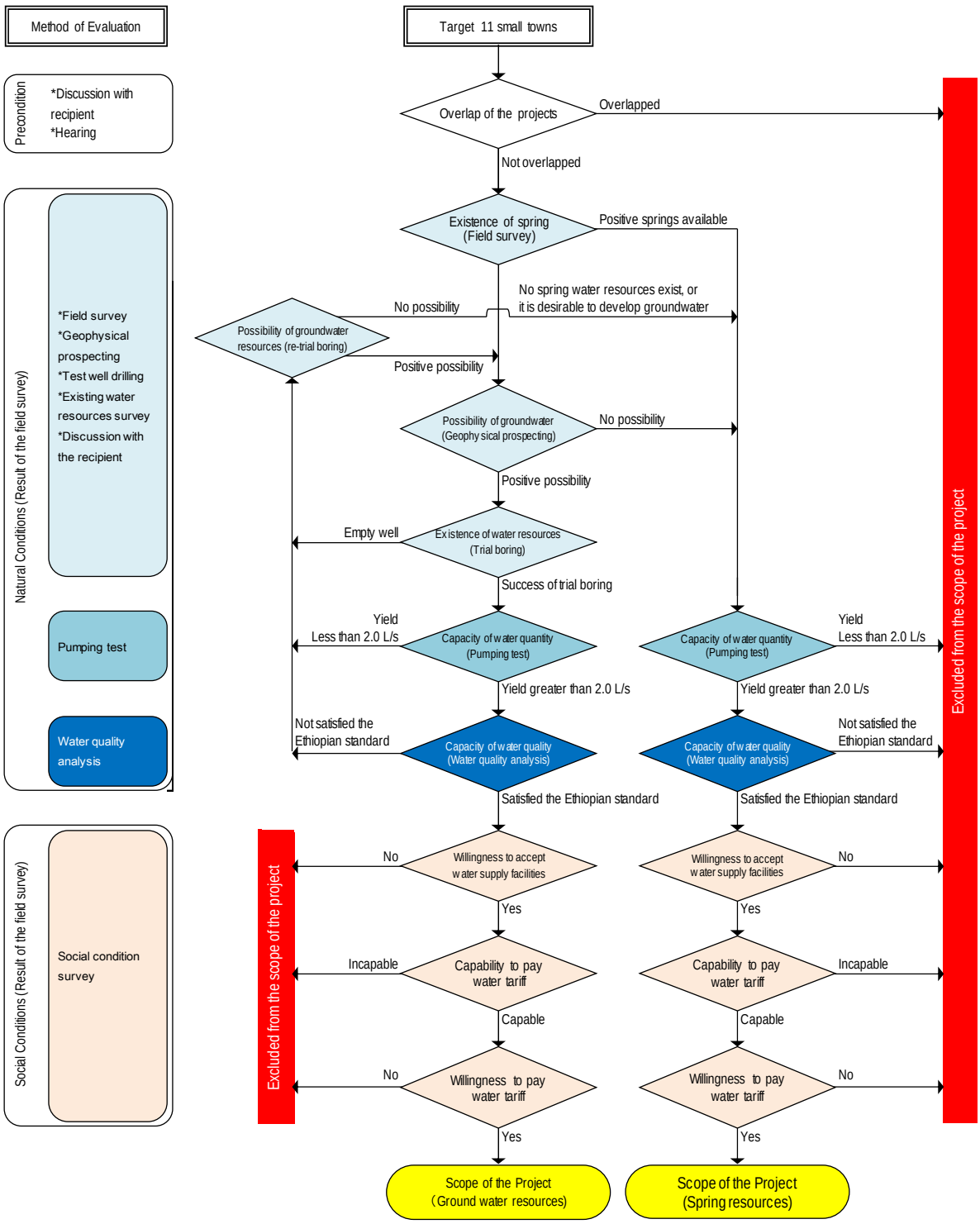


Figure 2-1: Flow of site selection

The result of evaluation for each town is shown below. In nine towns (Koshe, Kela, Tiya, Adilo, Teferi Kela, Mito, Alem Gebeya, Kibat and Tebela) new water sources by test well drilling were confirmed and in one town (Dalocha) an existing spring was confirmed to have sufficient quantity and quality. Therefore 10 towns were selected as target towns of the Project. However, Tora is excluded from this Project, because it is very difficult to develop a new groundwater source and to convert existing springs in this Project.

Table 2-3: Result of target site evaluation

Small town	Precondition	Natural conditions							Social conditions			Result of selection
	Overlap of Projects	Existence of spring resources	Existing of groundwater resources				Spring resources		Willingness to accept water supply facilities	Capability to pay water tariff	Willingness to pay water tariff	
			Geophysical prospecting	Test well drilling	Yield	Water quality	Flow rate	Water quality				
Koshe	No overlap	No springs	Positive	Succeeded	36.5 L/s	Satisfied	***	***	Yes	Capable	Yes	Water supply by ground water
Kela	No overlap	No springs	Positive	Succeeded	10.2 L/s	Satisfied	***	***	Yes	Capable	Yes	Water supply by ground water
Tiya	No overlap	No springs	Positive	Succeeded	2 L/s	Satisfied	***	***	Yes	Capable	Yes	Water supply by ground water
Adilo	No overlap	No springs	Positive	Succeeded	10 L/s	Satisfied	***	***	Yes	Capable	Yes	Water supply by ground water
Teferi Kela	No overlap	No springs	Positive	Succeeded	9 L/s	Satisfied	***	***	Yes	Capable	Yes	Water supply by ground water
Dalocha	No overlap	Existing	***	***	***	***	8.00 L/s	Satisfied	Yes	Capable	Yes	Water supply by spring
Mito	No overlap	No springs	Positive	Succeeded	14.28 L/s	Satisfied	***	***	Yes	Capable	Yes	Water supply by ground water
Tora	No overlap	No springs	Positive	Dry	***	***	***	***	***	***	***	Excluded from the Project
Alem Gebeya	No overlap	No springs	Positive	Succeeded	9.7 L/s	Satisfied	***	***	Yes	Capable	Yes	Water supply by ground water
Kibet	No overlap	No springs	Positive	Succeeded	13.1 L/s	Satisfied	***	***	Yes	Capable	Yes	Water supply by ground water
Tebela	No overlap	No springs	Positive	Succeeded	35.57 L/s	Satisfied	***	***	Yes	Capable	Yes	Water supply by ground water

Criteria of evaluation	Precondition	Overlap of Projects	No overlapping plans shall exist in the target towns.
	Natural conditions	Existing of groundwater resources	As a result of test well drilling, ground water shall exist.
		Existence of spring resources	Spring resources, which can be used for this Project, shall exist.
		Capacity of water quantity	Yield shall be greater than 2.0 L/s.
		Capacity of water quality	Water quality shall satisfy the Ethiopian standard.
	Social conditions	Willingness to accept water supply facilities	Residents (water management committee) shall have willingness to accept this Project.
		Capability to pay water tariff	Residents shall have capability to pay water tariff.
		Willingness to pay water tariff	Residents shall have willingness to pay water tariff.

