JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF GRADUATE STUDIES

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

HYDRAULIC ENGINEERING MASTERS PROGRAM

EVALUATION OF THE LEVEL OF SERVICE IN RURAL WATER SUPPLY SCHEMES: CASE STUDY ON KACHABIRRA DISTRICT, KEMBATA TEMBARO ZONE, SOUTHERN REGION, ETHIOPIA.

Thesis submitted to the School of Graduate Studies of Jimma University in partial fulfillments of the requirements for the Degree of Masters of Science in Hydraulic Engineering.

By

Teketel Mirkeno Woliso

November; 2015

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Main Advisor: Dr.-Ing Esayas Alemayehu (PhD), Associate Professor

Co-Adviser: Mr. Andualem Shigute (MSc.)

November; 2015

Jimma, Ethiopia

Declaration

I, the under signed, declare that this thesis:

Evaluation of level of service in rural water supply schemes in Kacha Birra Woreda is my original work, and it has not been presented for a degree in Jimma University or any other University and that all sources of materials used for the thesis have been fully acknowledged.

Name	Signature	Date
Teketel Mirkeno	______________________ /	________________

This thesis has been submitted for examination with my approval as University Supervisor

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Co-advisor		
3. Mr. Andualem Shigute (MSc.)	__________	______________
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ABSTRACT

Adequate domestic water supply is provided to sustainable development. However, limited access associated with poor water supply, sanitation and widening the poverty gap, gender inequality and prevalence of water borne diseases. Rural water supply projects primarily need the management of resources for human consumption in rural areas through the utilization to improve the access to clean and reliable water supply. It also increases quantity and quality of water supply services through a group of people on continuous basis. Therefore, focusing the factors that affect' and indicators of functionality such as accessibility, reliability, quality and quantity. Design and technical problems lack community interconnection and not effectively supervising and monitoring of the construction, environmental problems and unavailability at spare parts and technicians factors affects sustainability of water supply service and they are also indicator of the sustainability. This research is aimed to evaluation the level of service rural water supply schemes. Both qualitative and quantitave data gathering was carried out. Questionnaire, focus group discussion and key informant interview, field observation, existing document reviewing are the major data gathering techniques used in this study. The numerical part of the data were analyzed using Microsoft excel, SPSS (Statistical package for social science) the result was represented through tables, graphs and charts and the word parts was digested in the narration form. The respondents or households were selected by using representative random sampling technique for the purpose of the household survey and were the kebeles and the schemes are selected by using purposive sampling methods. The bacteriological water quality analysis in the sampled points has problems as compared with WHO drinking water standard and it is not recommended for drinking. Appropriate finance mechanisms of operation and maintenance when schemes fail by collection of daily water tariff and additional contribution of user communities to sustain the water supply projects. The institutional support after water supply projects developed was weak due to no meaningful training given WASHCOs members to make them responsible for operation or repair and maintenance of the water point no improve under staffing problem in the system. Also after implementation the institutional representatives' frequency follow up (visiting) is low, maximally once a year. From the survey results of the respondents, most household were allowed averagely to fetch about 25 to 75 liters per a day of water from the source and quantity of water consumed in the district per person per day which is not meets the target of national plan of UAP (15 l/p/day) in 30 minute round trips. Therefore, the rehabilitation and implementation new schemes better to tackle rural water supply the problems.

<u>Key words</u>: *Functionality, rural water supply, service and sustainability*

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ACRONYMS

ADF African Development Fund

CSA Central Statistical Agency

GIS Geographic Information System

GOs Governmental Organizations

GPS Global Positioning System

GTP Growth and transformation plan

HDW Hand Dug Well

IRC International Water and Sanitation Center

JMP Joint Monitoring Programme

KTZWIEOR Kambata Tambaro Zone Water, Irrigation and Energy office Repot

KWADO Kachabirra Agricultural development Office

KWIEOR Kachabirra Woreda Water, Irrigation and Energy Office Report

LPCD Liter per Capital per day

MDGs Millennium Development Goals

MOFED Ministry of Finance and Economic Development

MoWE Minister of Water and Energy

MoWIE Minister of Water, Irrigation and Energy

MoWR Minister of Water Resource

MPCD Minutes per capita per day

MUS Multiple Use Service

NGOs Non-Governmental Organizations

O & M Operation and Maintenance

RWSS Rural Water Supply and Sanitation Services

SNNPRS Southern Nation Nationality and People Regional State

SPSS Statistical Package for Social Science

UAP Universal Access Plan

UNICEF United National Children Fund

WASHCOs Water Supply Sanitation and Hygiene Committee

WBRR World Bank of Regional Report

WHO World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Back ground of the study

Access to clean water and sanitation is universal need and basic as well as human right. As a matter of fact, people around the globe face a problem of water scarcity. About 70% of the earth's surface is water and 3% of this is fresh water. Yet, out this, 99% is found beneath the surface. Surprisingly, most of this water is largely unavailable for utilization (Duddin and Hendrie, 1988). As stated in UNDP (2008), currently 700 million people in 43 countries live with water scarcity of these many are in sub-Sahara Africa which represents one quarter of the global population that faces water scarcity live in developing countries. This scarcity of water forced people around the world to use unsafe water for drinking and other domestic uses (WHO, 2009). Today, close to billion people living in the developing world does not have access to safe and adequate water (UNICEF/WHO, 2012). The greatest challenge facing different development actors in the water supply and sanitation sector is real sustainable progress on behalf of the 2.6 billion people still without access to improved sanitation and 884 million people without access to safe drinking water (WHO & UNICEF, 2010).

Likewise, lack of proper sanitation is a serious health risk and an affront to human dignity. UNICEF by its 2012 report estimates that about two-fifths of the global population did not have access to improved sanitation. The majority of these people live in Asia and Africa. Africa has the lowest sanitation coverage of the global regions. In Africa, only 60% of the population has access to improve sanitation, but the situation is worst in rural areas only 45% of the rural population has accessed to improved sanitation. Thus, as WHO (2010) stated people are force to defecate in open fields, in rivers or near areas where children play and food is prepared because they do not have access to improved sanitation. As reported by Fewtrell et al. (2007) around 94% of the global diarrheal burden and 10% of the total disease burden are due to inadequate sanitation and poor hygienic practices.

On the other hand, Ethiopia has an estimated annual runoff 122 billion m^3 and 2.8 billion m^3 of ground water potential (ADF, 2005).

This corresponds to an average of 1,731 m^3 of physically available water per person per year, a relatively large volume. However, due to large spatial and temporal variations in rain fall and lack of storage, water is often not available where and when needed (Seleshi et al., 2007).only about 3% of water resource are used of which only about 11% (0.3% of the total) is used for domestic water supply. Due to this the access to water supply and sanitation in Ethiopia is amongst the lowest in Sub-Sahara Africa and the entire world (MoWR, 2012; ADF, 2005). As a result, people are still dependent on unprotected water sources such as river, streams, springs and hand dug wells. Since these sources are open, they are highly susceptible to flood and birds, animals and human contamination. In addition, most sources are found near gullies where open field defecation is common and flood washed wastes affect the quality of water.

In order to address the problem, governmental and non-governmental organizations made efforts to construct improved source to access to safe and potable drinking water. Despite the above mentioned effort, improved water source are often located far from user households and due to the undulating nature of water the country's topography, water sources often occur at inconvenient locations, forcing people to travel long distances over continues short and long steep slopes (MoWR, 2012). This resulted in more waiting times, inadequate supply and for over burden of women and children for works being the characteristics of many improved schemes (Admasu et al., 2003). These factors lead to less access to water needed by the household for consumption and forced households to seek out alternate unimproved and unhealthy nearly water source due to reluctance in using improved sources (Admasu et al., 2003). It is common that people who are most vulnerable to water-borne diseases are those who use polluted drinking water sources. Water quality concerns are often the most important component for measuring access to improved water source. Acceptable quality shows the safety of drinking water in terms of its physical, chemical and bacteriological parameters (WHO, 2004).

According to ADF (2005), the Millennium Development Goals (MDGs) of Ethiopia is expected to increase the improved water supply coverage from 2004 levels of 25% water supply and 8% sanitation to 62% for water supply and 54% sanitation by 2015.