2-2-1-2 Policy of Natural Conditions

The rainfall 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. The roads that extend from the capital Addis Ababa to Hawassa such as Routes No. 6, 9, 41 and the route from Butajira to Ziway (detour route) are paved, but other roads are unpaved. Since the majority of the target towns are located along the highway, the access to the target sites is possible even in the rainy season. However, it may be difficult to access to the construction sites due to the roads of those sites that are unpaved. Therefore, the construction plan has to take into account the weather conditions as well.

2-2-1-3 Policy of Social Economic Conditions

Although the existing water supply facilities and water sources are managed by WMOs in the target sites, their experience of operation and maintenance is at a basic level and needs to be improved. In addition the inhabitants are lacking in knowledge on health and sanitation and lack of understanding on safe water. Currently, there are only a few households that are buying safe water. To improve the sustainability of the Project, it is important to increase the awareness of the inhabitants regarding the participation in the Project, hygiene 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) Authorization

1) Land-ownership and Concession

All Ethiopian lands are belonging to the country, there is no land-ownership, and all lands are under government management. On the other hand, the land use rights exist and it is necessary for the inhabitants and investors to rent the land from the state in order to use it. When they use the land of a local part of the Southern Nation, Nationalities and People's Region, the rental period is set according to the purpose and area, and the rental fee is determined depending on a class of applicable Zone and land. If it is inevitable to use the occupied residential areas and farmlands for public construction works, the town and water management organizations will evaluate and determine the area and the usage of the land, and a system to address the payment of the indemnification or provision of equivalent alternative land exists. In a part of the plumbing, this plan lays pipes on the farmland. Therefore, construction plans that avoid the busy farming season will be formulated and plumbing with minimum pipeline routes in the land in use will be selected.

2) Import Clearance and Tax Exemption

The Bureau of Finance and Economic Development (BoFED) is directly responsible regarding tax exemption and not the Regional Water Resources Bureau. From experience in grant aid projects in the past in Ethiopia, it can be judged that the exemption from taxation measures are possible, therefore, in order to avoid delays in procedures close communications should be maintained with the agency.

3) Application for Electricity Supply Facilities

The jurisdiction of the primary power station construction is Ethiopia Electric Power Corporation (EEPCO). Since the target towns have access to electricity supply, the construction of primary electricity lines to the neighborhood of the generator cabin is relatively easy. However, EEPCO will perform the construction and the schedule adjustment with EEPCO is necessary for the construction. It is necessary to confirm the construction schedule with the EEPCO appropriately while considering the construction progress because the construction of the primary electricity lines is the responsibility of WRB.

4) Road Crossing Permission

The jurisdiction of plumbing construction crossing the national highway is Ethiopian Roads Authority (ERA). Even if the cases of performing plumbing through the existing drainages buried underground without touching the national highway, a prior report to ERA is necessary. In case of performing drilling plumbing in the national roads, the conditions of the construction permission are such as the construction site is a public facility and to perform present condition restoration without changing the external appearance and it takes around one month from submitting the construction application to obtaining permission. WRB will submit the construction application.

(2) Electricity

Electricity is supplied to SNNPR by EEPCO, but due to the lack of capacity of the transformer substation, the electricity supply is not stable. Sudden blackouts occur even in major cities of Hawassa, Butajira and Soddo. The 10 target towns already have an electricity supply, but blackouts are frequent even in the major cities. Therefore, the installation of a diesel generator as a backup power supply during the blackouts will be planned in the facilities plan.

(3) Procurement Conditions of Engineers and Workers

Engineers, carpenters, plasterer mechanics and workers can be recruited in SNNPR. However there are few private construction companies that have experienced engineers and such companies also lack experience on large-scale constructions. In case of comparing with the construction companies of Addis Ababa, they are inferior in the aspects of technology, management capability, and experience. Therefore, engineers and workers will be procured from Addis Ababa.

(4) Working Conditions

The standards provided in Ethiopia for working hours per day are 8 hours from 8:30 a.m. to 5:30 p.m. Therefore, the formulation of the construction plan will conform to the same regulations above.

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

In Ethiopia, the local contractors are obliged to register, and are graded into 9 grades according to the number of employees and equipment they possess. And the local contractor that is ranked higher has enough technology and experience of facility construction. In this Project, the planning and cost estimation are carried out with the assumption of actively utilizing the local contractors that have been granted the higher grades.

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 mainly composed by WMOs, the roles of government, the method and ability of operation and maintenance of water supply facilities are not enough. Therefore, in order to improve the capacity of WMOs and Woreda offices, technical assistance (soft component) will be conducted.

In order to achieve operation and maintenance by WMO, Ethiopian side (especially Woreda office) has to provide 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, therefore the specifications employed by other Grant Aid Projects and other donors and SNNPRB will be referenced. And the design criteria are applied in Ethiopia basically. The other design conditions are applied the calculated number and method based on the actual situation.

Table 2-4: Planning condition for this Project

No.	Item	Design conitions	Standard to be conformed
1	Population growth rate	4.8 %/year	Same as SNNPRB
2	Water supply unit	8 towns 20.0 L/c/d Mito, Kibat*1 25.0 L/c/d Schools 5.0 L/c/d Health center 25.0 L/c/d	Ethiopia Standard*2
3	Amount of non-revenue water	15% of amount of revenue water	Ethiopia Standard*2
4	Water demand	Water Supplied Population × water suply unit ÷ 87.0% ÷ 83.3%	Ethiopia Standard*2
5	Daily ave. water supply amount	Water Supplied Population × water supply unit	
6	Daily ave. water supply amount per capita	Daily ave. water usage amount ÷ water Supplied Population	
7	Water supply ratio	Planning daily max. water supply amount ÷ water demand	
8	Planning effectiveness ratio	87.0% = 100% ÷ 115%	Ethiopia Standard*2
9	Planning daily ave. water supply amount	Daily ave. water supply amount ÷ planning effectiveness ratio	
10	Planning loading factor	83.3% = 100% ÷ 120%	Ethiopia Standard*2
11	Planning daily max. water supply amount	Planning daily ave. water supply amount ÷ Planning loading factor	
12	Hourly factor	Public faucets 2.67 = 24h ÷ 9h	Original calculation
		Private connection 2.00	Ethiopia Standard*2
13	Planning hourly max. water supply amount	Planning daily ave. water supply amount × hourly factor	Ethiopia Standard*2
14	Effective water head	5m principle	
15	Open hour for public faucets	9h = 3h (morning) + 3h (noon) + 3h (evening)	Ethiopia Standard*2
16	Pump operation time	8h principle, max. 12h	Ethiopia Standard*2
17	Capacity of reservoir	More 10,000 peoples 12h for ave. supply amount Less than 10,000 15h for ave. supply amount	Ethiopia Standard*2
18	Hydrologic accounting formula for pipes	Hazen Williams formula	
19	Flow coefficient	C: 110	

*1 25.0 L/c/d set in Mito and Kibat because of current water usage situation

*2 Rural Water Supply and Sanitation Design Criteria

(2) Project Target Year

Project target year is year 2020 confirmed on the inception report discussions.

(3) Water Supplied Population

Water supplied population in 2020 was calculated using population data of 2013 from the Ethiopian Central Statistical Agency (CSA). SNNPRB is set the population growth rate as 4.8% per year in urban area, 3.9% per year in rural area; however, for small towns in rural areas 4.8% per year is adopted because of consideration of trend of population inflow to small towns and of amalgamation of towns. Target of this Project is small towns; therefore, the population growth rate as 4.8% per year was adopted in this Project. Water supplied population in 2020 is as mentioned below.

Table 2-5: Water supplied population in 2020 (General)

Unit: Person

Small town	2013				Annual population growth rate*2	2020	
	Population*1			Household		Population	Household
	Male	Female	Total				
Koshe	5,277	4,605	9,882	1,865	4.8%	13,721	2,588
Kela	2,361	2,693	5,054	981	4.8%	7,017	1,362
Tiya	1,301	1,481	2,782	551	4.8%	3,863	765
Adilo	3,362	3,331	6,693	1,025	4.8%	9,293	1,423
Teferi Kela	2,467	2,311	4,778	877	4.8%	6,634	1,217
Dalocha	5,051	4,705	9,756	1,688	4.8%	13,546	2,343
Mito	2,466	2,245	4,711	1,078	4.8%	6,541	1,496
Alem Gebeya	2,898	2,353	5,251	1,024	4.8%	7,291	1,422
Kibat	4,191	3,964	8,155	1,426	4.8%	11,323	1,980
Tebela	4,717	4,256	8,973	1,646	4.8%	12,459	2,285
Total	34,091	31,944	66,035	12,161	***	91,688	16,881

*1 Data of Ethiopian Central Statistical Agency (CSA)

*2 Set 4.8 % per year to be adopted SNNPRB

The target towns have community facilities such as schools and health centers. The expected number of students in 2020 was calculated using the population growth rate (4.8 % per year) in order to consider increase of students. However, for the number of health center patients in 2020 the data from 2013 was used, because the ratio of patients with waterborne diseases is expected to decrease through the provision of safe drinking water by this Project.

Table 2-6: Water supplied population in 2020 (Community facilities)

Unit: Person

Small town	2013				Annual population growth rate	2020	
	School			H. Center		Students	Patients*
	Primary	Secondary	Total	Patients			
Koshe	2,348	985	3,333	60	4.8%	4,628	60
Kela	1,750	960	2,710	70	4.8%	3,763	70
Tiya	867	0	867	25	4.8%	1,204	25
Adilo	1,916	1,230	3,146	50	4.8%	4,368	50
Teferi Kela	1,633	916	2,549	40	4.8%	3,539	40
Dalocha	3,899	1,694	5,593	140	4.8%	7,766	140
Mito	1,600	487	2,087	40	4.8%	2,898	40
Alem Gebeya	1,819	545	2,364	65	4.8%	3,282	65
Kibat	4,541	1,369	5,910	80	4.8%	8,206	80
Tebela	1,648	3,450	5,098	40	4.8%	7,078	40
Total	22,021	11,636	33,657	610	***	46,732	610

* Number in 2013 adopted supposing to decrease the ratio of patietns by this Project

(4) Water Supply Unit

Water supply unit in UAP is set at 20.0 liters per capita per day (L/c/d). However, current water supply amount in each town was calculated in order to set feasible water supply unit. At first, monthly income by Water tariff mentioned on account ledgers was divided by unit of Water tariff, then water supply amount was calculated.

Table 2-7: Current water supply amount

Small town	Public faucet			Private connection		
	Income*1	Water tariff*2	Water supply amount	Income*1	Water tariff	Water supply amount
	Birr/month	Birr/m^3	m^3/month	Birr/month	Birr/m^3	m^3/month
Koshe	3,659.25	7.50	487.90	16,903.50	5.00	3,380.70
Kela	1,317.90	10.00	131.79	14,795.00	7.00	2,113.57
Tiya	8,000.00	15.00	533.33	***	***	***
Adilo	24,282.00	20.00	1,214.10	14,346.00	18.00	797.00
Teferi Kela	2,263.59	10.00	226.36	5,999.00	4.00	1,499.75
Dalocha	8,079.99	12.50	646.40	14,073.00	4.50	3,127.33
Mito	5,958.33	7.50	794.44	20,665.57	7.50	2,755.41
Alem Gebeya	9,425.00	7.50	1,256.67	10,461.67	5.00	2,092.33
Kibet	4,257.98	7.50	567.73	22,172.67	3.50	6,335.05
Tebela	2,041.67	10.00	204.17	9,000.00	2.00	4,500.00

*1 Monthly max. income of water recorded on ledger past 4 years

*2 Water tariff per 20 liters converted to 1 m^3

Next, calculated water supply amount was divided by population in 2013 and then current water usage amount per capita was calculated.

Table 2-8: Current water usage amount per capita

Small town	Water supply amount					Population (2013)	Current water usage amount per capita
	Public facets		Private connection		Total		
	m^3/month	m^3/day	m^3/month	m^3/day	m^3/day	Person	L/c/d
Koshe	487.90	16.26	3,380.70	112.69	128.95	9,882	13.05
Kela	131.79	4.39	2,113.57	70.45	74.84	5,054	14.81
Tiya	533.33	17.78	0.00	0.00	17.78	2,782	6.39
Adilo	1,214.10	40.47	797.00	26.57	67.04	6,693	10.02
Teferi Kela	226.36	7.55	1,499.75	49.99	57.54	4,778	12.04
Dalocha	646.40	21.55	3,127.33	104.24	125.79	9,756	12.89
Mito	794.44	26.48	2,755.41	91.85	118.33	4,711	25.12
Alem Gebeya	1,256.67	41.89	2,092.33	69.74	111.63	5,251	21.26
Kibet	567.73	18.92	6,335.05	211.17	230.09	8,155	28.21
Tebela	204.17	6.81	4,500.00	150.00	156.81	8,973	17.48

Current water usage amount in Mito and Kibat was significantly over 20.0 L/c/d. If water supply planning is designed with 20.0 L/c/d as water supply unit to these 2 towns, water demand will immediately exceed water supply capacity, and there is the possibility that water cannot flow until the end of faucets. Therefore, in Mito and Kibat, 25.0 L/c/d was adopted based on the current water usage conditions. In the other 8 towns, 20.0 L/c/d was adopted based on UAP.

Water supply unit for community facilities are 5.0 L/c/d in school, 25.0 L/c/d in health center applied by Ethiopian Design Standard.

(5) Planning Effectiveness Ratio

Amount of non-revenue water is set as 15% of amount of revenue water in Ethiopian Design Standard. Therefore, planning effectiveness ratio calculated to divide by total production amount was set 87.0% (=100%÷115%).