In 2010 the government presented the equally ambition Growth and Transformation plan (UAP, 2011) that aims at increasing drinking water coverage in rural area from 65.8% (baseline at 2011) to 98% at 15 l/p/day with in radius of 1.5 km and to increase Urban water supply 91.5% to 100% at 20 l/p/day with in radius of 0.5 km and thereby increase national water supply from 68.5% to 98.5% in the year 2015 (MoFED, 2010). GTP also targeted to improve sanitation by 84% at 2015 starting from 2010 with the following sequences 13.3%, 27.5%, 41.6%, 55.7%, 69.9% and 84%. On the other hand, different study in the country shows that the total water supply coverage in the country is increased from 22% to 42.2% between in the year 2002 to 2007 (ADF, 2005 and MoWRD, 2007) and 68.5% at the year 2010 (MoFED, 2010). Similarly MoFED report of 2012 shows that in the country level, the percentage of households with access to improved drinking water has increased from 25.3% n 2000/01 to 58.25% in 2011/12 (MoFED, 2011/12). The same report indicates that sanitation coverage per house hold has increased from 6.8% in 2004/05 to 67% in 2011/12.

In kachabirr districts from the total rural water supply schemes (312), 63% functional and 37% is non-functional. The non-functionality is the greatest problem in the area. It mainly causes rural water supply coverage of the woreda (70%) which is below the national. This is the serious to taken into consideration for increasing the water supply coverage of the rural populations (KWIEOR, 2015(KWIEOR, 2015).).

Therefore, realizing the critical importance of supplying portable water, national and regional governments, local and international NGOs invest many millions of capitals every year in developing countries to tackle the problem through the implementation of water supply projects. Thus, this study was intended to evaluate the levels of services of rural water supply projects in the study area.

1.2 Statement of the problem

Provision of efficient, reliable and reasonable users' acceptable water supply and sanitation services to the urban and rural population are major concern in Ethiopia.

Despite these efforts water supply coverage is lower than most of African countries (WBRR, 2001). There are several reasons that are known to be causes for this problem.

These are inappropriate technology choice, financial constraints for operation and maintenance of water supply schemes, inadequate skilled man power, supply-driven approach to project design and failure to involve user communities in decision making processes at the project preparation stage. Moreover; poor awareness of the community to adapt safe personal hygiene and sanitation facilities has retarded the growth in water supply coverage (MoWR, 2007).

Construction of portable water projects in rural areas is the first step to increase potable access and which contribute to the health of its members. However, this alone would not achieve all intended objectives. According to ADF (2005) and MoWR (2007) 33% of rural water services in Ethiopia are non-functional due to lack of funds for operation and maintenance, inadequate community mobilization and commitment, less community participation in decision making as well as lack of spare parts.

Hence, this research is important to evaluate and identify the causes for failure of rural water supply systems by determining the social and physical characteristics of functional and non-functional rural water supply schemes for future sustainability.

It also identifies both the degree and type of community involvements and the institutional support during and after the design, construction and maintenance phases of functional and non-functional systems.

1.3 Objectives

1.3.1 General objective

- The general objective of this study is evaluation of the level of service in rural water supply schemes.

1.3.2 Specific objectives

- To evaluate appropriate financing mechanism for operation and maintenance of rural water supply schemes.
- To assess factors that affect rural water supply schemes functionality and sustainability

- To assess the nature of institutional supports given for local communities after water supply projects are completed.

1.4 Research questions

1. How do we estimate financing mechanism for ongoing operation and maintenance water supply schemes with in communities?
2. What are the indicators and possible tracks that affect rural water supply schemes functionality and sustainability?
3. What kind of external supports are available for the rural communities? To what extent?

1.5 Significance of study

This study was supported by the conversation and argument among regional and sectorial actors to address the problems of sustainability and functionality in the early phase of project planning up to its service period. More specifically policy makers, project planners, water supply and sanitation performers, NGOs, community water boards and committees can benefit from the study for taking corrective actions in the planning phase, operation and maintenance aspects, managing in addition to community participation to sustain system in their service level.

Hence, this research will contribute to the better understanding of problems and factors related to sustainable rural water supply schemes. The study will serve as reference for those working in the planning, design, implementation and supervision works of rural water supply projects.

1.6 Limitation of the study

In these study main issues faced was lack of adequate information due to poor document handling by the woreda’s water resource office. It was difficult to get source of documents in an organized manner mean that laborious to get reality information. The study relied on the broad surface data and estimates. Because of in the area was no previous research study on water supply to see parameters and to do comparative study with another side of the previous one. Also this study did not include physicochemical laboratory analysis because of the time and financial limitations.

CHAPTER TWO
LITERATURE REVIEW

2.1 Water supply and sanitation in Ethiopia

Provision of safe & sufficient water supply; adequate sanitation services are indispensable components in sustainable development of Ethiopians urban and rural socio economic wellbeing. At present, most of the population does not have adequate and safe access to water supply and sanitation facilities. As a result, over 70% of the contagious diseases in the country are water born based diseases. Source of most of these diseases could be traced back to inadequate water supply and sanitation facilities (MoWR, 2001).

The water distribution systems in the country are generally inadequate. The problem is associated partly with unfavorable topography, seasonal fluctuation of the water reservoirs, low capital investment and lack of efficient water governance among concerned authorities (Getachew, 2002). Quite frequently, Ethiopian planners emphasize the agronomic engineering or technical aspects of water projects, while giving less attention to governance and participation of stake holders. Rahmato (1999) observed that among the main reasons given for the slow progress in water supply service in the 1980s (but still relevant today) are the lacks of comprehensive water legislation; inadequate investment of resources and the lack of a national water tariff policy.

In order to address the low coverage, Ethiopia has committed itself to achieve the Millennium Development Goals (MDGs), including target 10, on halving the share of people without access to water and sanitation by 2015. To reach and surpass the MDGs, the Ministry of water, irrigation and energy introduced a Universal Access Plan (UAP) with the aim to reach full coverage in water supply service for rural communities access is 15 liters per capital of safe water per person in 1.5 Km radius and urban communities access is 20 liters per day per capital within 0.5 Km distance by the year 2012 (MoWR, 2006).

However; the Ministry of Water Resource (MoWR, 2007) estimated that 33% of water supply schemes in Ethiopia are non-functional at any time, with negative impacts on coverage and universal access due to lack of funds for operation and maintenance, inadequate community mobilization, without commitment and a lack of spare parts (Moriarty et al., 2009).

2.2 Domestic rural water supply and sanitation in socio-economic development

As demand grows, water stress increases and poor find it more difficult to meet their water needs. Water sources are often distant, polluted or intermittent. The burden falls especially heavily on women who typically end up doing most of the water collection and children who typically suffer most from the diseases associated with inadequate water supplies (Briscoe and Garn, 1995).

The provision of safe drinking water and basic sanitation contributes to sustainable improvement in peoples' lives regarding their health and education situation; the preconditions for productive employment as well as for the eradication of extreme hunger and the employment of women development of community water supplies and sanitation results in improved social, economic and health conditions (Davis et al., 1993).

One of the critical components of the Millennium Development Goals (MDGs) is increasing access to domestic water supply coupled with improved water resource management and development in rural areas (Lenton et al., 2008). According to WHO domestic water supply is water used for domestic purposes which include drinking, cooking and bathing. Therefore, when measuring adequacy of water in the household all such uses should be considered (WHO, 2003b). To ensure that rural households are water secure, it is necessary to evaluate the number, geographic location, yield, dependability, season and quality of the water sources (Kahinda et al., 2007). Besides, equipping people in rural communities with appropriate technologies and skills to enable them harvest rain water and excavate underground water together with effective management of these sources can provide sustainable solutions to the problems associated with the scarcity of domestic water supply in rural households (Malley et al., 2008).

Improvement of water supply service in rural areas can in turn give women more time for productive endeavors, adult education, empowerment activities and leisure (Panda, 2007). In the water supply and sanitation, the terms safe, adequate and improved are used to describe water supply and sanitation coverage.

The Global Water Supply and Sanitation assessment 2000 report by WHO/UNCEF differentiates between the terms improved, safe and adequate because of the lack of information on safety and adequacy of water supplies and sanitation facilities. As a result, it was assumed that certain types of technologies are safer or more adequate others and the term improved was used to describe the different types of water supply and sanitation technologies that are considered as coverage (WHO/UNCEF, 2000).

Table2. 1 Improved and unimproved water supply and sanitation technologies

Types of technology	Water supply	Sanitation
Improved	- Household connection - Public standpipe - Borehole - Protected dug well - Protected spring - Rainwater collection	- Connection to a public sewer - Connection to a septic system - Pour-flush latrine - Simple pit latrine - Ventilated improved pit latrine
Not improved	- Unprotected well - Unprotected spring - Vendor provided water - Tanker truck provision of water	- Service or bucket latrines - Public latrines - Open latrine

(Source: WHO/UNCEF, 2000)

2.3 Existing estimates of per capital water requirements

A range of estimates of per capital water requirements have been developed. The WHO and UNCEF in their global assessment of water supply adopted the figure of 20 l/c/d for domestic hygiene purposes from a source located within one kilometer of a person's dwelling and coming from one of a range of technologies generally considered capable of supplying safe water. No clarification was given, however, to estimate of 20 l/c/d was derived (WHO/UNCEF, 2000).