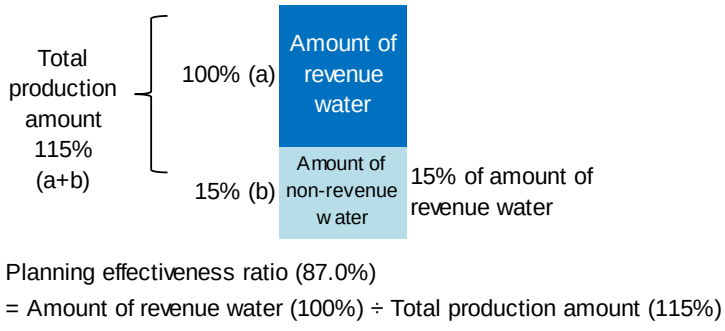


Figure 2-2: Relation of revenue and non-revenue water

(6) Planning Loading Factor

Planning daily maximum water supply amount is set as 120% of planning daily average water supply amount in Ethiopian Design Standard. Therefore, planning loading factor was set 83.3% (=100%÷120%).

(7) Hourly Factor

In 9 towns except Tiya, public faucets and private connection are operated together, therefore hourly

factor was calculated for each water supply facility. Hourly factor for pipeline to public faucets was set 2.67 (=24 h/day÷9 h/day) based on usage hour (9 hours) applied by Ethiopian Design Standard. Then hourly factor for pipeline to private connection to be connected by inhabitants was set at 2.00 applied by Ethiopian Design Standard. Calculated hourly factor was divided by current ratio of each water supply facility; hourly factor in each town was calculated.

Table 2-9: Hourly factor

Small town	Popullation (2013)	Number of users		Ratio of Users		Time factor		Time factor for each town *3
		Public faucet	Private connection	Public faucet	Private connection	Public faucet *1	Private connection *2	
Koshe	9,882	7,460	2,422	75.0%	25.0%	2.67	2.00	2.50
Kela	5,054	2,721	2,333	54.0%	46.0%	2.67	2.00	2.36
Tiya	2,782	2,782	0	100.0%	0.0%	2.67	2.00	2.67
Adilo	6,693	5,772	921	86.0%	14.0%	2.67	2.00	2.58
Teferi Kela	4,778	3,977	801	83.0%	17.0%	2.67	2.00	2.56
Dalocha	9,756	7,034	2,722	72.0%	28.0%	2.67	2.00	2.48
Mito	4,711	3,133	1,578	67.0%	33.0%	2.67	2.00	2.45
Alem Gebeya	5,251	3,815	1,436	73.0%	27.0%	2.67	2.00	2.49
Kibet	8,155	2,292	5,863	28.0%	72.0%	2.67	2.00	2.19
Tebela	8,973	1,615	7,358	18.0%	82.0%	2.67	2.00	2.12
Total	66,035	40,601	25,434	***	***	***	***	***

*1 2.67 = 24h ÷ 9h

*2 Adopted on Ethiopian Design Standard

*3 Calculated by hourly factor of each water supply facilities and ratio of usage

(8) Planning Daily Average Water Supply Amount

Planning daily average water unit calculated based on population in 2020 and water supply unit are as follows.

Table 2-10: Planning daily average water supply amount

Small town	General			School			Health center			Daily ave. water supply amount
	Population (2020)	Water supply unit*1	Total	Students (2020)	Water supply unit*2	Total	Patients (2020)	Water supply unit*3	Total	
	person	L/c/d	m^3/day	person	L/c/d	m^3/day	person	L/c/d	m^3/day	m^3/day
Koshe	13,721	20.0	274.42	4,628	5.0	23.14	60	25.0	1.50	299.06
Kela	7,017	20.0	140.34	3,763	5.0	18.82	70	25.0	1.75	160.91
Tiya	3,863	20.0	77.26	1,204	5.0	6.02	25	25.0	0.63	83.91
Adilo	9,293	20.0	185.86	4,368	5.0	21.84	50	25.0	1.25	208.95
Teferi Kela	6,634	20.0	132.68	3,539	5.0	17.70	40	25.0	1.00	151.38
Dalocha	13,546	20.0	270.92	7,766	5.0	38.83	140	25.0	3.50	313.25
Mito	6,541	25.0	163.53	2,898	5.0	14.49	40	25.0	1.00	179.02
Alem Gebeya	7,291	20.0	145.82	3,282	5.0	16.41	65	25.0	1.63	163.86
Kibet	11,323	25.0	283.08	8,206	5.0	41.03	80	25.0	2.00	326.11
Tebela	12,459	20.0	249.18	7,078	5.0	35.39	40	25.0	1.00	285.57
Total	91,688	***	1,923.09	46,732	***	233.67	610	***	15.26	2,172.02

*1 25.0 L/c/d adopted in Mito and Kibat, 20 L/c/d in other 8 small towns

*2 5.0 L/c/d adopted based on Ethiopian Design Standard

*3 25.0 L/c/d adopted based on Ethiopian Design Standard

(9) Planning Hourly and Daily Maximum Water Supply Amount

Planning hourly maximum water supply amount and planning daily maximum water supply amount to be used for the design of capacity of reservoir and diameter of pipeline was calculated using planning loading factor and hourly factor as follows.

Table 2-11: Planning hourly and daily maximum water supply amount

Unit: m^3/day

Small town	Daily Ave. water supply amount	Planned effectiveness rate	Planning daily ave. water supply amount	Planned load factor	Planning daily max. water supply amount	Time factor	Planning hourly max. water supply amount
	a	b	c=a÷b	d	e=c÷d	f	g=c×f
Koshe	299.06	87.0%	343.92	83.3%	412.70	2.50	859.80
Kela	160.91	87.0%	185.05	83.3%	222.06	2.36	436.72
Tiya	83.91	87.0%	96.50	83.3%	115.80	2.67	257.66
Adilo	208.95	87.0%	240.29	83.3%	288.35	2.58	619.95
Teferi Kela	151.38	87.0%	174.09	83.3%	208.91	2.56	445.67
Dalocha	313.25	87.0%	360.24	83.3%	432.29	2.48	893.40
Mito	179.02	87.0%	205.87	83.3%	247.04	2.45	504.38
Alem Gebeya	163.86	87.0%	188.44	83.3%	226.13	2.49	469.22
Kibat	326.11	87.0%	375.03	83.3%	450.04	2.19	821.32
Tebela	285.57	87.0%	328.41	83.3%	394.09	2.12	696.23
Total	2,172.02	***	2,497.84	***	2,997.41	***	6,004.35

(10) Water Demand Flow

Water demand flow of this Project is mentioned as follows.

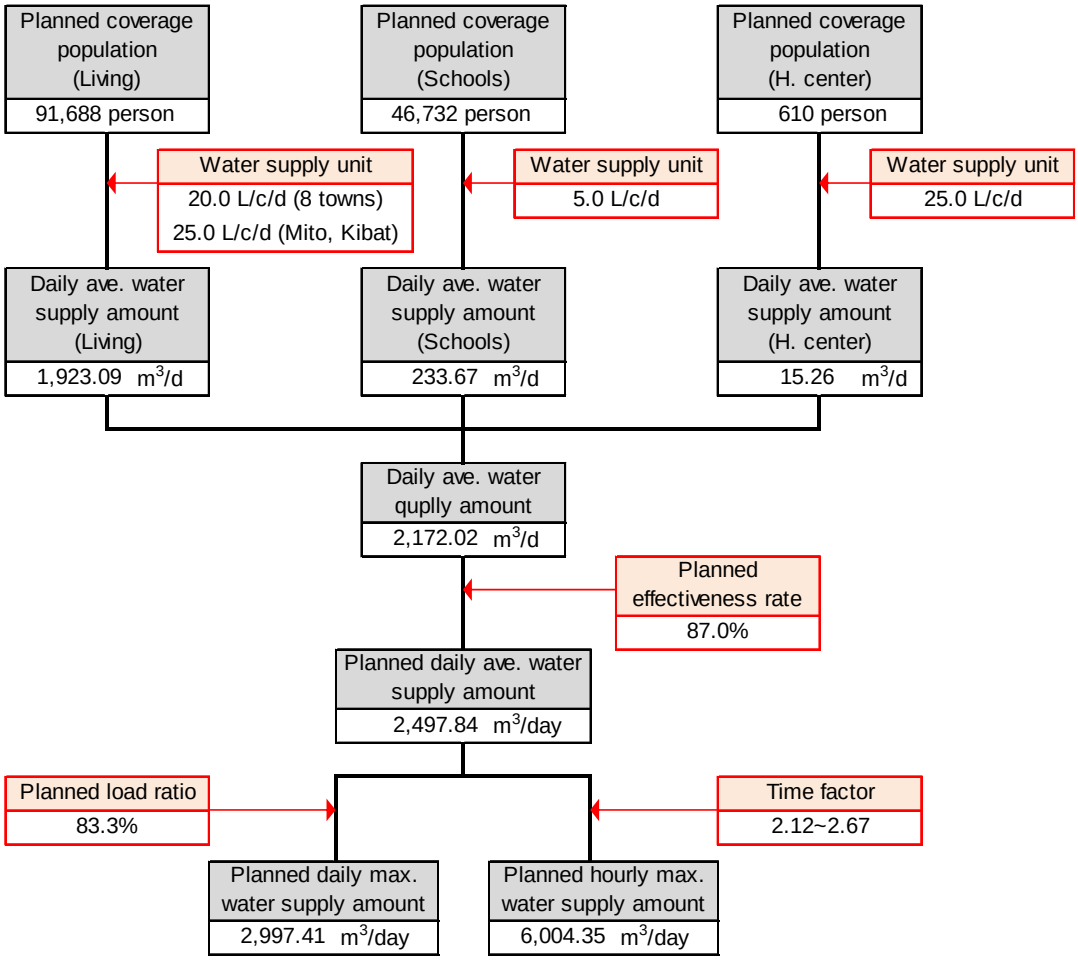


Figure 2-3: Planned water demand flow

2-2-2 Basic Plan (Construction Plan)

2-2-2-1 Overall Plan

This Project is to construct water supply facilities consisting of water source (groundwater or spring), generator house, reservoir, pipeline and public faucet in ten target towns. Overall plan of this Project is as follows.

Table 2-12: Outline of the Project

Work type	Specification		Unit	Quantity										Total
				Koshe	Kela	Tiya	Adilo	Teferi Kela	Dalocha	Mito	Alem Gebeya	Kibet	Tebela	
Well points	Existing well		Place			1						1		2
	New well		Place	1	2	1	2	2		1	1	1	1	12
	Sub total		Place	1	2	2	2	2	0	1	1	2	1	14
Generator house	New		Place	1	2	2	2	2		1	1	2	1	14
	Sub total		Place	1	2	2	2	2	0	1	1	2	1	14
Transmission pipe	SGP	φ150mm	m	2,170								4,000	1,430	7,600
		φ100mm	m		5,740		3,080			970	2,010	3,060		14,860
		φ75mm	m			2,610		3,140						5,750
	Sub total		m	2,170	5,740	2,610	3,080	3,140	0	970	2,010	7,060	1,430	28,210
Collection chamber	RC, 60m^3		Place						1					1
	Sub total		Place	0	0	0	0	0	1	0	0	0	0	1
Reservoirs	Ground RC	114.5m^3	Place										1	1
		100.7m^3	Place				1							1
		72.0m^3	Place	1										1
		15.7m^3	Place		1									1
	Elevated Steel	193.7m^3	Place									1		1
		122.0m^3	Place								1			1
		114.8m^3	Place					1						1
		131.2m^3	Place							1				1
		32.8m^3	Place			2								2
	Sub total		Place	1	1	2	1	1	0	1	1	1	1	10
Distribution pipe	SGP	φ150mm	m	1,350					3,640		650	690	530	6,860
		φ100mm	m		920	390	220	1,130	200		1,100	570	70	4,600
		φ75mm	m	1,776	660	1,290	520	590	430	480	770	2,490	2,060	11,066
		φ50mm	m	1,151	150	720	1,460	490	2,470	290	1,570	2,510	3,690	14,501
		φ40mm	m	2,220	6,870	1,590	2,050	2,160	5,500	2,110	2,200	4,250	8,240	37,190
	Sub total		m	6,497	8,600	3,990	4,250	4,370	12,240	2,880	6,290	10,510	14,590	74,217
Public faucets	Renovation		Place	10	9	3	6	10	8	10	8	15	8	87
	New		Place	7	9	5	6	6	10	5	5	8	8	69
	Sub total		Place	17	18	8	12	16	18	15	13	23	16	156

2-2-2-2 Facility Plan

2-2-2-2-1 Water Supply System

(1) 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 be operated and maintained 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 use large amounts of power.
- To ensure easy operation and maintenance by WMO, complex water supply systems and high-spec equipment are not planned.
- To minimize initial investment (construction cost), equipment able to be procured in Ethiopia, and construction methods and secondary products (spare parts) that are in general circulation in Ethiopia are planned.

(2) Water Supply System

1) Water Supply System #1

This water supply system is planned in 2 towns (Koshe and Kela). This system is composed of one unit including a groundwater source secured in the test drilling survey, motorized pump, reservoir and public faucets. The elevation of the construction site of the reservoir is higher than the elevation of the construction site of the public faucets; therefore, the ground reservoir type is planned. The water is distributed from the reservoir to public faucets by gravity. Also, service pipe and private connection were installed in target sites, and each household is receiving water supply. Therefore, the project will install the distribution pipe which is not connected public faucet to make the connection of public faucet easy. Installation and rehabilitation of service pipe and private connection will be conducted by the Ethiopian side, and will not be conducted by the Project.

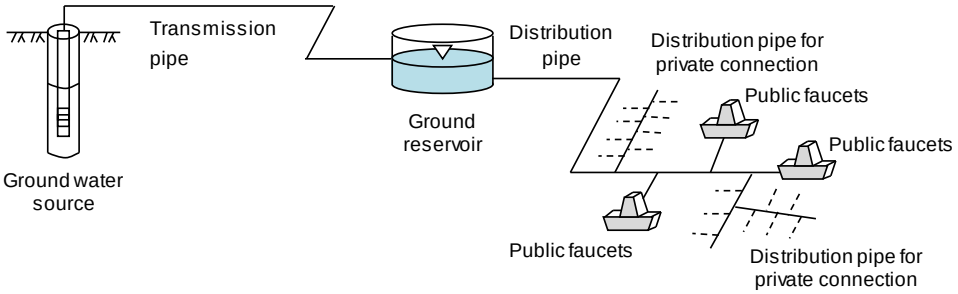


Figure 2-4: Water supply system #1

2) Water Supply System #2

This water supply system is planned in 2 towns (Adilo and Tebela). This system is composed of one unit including a new groundwater source, motorized pump, reservoir, pressure reduced tank and public

faucets. The elevation of construction site of reservoir is higher than the elevation of construction land of public faucets; therefore a ground reservoir is planned. However there is possibility of damaging the end of public faucets, because of the large difference in elevation. Therefore pressure reduction tank is planned to avoid high water pressure to public faucets. In addition, the areas which have difference in height between pressure reduced tank and public faucet is less than 5m are supplied water before reducing pressure, because water head has to be secured 5m at least on Ethiopian Design Standard.