Gleick argues that at least 50 l/c/d are required to meet human and ecological needs, namely 5 l/c/d for drinking in tropical climates, 20 l/c/d for sanitation, 15 l/c/d for bathing and 10 l/c/d for food preparation (Gleick, 1996).

Howard and Bartram argue that 7.5 l/c/d can be calculated as the basic minimum water requirement to meet direct consumptive needs of which 2 l/c/d is required for food preparation. When water required for maintaining human hygiene is considered also calculating a minimum water requirement become less precise as the effective use of water for hygiene purposes is more important than the quantity used with only a very small quantities of water required preventing water acting as an absolute constraint on hygiene. With basic access of approximately 20 l/c/d (7.3 m^3/c/y), it is unlikely that all water requirements for hygiene will be met at 50 l/c/d (18.3 m3/c/y) intermediate access most requirements can be met and at 100 l/c/d (36.5 m3/c/y) optimum access, all requirements can be met (Howard and Bartram, 2003).

Table2. 2 Minimum per capital water requirements estimates

Source	Estimate (l/c/d)	Basis of estimate
WHO/UNCEF (2000)	20	Basic domestic health and hygiene needs
Gleick (1996)	50	Basic domestic health and hygiene needs
Howard and Bartram (2003)	100	All domestic health and hygiene needs

(Source: Chenoweth, 2007)

2.4 Water supply service levels and its ladders

It is important to define characteristics of service a consumer has access to in terms of service attributes.

The most commonly used service attributes are the quantity of water , quality of water, the reliability and accessibility of supply, which is expressed typically as the distance between the water point and the homestead or in terms of crowding (number of people with whom a water point is shared). A level is then a normative description of that service attribute. For example, access to 50 l/per/day reflects a higher level of service than access to 25 l/per/day.

Some would argue that the cost or the affordability of the supply should be considered as part of service level as well.

While undoubtedly important, this is fundamentally different, as it is a reflection of financial (management) costs to get to a certain service level (Moriarty et al. and Van Koppen et al., 2009).

2.4.1 Water service level

For WASHCost, water service focus on the delivery of water to people. A conceptual difference is made between the service itself, loosely defined as the quantity of water of given quality accessible by users and the system used to deliver it.

In practice the two are often closely related. For example, borehole and hand pumps operated at the village level provide one type of service; a professionally managed network of house hold taps another. However, the difference between system and service is critical. By focusing on systems and specifically on the capital costs of rolling out new water supply infrastructure, engineers and planners risk losing sight of what they are or should be trying to achieve. Coverage is often calculated by counting the number of systems implemented without considering whether they are in fact providing the planned level of service (Moriarty et al., 2011).

A water service is defined by the answers to questions such as:

- Do the systems provide the designed amount of water?
- Do they do so every day?
- Does everyone in the community have access to them?
- Do they meet national norms for quality?

The water service accessed by an individual can only be said to meet a certain standard or level when the answers to all these questions are in the affirmative. A water service is, therefore, the provision of access to water that meets a set of key indicators define the serve.

Table2. 3 General Water supply service level

Service level	Quantity (l/p/day)	Quality	Accessibility (mpcd)	Reliability	Status per JMP definition
High	≥ 60	Good	< 10	Very reliable	Improved
Intermediate	>40	Acceptable	<30	Reliable or Secure	
Basic or normative	>20				
Sub-standard	>5	Problematic	<60	Problematic	Unimproved
No service	<5	Unacceptable	>60	Unreliable or insecure	

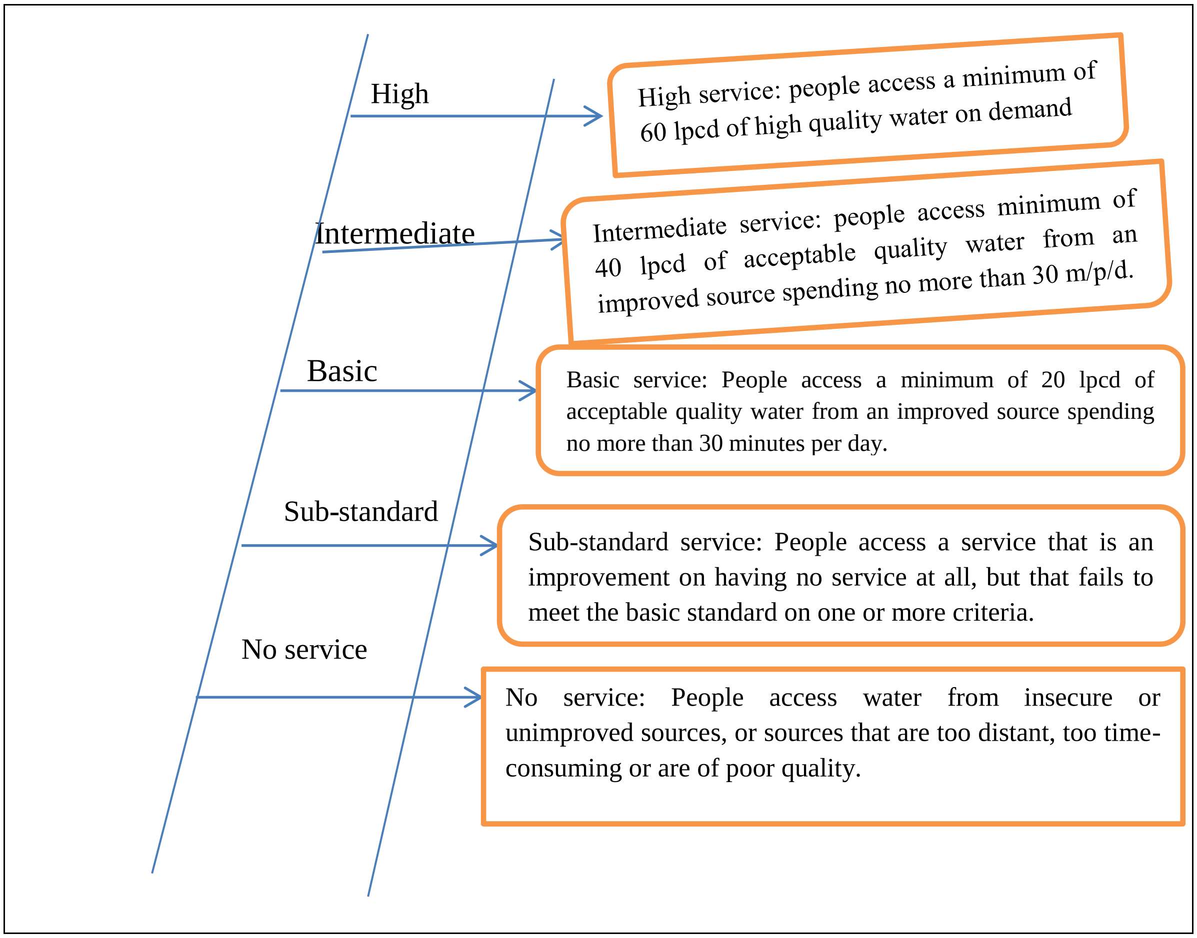
(Source: Moriarty et al, 2011)

Service level is collection of different indictors one is dependent of the other. Its definition varies across countries. It may be set through a combination of engineering factors (what is easy or possible) and social and political factors (what is politically acceptable, the cost, the desire and capacity of community to press for improvements and historical norms) (Moriarty et al, 2011).

The most common indicators against which the quality of water services can be assessed include (Moriarty et al, 2011):

- Quantity - measures in liters per capital per day (lpcpd).
- Quality - typically composed of one or more separate indicators looking at physical, chemical and biological quality.
- Distance – from the household or the center of a community to a water point.

In addition, countries may also use other national or international norms such as the number of people sharing a point source and the reliability of the service typically defined as the proportion of the time that it to its prescribed level.