As well, service pipe and private connection were installed in target sites, and each household is receiving water supply. Therefore, the project will install the distribution pipe which is not connected public faucet to make the connection of public faucet easy. Installation and rehabilitation of service pipe and private connection will be conducted by the Ethiopian side, and will not be conducted by the Project.

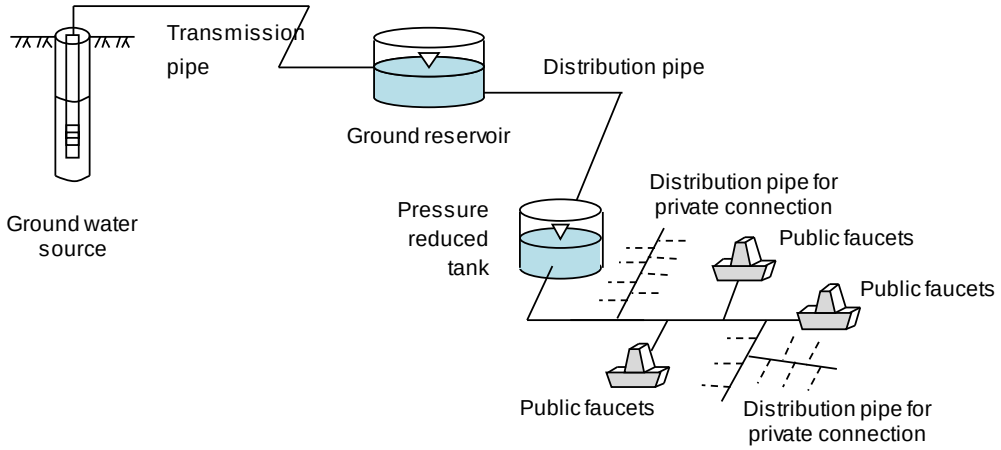


Figure 2-5: Water supply system #2

3) Water Supply System #3

This water supply system is planned in 5 towns (Tiya, Teferi Kela, Mito, Alem Gebeya and Kibat). This system is almost the same composition as water supply system #1 mentioned above, water source is groundwater secured in test well drilling. However in Tiya and Kibat, water yield of new wells is not sufficient, therefore existing wells are converted for this Project. The elevation of construction site of reservoir is lower than the elevation of construction land of public faucets; therefore an elevated reservoir tank is planned. The water pressure is secured in order to distribute until the end of public faucets.

As well, service pipe and private connection were installed in target sites except Tiya, and each household is receiving water supply. Therefore, the project will install the distribution pipe which is not connected public faucet to make the connection of public faucet easy. Installation and rehabilitation of service pipe and private connection will be conducted by the Ethiopian side, and will not be conducted by the Project.

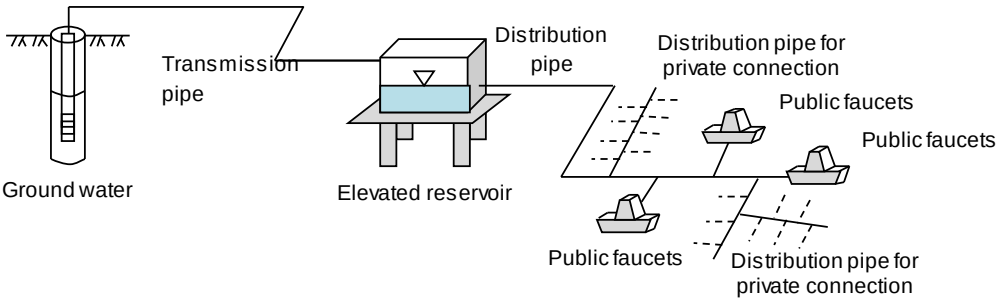


Figure 2-6: Water supply system #3

4) Water Supply System #4

This water supply system is planned in 1 town (Dalocha). Existing spring evaluated as sufficient water quantity and quality for the Project is converted. Spring water is collected in a collection chamber, and then transmitted to the reservoir. Existing reservoir is converted for use in the Project, because it was evaluated as having sufficient capacity and elevation, and no damage. The water is distributed from reservoir to public faucets by gravity. And same as Adilo and Tiya, pressure reduction tank is planned to reduce water pressure to public faucets.

As well, service pipe and private connection were installed in Dalocha, and each household is receiving water supply. Therefore, the project will install the distribution pipe which is not connected public faucet to make the connection of public faucet easy. Installation and rehabilitation of service pipe and private connection will be conducted by the Ethiopian side, and will not be conducted by the Project.

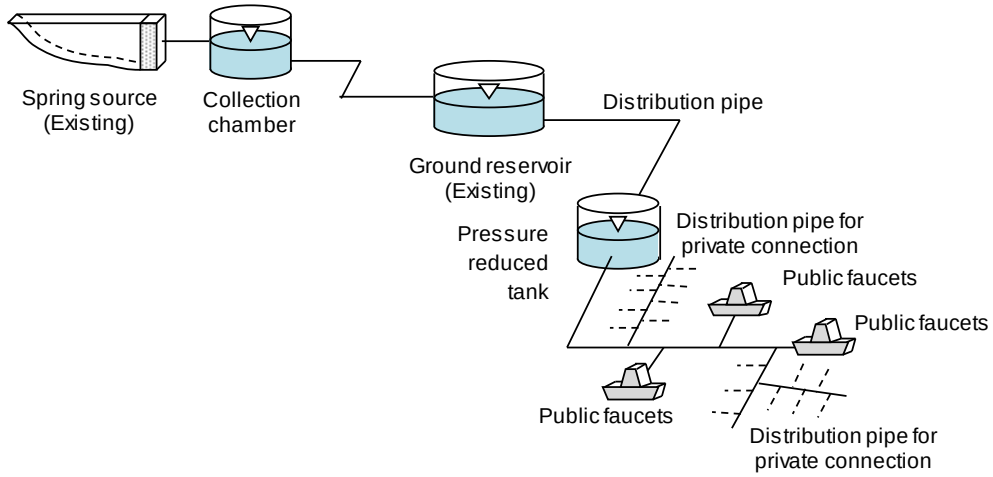


Figure 2-7: Water supply system #4

2-2-2-2-2 Water Source

In Dalocha of the existing spring has sufficient quantity, therefore this water source is used in the design of a new water supply facility. However, in other 9 towns, water source is designed using groundwater secured in test well drilling. Basic concept of water source in this Project is as follows.