(Source: Moriarty et al., 2010)

Figure2.1 Water service delivery ladder

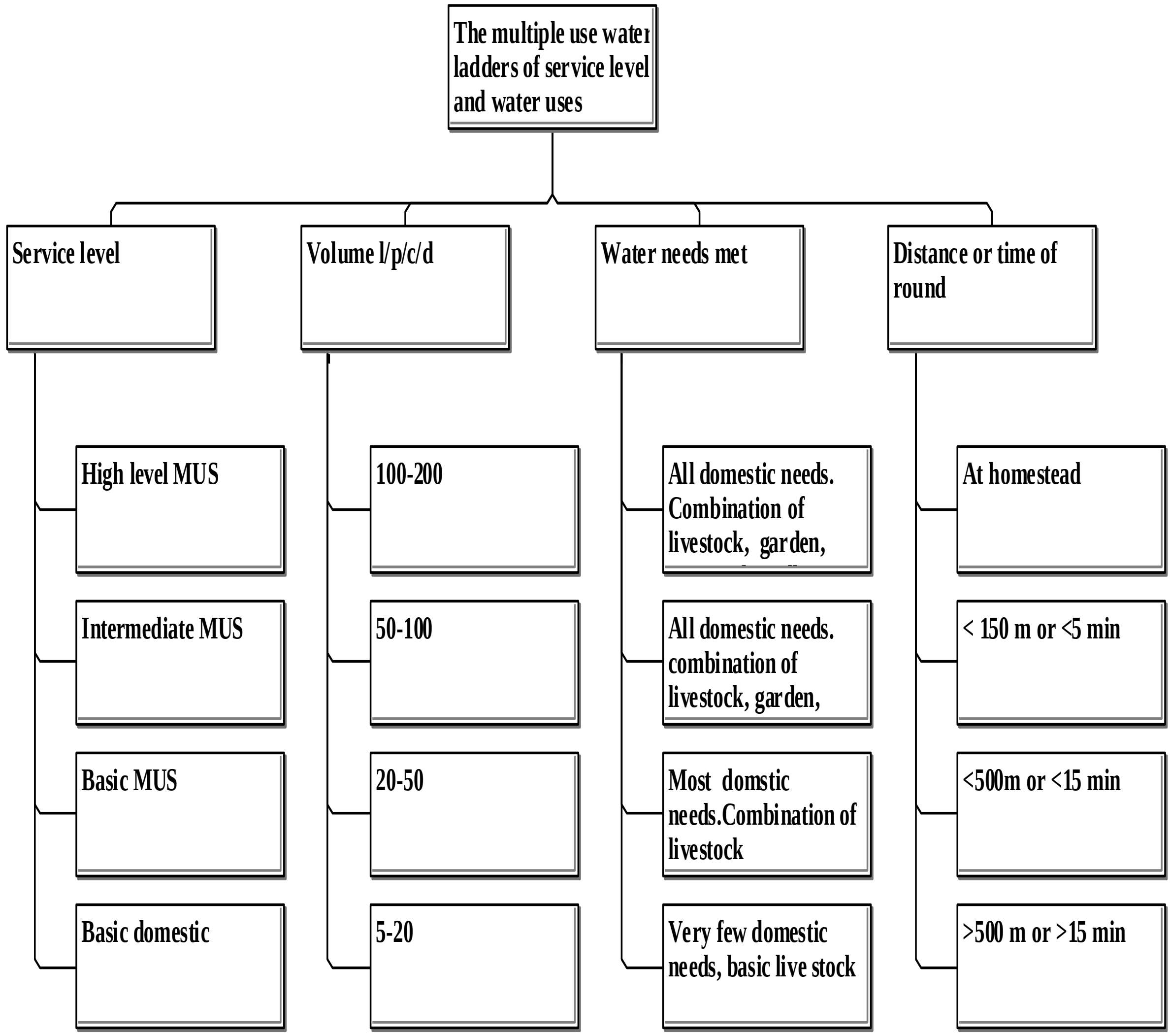
2.5 Multiple-use services and access to water resources

Seifu, A. (2012) showed that rural water supplies can be built to provide a range of services in addition to the domestic supply.

These additional services are usually termed as multiple use water service (MUS) which includes water for livestock, irrigation, home gardens or other small-scale productive uses in addition to water for drinking, washing and cooking. Multiple use water services are intended to meet the domestic and productive demands of the poor in a more comprehensive manner.

If appropriately planned, designed and managed, MUS have a much greater potential to reduce poverty to lesson health hazards and to circumvent the vulnerability of rural households.

Climbing the water ladder obviously implies the use of more water as compared to basic domestic supplies. Since planned MUS development has so far mainly taken place at a pilot scale, no empirical evidence is available on implications at a sub catchment scale. Yet, it can be estimated that the amount required remain relatively small when considered at a catchment scale. Domestic water supply represents only a small percentage (10-20%) of total water abstraction in most countries (Van koppen and Hussain, 2007). Rural water supply is likely to be less than half of that as larger part of the population lives urban areas, where water consumption also tends to be higher. If all villages in a country would upgrade from a basic domestic supply to higher levels of access, similar to the ones found in urban areas, consumption would double or triple and consumption for rural water supply would possibly end up representing 10% of total water abstractions.



(Source: Van koppen and Hussain, 2007)

Figure2.2 The multiple use water ladders of service level and water uses

2.6 Sustainability of rural water supply systems

2.6.1 Concepts and definition

Sustainability of water supply schemes is whether benefits from the service continue satisfactory until the end of the design life.

Benefits include healthy benefits through providing improved quality of water from protected source; water delivery to reduce time spent and convenience (Mebrahtu, M. 2012).

Sustainable rural water supply is defined as one in which the water source are not over-exploited but naturally replenished, facilities are maintained in a functional state which also ensures a reliable and adequate water supply and also benefits of the supply continue to be realized by all users over a prolonged period of time. Enabling rural water supply schemes to remain operational over the design period requires a number of complex and interrelated technical, social, environmental, financial and managerial issues up on which failures in meeting any of these can lead to failures of schemes (Abrams, 2013). The same source pointed out that 'if the water flows' then all of the many elements which are required for sustainability must have been in place.

A service is sustainable when (IRC& WHO, 2000);

- It functions properly and is used.
- It provides the service for which it was planned including; delivering the required quantity and quality of the water; providing health and economic benefits and in the case of sanitation, providing adequate sanitation access.
- It functions over prolonged period time, according to the designed life-cycle of the schemes.
- The management of the service involves the community (the community itself manages the system); adopts a perspective that is sensitive to gender issues; establishes partnerships with local authorities and involves the private sector as required.
- Its operation, maintenance, rehabilitation, replacement and administration costs are covered at local level through user fees or through alternative sustainable financial mechanisms.
- It can be operated and maintained at the local level with limited but feasible, external support (e.g. technical assistance, training and monitoring).
- It has no harmful effects on the environment.

2.6.2 Factors Affecting Sustainability of Rural Water Supply Schemes

Several factors undermine the sustainability of improved water supply and sanitation services. Sustainability of rural water supply and sanitation services is a complex issue that depends upon many interrelated factors.

Policy context, institutional arrangement, initiation and demand by beneficiaries, community engagement, technology choice, operation and maintenance costs, ongoing contract, poor construction, financial and economic issues, spare-part supply and monitoring systems are among the factors that are crucial for ensuring the sustainability of rural water supply and sanitation projects (Harvey and Reed, 2007).

In addition, the sustainability of RWSS is also affected by natural and environmental factors such as recurrent drought coupled with erratic rain fall and reduction of ground water sources. Thus, the dimensions of sustainability of water supply schemes and its service delivery are multifaceted. There are five key sustainability areas such as technical, social, financial, environmental and human health issues to address (Brikke and Bredero, 2003).

- Technical factors

This refers to the reliable and correct functioning of the technology and for water supplies the delivery of enough water of an acceptable quality. Important dimensions of technical factors in include: technology selection and complexity of the technology; technical capacity of the system to respond to demand and provide the desired service level; a technical good design; technical skill needed to operate and maintain the system; the availability, accessibility and cost of spare parts; and the overall costs of operation and maintenance (Brikke and Bredero, 2003).

- Community factors

Under these factors vital aspects include: demand for an improved water supply and sanitation service; community participation in all project phases; the capacity and willingness to pay; management through a locally organized and recognized group; financial and administrative capacity of management; socio-cultural aspects related to water and individual, domestic and collective behavior regarding the links between health, water hygiene and sanitation (Brikke and Bredero, 2003).

- Economical/ Financial factors

Systems can only function if financial resources meet at least the costs of operation, maintenance and common repairs. Equity elements related to who pays for all this and how fairly payments are shared between and within households (Brikke and Bredero, 2003).

- Environmental and human health factors

The following are major issues to be considered under these factors: quality of the water source (this will determine whether the water needs to be treated and will influence the technology choice); adequate protection of the water source or point; the quantity of water and continuity of supply and impact of wastewater or excreta disposal on the environment. In dry areas, lack of drainage of wastewater has created new risks of insect breeding that have brought outbreaks of malaria, dengue and filariasis (Brikke and Bredero, 2003).

2.8 Functionality of rural water supply schemes

Functionality refers to a condition where by the system provides water to the users. Therefore, the scheme is said to be fully functional when the quantity and quality of the water point is sufficient that the people can fetch water from it. Though it is controversial, shortage of water or less discharge of the well can't fully satisfy the criteria of a functional and non-functional water scheme (Ahmed, A., 2013).

As functionality only gives an indication of whether or not water facility are working and providing the water service that it should be providing; it is essential to look beyond functionality of facilities and also assess water service provided by water facility and the level of service that people are receiving in a certain geographical area.

A facility that is functioning at certain point in time can be broken down for considerable length of time. Further, a functioning facility can be providing water of an unacceptable quality or quantity or can be hard to access, for example because of the distance or too many people depend on the facility. In that case, the system may be functional but not providing a high level of service.

There is thus a need to assess not only functionality, but also to look at functionality over time (reliability) and other service characteristics, like accessibility of the service and quality and quantity of water provided and used.

Further, it is important to access weather management structure and service provision and support arrangements are in place to ensure that the facility is not only providing water service today, but has a high chance of doing so for a long time to come (Marieke, A. and IRC, 2013).

A water point described as being functional if it actually in use by the local community at a particular point in a time.

Poorly sited water point that still technically works but which the community has decided not to use; therefore, considered non- functional. Functionality rates are the percentage of all water points in a particular area of a particular type that are functional (Water Aid Tanzania, 2009).

2.8.1 Indictors of functionality

Functionality according to four indicators when (SNV, 2013).

- Quality

Assessed against standard of drinking water

- Quantity

Volume of drinking water used per person per day.

- Accessibility

Distance or time need to reach, queue, collect and return with water.

- Reliability

Days per year the supply provides water.

2.9 Water quality

To provide safe water there is a need to ensure that the quality of drinking water is assessed and monitored (UNEP, 2008).

Even a personal preference such as taste is a simple evaluation of acceptability. Drinking water quality is assessed by comparisons of water samples to drinking water quality guidelines or standard (WHO, 2004).

2.9.1 Bacteriological drinking water quality aspects

Testing the Bacterial Contaminants in water can be simplified by utilizing the presence of an indicator organism.

An indicator organism may not necessarily pose a health risk but it can be easily isolated and enumerated, is present in large numbers, is more resistant to disinfection than pathogens, and does not multiply in water and distribution systems (Gadgil, 1998).

Traditionally, total coliform bacteria have been used to indicate the presence of fecal contamination; however, this parameter has been found to exist and grow in soil and water environments and is therefore considered a poor parameter for measuring the presence of pathogens (Stevens et al., 2003).

Though, total coliform bacteria are not likely to cause illness, but their presence indicates that your water supply may be vulnerable to contamination by more harmful microorganism (Stevens et al., 2003). The same source also proves that, Total Coliform Bacteria are not likely to cause illness, but their presence indicates that your water supply may be vulnerable to contamination by more harmful microorganisms.

An exception is Escherichia coli (E.coli) the most numerous of the Total Coliform Group found in animal or human feces, rarely grows in the environment and is considered the most specific indicator of fecal contamination in drinking-water (WHO, 2004). The presence of E.coli in water indicates recent fecal contamination and may indicate the possible presence of disease-causing pathogens, such as Bacteria, Viruses, and Parasites. (WHO, 2004 and Stevens et al.2003).

The risk of coliform presence can depend on the health or sensitivity of the consumer. The risks of E. coli presence, slightly greater than WHO Guideline's zero count per 100ml may be of only low or intermediate risk. According to IRC (2002) as cited by Meseret (2012) about risk classification for E. coli of water supplies shown below.

Table2. 4 Water quality counts per 100ml and the associated risk

Count per 100ml	Risk Category
0	In conformity with WHO guidelines
1_10	Low risk
11 _100	Intermediate risk
101_1000	High risk
>1000	Very high risk

(Source: IRC 2002 and Meseret, B. 2012)

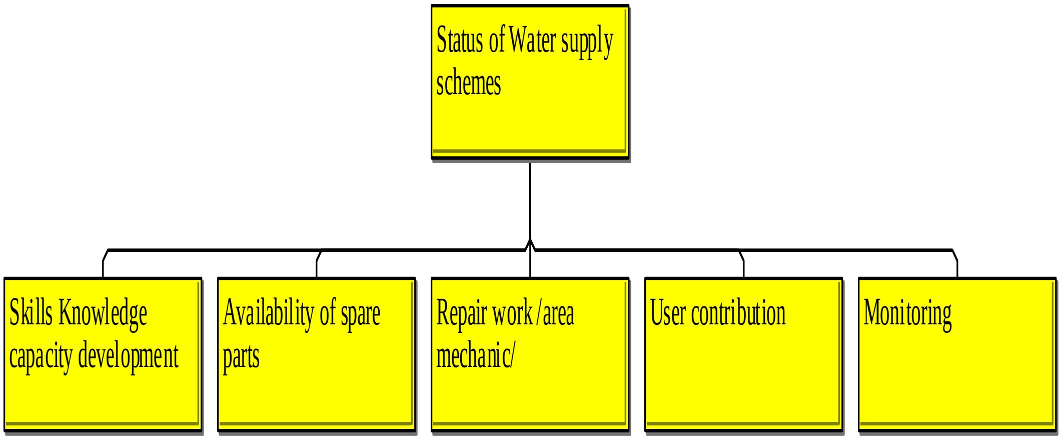
2.10 Principle of community based operation and maintenance

Operation and maintenance mechanisms refers to a series of operation and maintenance structural systems that are required to be established and conducted by various stakeholders in order to maintain water supply schemes in sustainable manner.

Therefore, the establishment of an operation and maintenance mechanism appropriate to sustaining hand pumps and reducing downtime is based on the recognition and understanding of factors that affect the status of hand pumps as these factors inform both the users and the person repairing (area mechanic/care taker) on how much work needs to be done and how much it will cost (MoWE, 2013).Increasing governmental supports and recognition of local communities about importance of integrating operation and maintenance in all development phases of water supply and sanitation projects, including the planning, implementation, management and monitoring phases very important (Brikke and Bredero, 2003). National government plays a vital role in creating an enabling environment with in which an operation and maintenance policy frame work can be developed, which is one of the key elements of sustainability.

Government can foster such an environment in a number of ways including through legal provisions, regulation, education initiatives and training programs and by communicating information. Experience has shown that the effectiveness of operation and maintenance is not solely connected to engineering issues and personnel involved in operation and maintenance, but also assessment and development should cover a range of relevant disciplines: social development, economic, health, institutional and management aspects and engineering. It is important that the process be consultative and carried out in partnership with the operators and users of the service. An economic alternative to invest in new water supply projects is to rehabilitate defective services but, as with a new scheme the rehabilitation option must include analyses of the community's preferences and needs of the capacity of the community to sustain the system (potentially with support of the water agency). When assessing the potential for rehabilitation, the community and the agency together need to study the reasons for the system's breakdown, analyze the problems involved and formulate recommendations for feasible alternatives to rehabilitate the system. Rehabilitation should not be confined to replacing broken equipment or infrastructure. It is also important to look in to the reasons why the system was not sustained and is in need of rehabilitation, including poor management, lack of maintenance, and lack of skilled personnel, poor quality materials and equipment.

However, to ensure that long term benefits do, in fact accrue the projects must be sustainable, which means appropriate technologies must be selected and O & M should be integrated in to project development from the early phase of project planning or at the beginning (Brikke and Bredero, 2003).



(Source: MoWE, 2013)

Figure2. 3 Operation and maintenance mechanism to ensure sustainability

CHAPTER THREE

METHODOLOGY

3.1 Description of the study area

Kachabirra district is one of the districts in Kambata Tembaro zone in Southern Nation Nationalities and peoples region. The district capital is found 327 Kms away from the capital, Addis Ababa and 144 Kms away from the regional capital, Awassa. The district lies between N07°17'08.3'' and N07°12'30.1" North latitude and E37°47'04.8''and E037°50'30.6" degree east longitude (KTZWIEOR, 2014). The total area of the district is estimated to be 306 square kilo meters and is divided in to 20 rural and 2 semi urban kebeles.