- If quantity and quality of wells constructed in test well drilling is sufficient, it is converted to production well, then planning daily maximum water supply amount is designed using this source.
- Based on suitable yield from the results of the pumping test, pumping operation hour is calculated

in order to secure the planned daily maximum water supply amount. Pumping hours is basically set to 8 hours, as per the Ethiopian Design Standards. However, there are production wells that have a low suitable yield, and the planned daily maximum water supply amount cannot be secured with only 8 hours of operation. Therefore the planned daily maximum water supply amount is secured by a maximum of 12 hours of operation between 7:00 and 19:00.

- If planned daily maximum water supply amount cannot be secured with 12 hours of operation, the shortfall amount is to be secured using existing wells (groundwater) in order to secure the entire planned water supply amount.

In Tiya and Kibat, planned daily maximum water supply amount cannot be secured by new production wells in test well drilling; therefore, existing wells are converted for this Project. Water source plan of this Project is as shown below. Planning daily maximum water supply amount can be secured in all towns with a maximum of 11.09 hours (Tiya) pumping operation.

Table 2-13: Water source plan

Small towns	Water demand		Amount of water production								
	Planning daily ave. water supply amount	Planning daily max. water supply amount	Existing source*1			New groundwater source					Total
			Yield	Operation time*2	Production	Yield		Operation time*2	Production		
						#1	#2		#1	#2	
	L/s		h/day	m^3/day	L/s	L/s	h/day	m^3/day	m^3/day	m^3/day	
Koshe	343.92	412.70			0.00	25.50	***	8.00	734.40	0.00	734.40
Kela	185.05	222.06			0.00	3.64	3.50	8.64	113.22	108.86	222.08
Tiya	96.50	115.80	1.50	11.09	59.89	1.40	***	11.09	55.89	0.00	115.78
Adilo	240.29	288.35			0.00	5.00	5.00	8.01	144.18	144.18	288.36
Teferi Kela	174.09	208.91			0.00	3.50	3.52	8.27	104.20	104.80	209.00
Dalocha	360.24	432.29			691.00	***	***	***	0.00	0.00	691.00
Mito	205.87	247.04			0.00	10.01	***	8.00	288.29	0.00	288.29
Alem Gebeya	188.44	226.13			0.00	6.79	***	9.26	226.35	0.00	226.35
Kibat	375.03	450.04	3.80	9.70	132.70	9.10	***	9.70	317.77	0.00	450.47
Tebela	328.41	394.09			0.00	24.92	***	8.00	717.70	0.00	717.70
Total	2,497.84	2,997.41	***	***	883.59	***	***	***	***	***	3,943.43

*1 Existing water source to be converted to this Project. Ground water in Tiya and Kibat, spring in Dalocha

*2 Basically 8 hours operation, max. 12 hours

The type of pump selected is a submersible motorized pump after considering the ease of procuring the pump body and spare parts in Ethiopia.

2-2-2-2-3 Reservoir

(1) Design

In Ethiopian Design Standard, capacity of reservoir is secured amount for 15 hours of daily average water supply amount in towns with a population of less than 10,000 people, and 12 hours in towns with populations of more than 10,000 people; therefore, this standard is applied in this Project. Moreover, in general, existing reservoirs will be converted, and the shortfall will be covered by the new reservoir. However, if it is difficult to secure suitable water distribution and pressure such as because the existing reservoir is in a poor state of repair or there are structural problems or issues related to location, then a new reservoir will be planned in order to secure the entire planned amount.

Ground reservoir is planned if there is high land to construct within the town, however, elevated

reservoir is planned in order to secure pressure if there is no high land.

(2) Structure

Ground reservoir in Ethiopia is constructed by stone masonry or reinforced concrete (RC) generally; therefore, each feature was compared and considered.

Table 2-14: Comparison of structure of ground reservoir

Type	Stone masonry	Reinforced concrete
Structure	○ General structure in Ethiopia to load stones doubleness and fill up concrete.	○ General structure in Ethiopia consisting hardpan, slab and wall made by RC.
Quality	△ Quality is not secured because stones have variety of form and size, so it takes time for filling up of concrete and loading stone.	○ Quality is secured because concrete places hardpan, slab and wall in same time.
Water-tightness	× Stones and concrete doesn't unit so water-tightness is defective. It is difficult to find leakage point.	○ Water-tightness is secured because concrete places in same time.

As a result of consideration, RC type is selected for structure of ground reservoir in this Project.

In addition, elevated reservoir is selected reservoir and frame made by RC or reservoir made by steel and frame by RC generally; therefore, each feature was compared and considered.

Table 2-15: Comparison of structure of elevated reservoir

Type	Reservoir and frame made by RC	Reservoir made by steel and frame by RC
Structure	○ General structure in Ethiopia to set RC reservoir on RC flame.	○ General structure in Ethiopia to set steel reservoir on RC flame.
Quality	○ Quality is secured to manage concrete placing properly.	○ Quality is secured to manage concrete placing and welding properly.
Construction period	× Construction period becomes long term because work place is altitude.	△ Construction period becomes short term because main work is welding.
Safeness	× Safeness is not secured because of work place is altitude then it is difficult to keep space.	△ Safeness is secured to keep welding space.
Quantity of materials	△ Each size of member of framework increases to set RC structure object on the frame.	○ Each size of member of framework decreases than RC structure object.
Water-tightness	○ Water-tightness is secured to manage concrete placing properly.	○ Water-tightness is secured to manage welding properly.

As a result of consideration, reservoir made of steel with a RC frame was selected for the Project because of actual performance, easiness and safety of construction.

2-2-2-2-4 Pipe Line

(1) Design

In target 10 towns except Tiya, water supply service with public faucets and private connection is mixed operating actually; even this Project is planned as water supply service with public faucets. Most of private connection was connected directly to main pipe line on management of WMOs. Target of piping plan for this Project is until connecting to public faucet. It is necessary to reconnect to main pipe line to be constructed on this Project in order to use private connection continuously. Currently, the end of users of private connection cannot get sufficient water quantity because of shortage of volume of water and reservoir tank, increasing of head loss due to the small diameter of distribution pipe, and so on. If they connect to main pipe line in this Project, they can get sufficient water amount even those who live at the ends of the pipelines.

Therefore pipe diameter and place of valves in this Project are planned not to connect public faucets only, but to secure water supply amount for private connection and connect pipe line for private connection also. However the target of the Project is connection to public faucets only, the connection to private connection is the responsibility of the Ethiopian side (users). In addition, the existing pipe lines consisted of small diameter against planning water supply amount and aging are replaced in this Project.

As well, in order to utilize the existing private connections, confirmation and understanding of WMOs of each small towns and RWRB about reconnection of the private connection by residents burden in the area to replace the distribution pipe in this Project, has already been obtained. On the other hand, in order to reduce the cost of private connection which is resident burden, it is desired that installation of private connections are conducted in the period of digging. Therefore, WMOs need to explain to residents about the connection cost and construction time before the Japanese Contractor starts plumbing. Clarification of piping works is shown below.