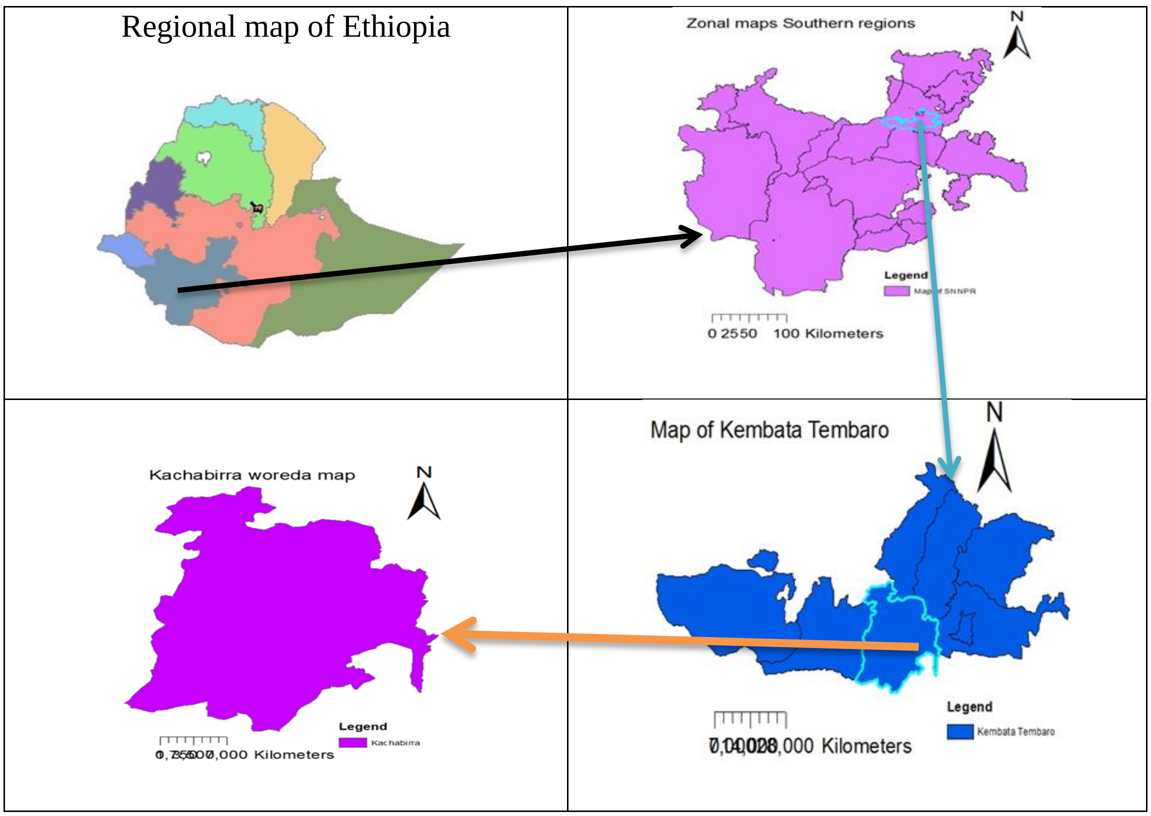


Figure3.1 Map of study area

3.1.1 Climate and topography

The study area belongs to the ‘’Dega’’and ‘’Woyna Dega’’ agro-climatic zone with bimodal rain fall distribution “Belg” and “Kiremt”. For the study area “Belg” is short rain fall season that last between January and April. During this period the area receives a monthly average rain fall of 150 mm. The “Kiremt” season which is the longest period rain period between May and October with a monthly average rain fall of about 205.2 mm. Rain that occurs during this time is intensive and short. The average minimum and maximum temperature of the study area ranges between 18^0 C and 31^0 C respectively (KWADO, 2014). Regarding to topography, its altitude ranges from 1600- 2800 m.a.s.l. and its slope ranges from gentle to moderate slope.

3.1.2 Population

According to (CSA, 2014) the estimated population of Kachabirra district was 138907 from these 110190 are rural areas and majority population who lives in the rural areas with annual growth rate of 2.9%.

3.2 Status of existing water supply schemes

There are two types of rural water supply schemes; micro and macro schemes in the study area. The micro schemes are defined as those rural water schemes comprising point source supplies such as hand dug wells equipped with hand pumps, collection tanks, stand posts and protected springs while macro schemes are those schemes with powered systems such as submersible pumps, gravity schemes or point source with collection tanks supply more than four communal stand pipes (GOS, 2003).

There are totally 312 water supply schemes in the district, from which 132 water points (17 springs with distribution networks), 61 on spot springs, 53 handdug wells, 4 deep wells (with submersible pumps), 27 rope & washer pumps and 35 shallow wells. From the total water supply schemes 197 are functional and 115 are non-functional.

This implies that 63 % are functional and 37 % are non-functional. Normally, non-functionality is great problem in the district (KWIEOR, 2015).

3.3 Research designs

The research methodology chosen for this research study was a cross sectional study to examine level of service, users' satisfaction and different opportunities and factors affecting sustainability and functionality of rural water schemes; financing mechanism for operation and maintenance and institutional supports on water supply projects constructed in the district. Focus group discussions, key informant interview, observation and exploratory survey design was used in order to augment and enhance the study. Such qualitative methods were helpful to find adequate information and to get individual, group and institutional views. This study was designed in the way that important information could be obtained about the rural water supply schemes.

3.4 Data collection

Both primary and secondary data was utilized by employing quantitative and qualitative methods. The data collection processes applied in this research was interview type and reviewing previous documents. The questions were adjusted by yes or no, multiple choice and other questions with options of description. Large portion of questioner handing out was done personally whereas the collection and organization of data was handled by assistant data collectors.

3.4.1 Methods of data collection

- Primary data collection
    - Household survey;

      Information was collected from sampled households by using structured interview questionnaires.
    - Focus group discussion;

      Water user committee (WASHCOs) and community were interviewed.
    - Key informant interview;

      NGOs and district water resource development department.
    - Field observation; Current states of water supply schemes, design system, Carrying capacity (actual) and damage conditions and its causes, sanitary issues and relevant data's were observed.

Also the water supply schemes of the districts spatial distribution and location coordinates were collected by using GPS (Global positioning system) for the purpose of preparing map to represent the location of schemes by using GIS version 10.1 Software.

- Secondary data collection

Reviewing of existing different data sources publications, research documents and reports and other sources from sector offices and concerned bureaus inside and outside of the district were carried out.

- Bacteriological Water Quality Parameter

To assess the Bacteriological parameters of the water, the following parameter was assessed.

- Fecal Coliform.
- Total Coliform.

3.5 Sampling Techniques

3.5.1 Sample frame

From kachabirra district, water resource development office report, shows that there are 312 water points (schemes) constructed by various organizations (governmental and none governmental organizations). From these around 63% is functional and the remaining one is non-functional in the study area.

Sampling frame was taken of community water points constructed by different institution from 2009 to 2014 period’s intervals.

From the community water supply schemes 50 were identified for the sample frame.

3.5.2 Sample size and technique

- Sampling size:

Representative random sampling was employed and determined by setting confidence interval of 95% and margin of error 5% using the following formula.

$$SS = \frac{P(1-P)Z^2}{C^2} = \frac{3.8416x.5x.5}{0.0016} = 600$$

SS = Sample Size.

Z = Z-value (1.96 for a 95 percent confidence level).

P = Percentage of population picking a choice, expressed as decimal (0.5).

C = Confidence interval, expressed as decimal (0.04).

Sample size: finite population (Where the population is less than 50,000).

New SS $= \frac{SS}{[1+(SS-1/POP)]} = \frac{600}{[1+(600-1/2890)]}$ =500HHs

Pop = Population

Therefore, by the representative sampling method 500 households were selected for the interviews.

- Sampling technique:

The first users were taken by lottery method at every 6th interval individual household was interviewed by using the following formula.

Interval of households = $\frac{\text{Total number of household}}{\text{ss}}$ = 2890/500=5.78 ~ 6 (interval households for interview)

- Kebele selection**:**

From the total of 20 rural kebeles in district, due to budget and time constraints 25% of the total kebeles of the district were selected by using purposive sampling techniques where more water points (schemes) have been constructed with discussion of the district water, mining and energy development office.

3.5.3 Water quality test

- Sampling point selection

Temporal and spatial variation of water quality analysis is very important for the water sampling points to evaluate the water quality change at different weeks and one sampling point to the next sampling points respectively. However, due to time and budget limitations the required samples for quality test were only collected from five points in five kebeles of the study area. The sampling points were selected based on the public complaint and discussion with key informants on the water quality from each kebele.

Accordingly, Gemesha kebele borkosha(1) shallow well, Zogoba chufo(2) onspot spring, Lesho chafa(1) shallow well, Walana danshe(4) small community reservoir and Mino damo HDW water supply schemes.

Samplings were collected in 100ml glass bottles for the two parameters from five sampling points. Duplicate water samples from each sampling sites were taken and analyzed for selected bacteriological parameters. Water sampling and preservation techniques followed the standard methods of water sampling and preservation techniques (APHA, 1998). Before collection bottles were washed with distilled water to avoid contamination.

The water samples were handled an aseptically in sterile glass bottles, labeled and kept in an ice-box during transportation to Kembata Tembaro Zone Water, Mine and Energy Department for bacteriological quality analysis. Bottles were preserved using icebox and a total of 10 water samples from five samples sites of the study area were taken for the selected bacteriological parameters.

3.6 Study variables

The study variables assessed in this research are both independent and dependent variables.

- Independent variable: are more related with specific objectives.
    - Design
    - Operation
    - Structural quality
    - Functionality of schemes
- Dependent variable: variables which are the output and its result depend on the independent variables which related to general objective.
    - Service of water

3.7 Data Quality Assurance

In order to assure quality of data taken much precision was taken in arranging ultimate interviewer questions starting only desired points, short and precise. Test runs were taken on the question to eliminate weak questions.

Adequate trainings were given to data collectors and partial involvement of the data collecting process was also insuring the quality of data gathered.

3.8 Data analysis

After the important data were collected the following step was analyzing it using various techniques.

The quantitative data collected from the beneficiaries (sampled households) were coded & processed using SPSS version 20. The results were explained by using tables, graphs, charts and pictures. Descriptive statistics such as mean, frequencies and percentages were produced for quantitative data based on the nature of the data collected about schemes and from user respondent.

Qualitative data from the sampled users were analyzed by using words in narrative forms and Microsoft excel. This data gathered from key informants, WASHCOs and field observations and document review were made used to explain results based on the nature of collected data from users and water supply schemes.

3.9 Analysis of bacteriological parameters

Escherichia coli (thermo tolerant coliforms) are generally measured in 100ml samples of water. The procedures include membrane filtration followed by incubation of the membranes on selective media at 44–45 °C and counting of colonies after 24 h.

Composite samples were used to improve the precision of the estimated average contaminant concentrations.

In the laboratory, the two samples from each site were mixed into one and a composite sample was subjected for membrane filter analysis of fecal coli forms (TTC).

The composite samples were mixed thoroughly by shaking and filtered under laboratory hood, using Wag Tech Membrane Filtration apparatus and membranes, pore size 0.45 μ m, 47mm diameter, sterile and gridded. The membranes were then transferred aseptically to m-FC agar with rosolic acid in glass Petri dishes for TTC. Prepared culture dishes were inverted and incubated for 24h at 44.5°C.

Upon completion of the incubation period typical blue colored for TTC on the surface of membrane filter was counted using a low power binocular wide field dissecting microscope, with a cool white fluorescent light source for optimal viewing sheen.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 General back ground information of the respondents

This section was concerned about the back ground information of the respondents. It delivers a general over view of water uses, collections and allocations in rural household in the study area. The common identified back grounds are; Sex, education, occupation and household size of the respondents. These highly determine the water demand in the households and the extent to which the house holds get involved in this subject. These can help researcher to see which areas are critical to enhance rural water supply systems.

Table4.1: General back ground information about the respondents

General back ground respondents	Constraints of respondents	Frequency	Percent
Sex	Male	219	43.8
	Female	281	56.2
	Total	500	100
Educational status	Illiterate	241	48.2
	first cycle	144	28.8
	second cycle	77	15.4
	high school	27	5.4
	above high school level	11	2.2
	Total	500	100.0
Occupation (income source)	Farming	407	81.4
	Employee	35	7
	daily labour	40	8.0
	small scale business	18	3.6
	Total	500	100.0
Family size	1-4	141	28.2
	5-6	261	52.2
	>6	98	19.4
	Total	500	100.0

From table 4.1 the sample respondents' high percentage (56.2%) is female and the remaining 43.8% is male.

From this women are dynamic participant in socio economic issues; they are responsible for fetching, collection, usage and provision of water supply. Because of this, participation of women is crucial as it could render the real problems and proposed solution regarding water issues.

Educational level (status) of the respondents given in table 4.1 in the study area majority, 48.2 % of the respondents were illiterate. About 28.8% of the respondents have first cycle, 15.4% second cycle, 5.4% high school level and 2.2% above high school level. Therefore, most percentages of respondents are uneducated due to this reasons there is limited awareness water supply system and management. From the same table also the sample households have different occupation. These include farm, employee, small scale business and daily labour including additional income of households. From total of 500 sample household 81.4% farmers, 7% employee, 8% daily labour and 3.6% small scale business. Mixed farm is common source income in the area. Family sizes of the households are main factor to determine the amount of the water available and to construct as well as develop water points. From the survey result 28.2% are between1-4 family members, 52.2% are 5-6 family members and >6 family members are 19.6%.

4.2 Source of water supply

The main source of the water supply in the study area is spring, hand dug wells and shallow wells. Among these springs are dominant and high percentages of the water supply source in the district covers 53.2%. Others hand dug wells and shallow wells covers 25.8% and 21% respectively.

Table4. 2: source of rural water supply

Sources	Frequency	Percent
Hand dug wells	129	25.8
Springs	266	53.2
Shallow wells	105	21.0

4.3 Community Commitments and management in water supply projects

I. Participation of community: In all phases of the projects starting from inception, planning, implementation, construction and management are the main question of the sustainability of certain water supply projects.

Therefore, from the field survey 91.6% of the respondents precipitated in development of water supply projects in the community. Therefore, the community participation includes different stages such as inception, planning, construction and managements of the projects.

As shown on figure 4.1 below most of the communities' participation was at construction and schemes management stages. Around 33.6% and 24.4% of the respondents were participated in construction and schemes management, 20.2% and 21.8% respondents participated in stages of inception and planning, respectively. Therefore, community involvement in its essential stage is important to sustain the projects.

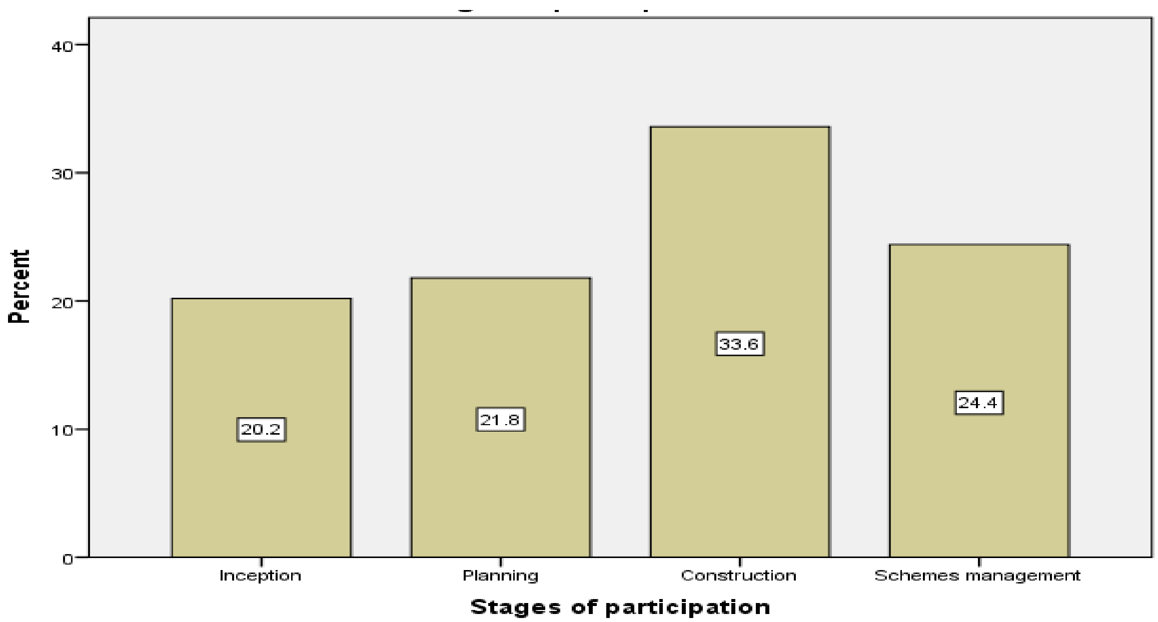


Figure4.1 Stages of community participation in phases of water supply projects

II. Community contribution: Community contribution is the base of community participation, including cash, labour and local material or all.

It can also indicate that demands to service, support capital costs to build more water points through efficient utilization of locally available resources.

Additionally, it leads user's ownership feeling, responsiveness to look after their facility to sustain their water supply project. In the graph below most of the communities' contributions were labour and local materials 48.8% and 31.8%, respectively; and those who cannot participate due to economic reasons by affording to pay in cash can contribute in labour and local construction material such as stones, sand and others. Only few contributed money (4.4%) and 15% (all) participated in contributing in labour, money and local materials.