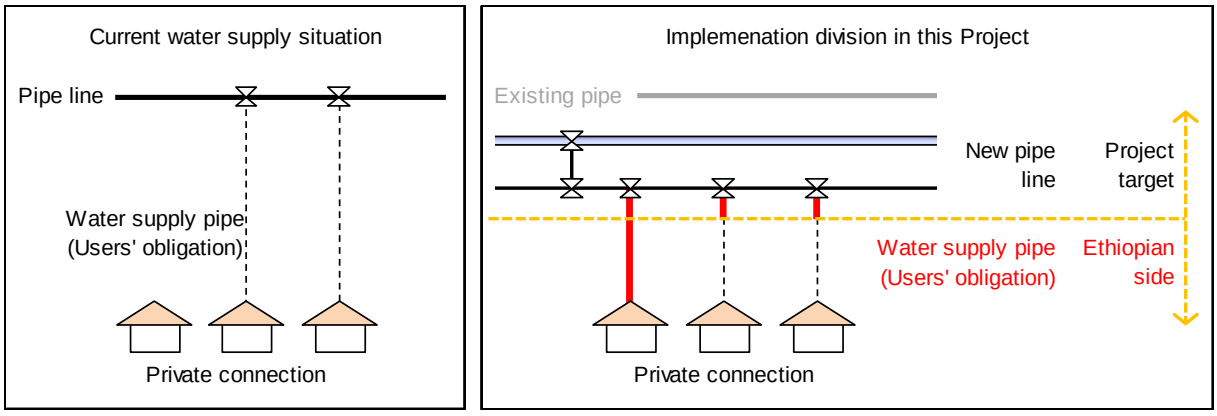


Figure 2-8: Clarification of pipe connection

The cost of connection to main pipe line is calculated as shown on Table 2-16.

Table 2-16: Cost of re-connection to main pipe line

Item	Unit price*	Distance	Price
	Birr/m	m	Birr
Additional cost for private connection	82.1	2.0	164.2

* Incuding excavation, connection and back filling with materials.
Unit price in cost estimation is adopted.

In case of the inhabitants are commenced the water supply service of private connection, they have to prepare connection fee (1,200 to 1,800 Birr) consisting the material (pipes, valves, water meter, tap etc.), labor charge and registration fee to WMOs. Therefore it seems that the users of private connection can prepare the cost of re-connection, because they had already paid this amount, and their water supply condition will be improved. And it is better to connect around the same time of piping work period by the Contractor. There is possibility to delay re-connection because the re-connection is the responsibility of the users. If so, the users cannot use private connection temporarily, however they can get water using public faucets to be constructed in this Project in their living area.

Basically final pipe structure was planned as one system taking operation and maintenance by WMOs into consideration. Existing pipe is converted to the Project, however, new pipe laying are considered if the existing pipe is not sufficient diameter and age. Direction to public faucets is selected to the shortest line. Minimum diameter of pipe is approx. 40mm (1-1/2 inch) is selected in order to be able to flow planning hourly maximum water supply amount and discharge of mud.

(2) Pipe Materials

Pipe material to be used generally in Ethiopia are ductile cast iron pipe, steel pipe and PVC pipe, therefore, each feature was compared and considered.

Table 2-17: Comparison of pipe material

Type	Ductile cast iron pipe	Steel pipe	PVC pipe
Contruction period	△ Construction period becomes longer because of heavy weight.	△ Weight is lighter than ducile, but It takes time for connection.	○ Construction period becomes shorter because of light weight.
Withstand pressure	○ It is excellent at withstand pressure and no problem for normal use.	○ It is excellent at withstand pressure and no problem for normal use.	△ Leaking occurs at TS connection points (less that 50mm diameter) with time passage. There are possibiity to break by solvent crack.
Decay durability	○ It is no problem for decay durability and it doesn't make an impact even pipe outcroping by	○ It is no problem for decay durability and it doesn't make an impact even pipe outcroping by	× It may make an impact to load vehicles when pipe outcroping by rain.
Procurement	△ It is difficult to purchase in rural.	○ It is easy to purchase and repair of leakage.	○ It is easy to purchase and repair of leakage.
Economic efficiency	× It is expensive.	△ It is comparatively expensive.	○ It is cheap.

As a result of consideration, steel pipe was selected for the Project because of comparison of durability, possibility of leakage and easiness to procure in Ethiopia, even though PVC pipes are cheaper.

2-2-2-2-5 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.

2-2-2-2-6 Public Faucets

Construction place and number of public faucets are decided by landscape, population density and intention of habitants and WMOs. The place of public faucets is selected especially to consider being able to access all habitants within 500m as the goal of One WaSH Program.

Number of users per one public faucet is set 150 person/tap in Ethiopian Design Standard. Therefore number of tap is planned by the number of users; however, number of users of private connection in 2020 cannot be calculated at this time. Number of users of private connection is increasing; therefore, numbers of users of private connection in 2020 is guessed to be more than the number of users in 2013. Therefore current number of users of private connection in 2013 is set as minimum number of users in 2020; number of users of public faucets in 2020 is calculated to reduce this number from total population in 2020. In the meantime, in normal life water is fetched often at the same time in the morning, noon and early-evening, and there may be a congestion of users at the same time. Therefore, if public faucets with 2 taps are planned, it may mean users have to wait to get their water. And also it may mean that repairs are needed earlier if one of only two taps is broken. Therefore public faucets are planned by 4 taps or 6 tap types in this Project. In addition, the most of existing public faucets have damage and defect on their bodies and water taps.

A large proportion of existing public faucets do not fulfill the required functionality due to aging related cracks in concrete, missing faucets, break downs, etc. Therefore, public faucets are assumed to lose functionality and not be able to be used in the future. This also applies to all public faucets that were built at the same time. Even if there is no problem at present, it means there is a high possibility that the functionality of faucets will reduce in future.

Therefore, all existing public faucets are eliminated and constructed in this Project.

Table 2-18: Type of public faucets

Small town	Population (2020)	Private connection users*1 (2013)	Public faucets users (2020)	Number of planned public faucets	Users per one public faucet	Taps per public faucet	Type of public faucet*2
	a	b	c=a−b	d	e=c÷d	f=e÷150	
Koshe	13,721	2,422	11,299	17	665	4.43	6 taps
Kela	7,017	2,333	4,684	18	260	1.73	4 taps
Tiya	3,863	0	3,863	8	483	3.22	4 taps
Adilo	9,293	921	8,372	12	698	4.65	6 taps
Teferi Kela	6,634	801	5,833	16	365	2.43	4 taps
Dalocha	13,546	2,722	10,824	18	601	4.01	4 taps
Mito	6,541	1,578	4,963	15	331	2.21	4 taps
Alem Gebeya	7,291	1,436	5,855	13	450	3.00	4 taps
Kibet	11,323	5,863	5,460	23	237	1.58	4 taps
Tebela	12,459	7,358	5,101	16	319	2.13	4 taps

*1 Number of users of private connection cannot be supposable, therefore number of users in 2013 is adopted as minimum number in 2020.

*2 Public faucet with 2 taps is inconvenience, therefore 4 taps or 6 taps are adopted.

2-2-3 Outline Design Drawing

Outline design drawings of the Project are mentioned below.