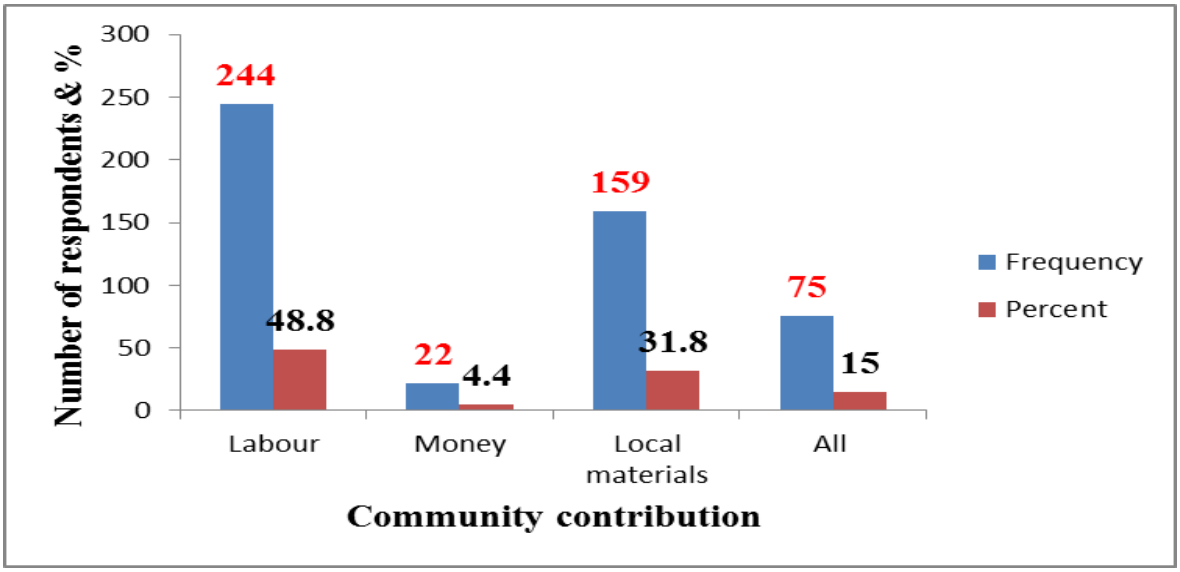


Figure4.2: Community contributions in the construction of water supply schemes

III. Ownership feeling of the community: The active participation of the community for the identification of problems, resources mobilization and implementation leads to the sense of ownership feeling. It is directly or indirectly related to community participation. Actually, ownership feeling mean one feels property as this own resources or properties. The figure below shows 86.8% feels own, 7.8% government and 5.4% NGOs of respondent.

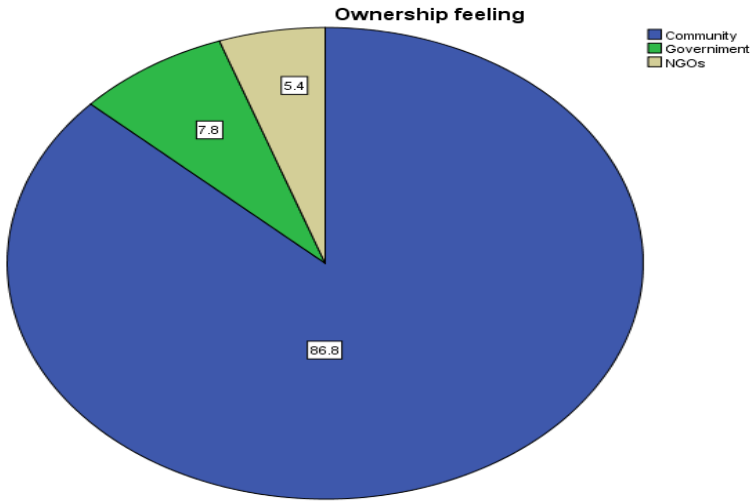


Figure4.3: Ownership feeling of respondents rural water schemes

4.4 Spatial distribution of water supply schemes

As represented below in sampled districts water supply schemes or points in the map shows the coverage of water points with in the 1.5 km radius in sampled kebele above 73% coverage with in these rounds. This contains both functional and non-functional water supply schemes shown in the map. Therefore, such estimation is important for the foregoing deductions.

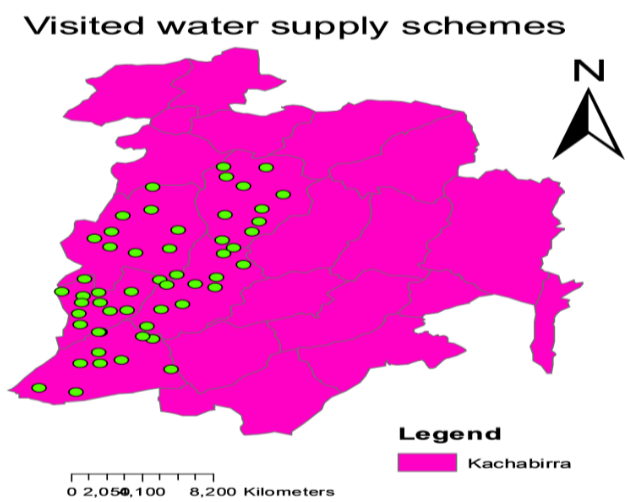


Figure4.4: Distribution of visited water points in the district.

4.5 Domestic water uses and its services level indicators

Domestic water use patterns are normally similar in the study area regardless of the types of the water supply schemes and the distance covered to reach the water point.

4.5.1 Amount of water collection and household water uses

The average amount of water collection per day depends upon different factors of water supply systems that mean availability of water, ground water levels, population, household size and number in the community. From the survey results of the respondents, most household were allowed to fetch about 25 to 75 liters per a day (by 25 or 10 liters jerkens) of water from the source.

Multiple use water supply services are intended to meet the domestic and productive demand of the poor in more comprehensive manner.

If appropriately planned, designed and managed, they have a much greater potential to reduce poverty to lesson health hazards and to circumvent livelihood vulnerability of rural households. They can also facilitate gender equity, cost recovery and sustainability of the water facilities (Fontein, M., 2007).

From the survey results the main uses water in the households is for domestic purposes 100%. All sampled households uses jary cans to collect water, these jarycans which can holds 25 liters and children use 10 liter jarycans. The per capital consumption of water in each respondent household was calculated by:

Multiplying the number of jary cans use per day with the average amount of liters it contains then dividing the results by average household family members. Therefore, the daily personal consumption minimum 15 liter per person per a day and yearly consumes 5475 liters per year MDGs target but only 14% of respondents meet this target in the districts means that 15 l/p/day shown figure below.

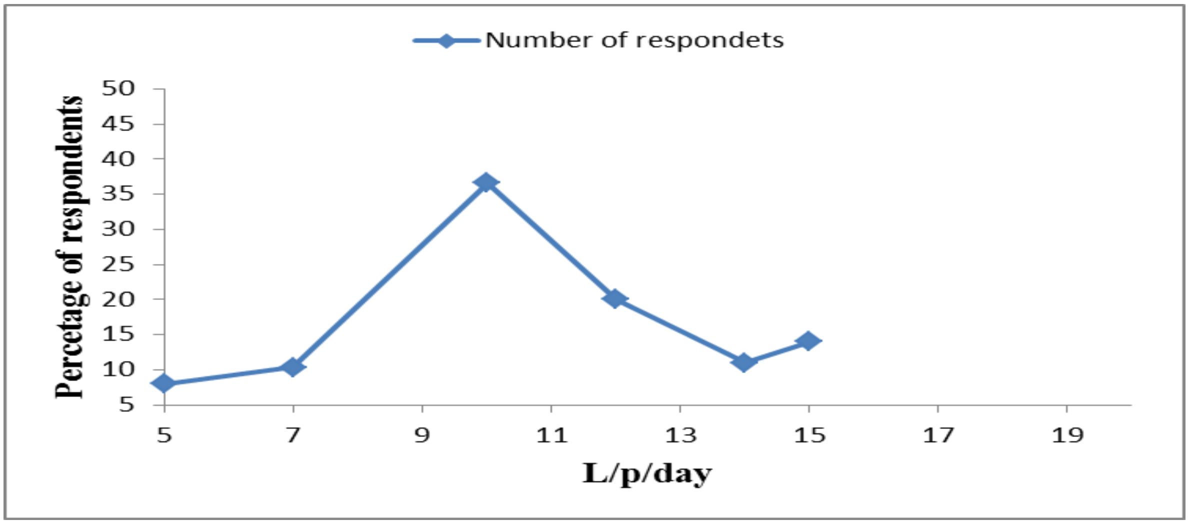


Figure4.5: average water consumption of respondents' liter per person per a day

4.5.2 Accessibility of water supply services

I. The distance travelled and time required fetch water

ADF (2005) indicates that women in rural areas often travel long distance to collect water accounting for to two to six hours per day. The respondent in the study area were asked to give information on the time it took them to fetch water from water supply schemes. Although the values obtained were not based on exact measurement it is approximately used to estimate the time taken from rural water supply services. The researcher was so careful about over estimation and under estimation. UAP aims 30 minute round trips time to collect water from source for rural supply systems. From the survey results the maximum time to fetch water from the supplied services including waiting time varies from 15 minutes to 150 minutes with mean duration 63.45 minutes and standard deviation of above 31.65 minute. Above 15% of the respondents of households meet the targets set for time spent to fetch water in 30 minute round trips of UAP (2011). From the field observation the increasing time to collect water is directly related line waiting.

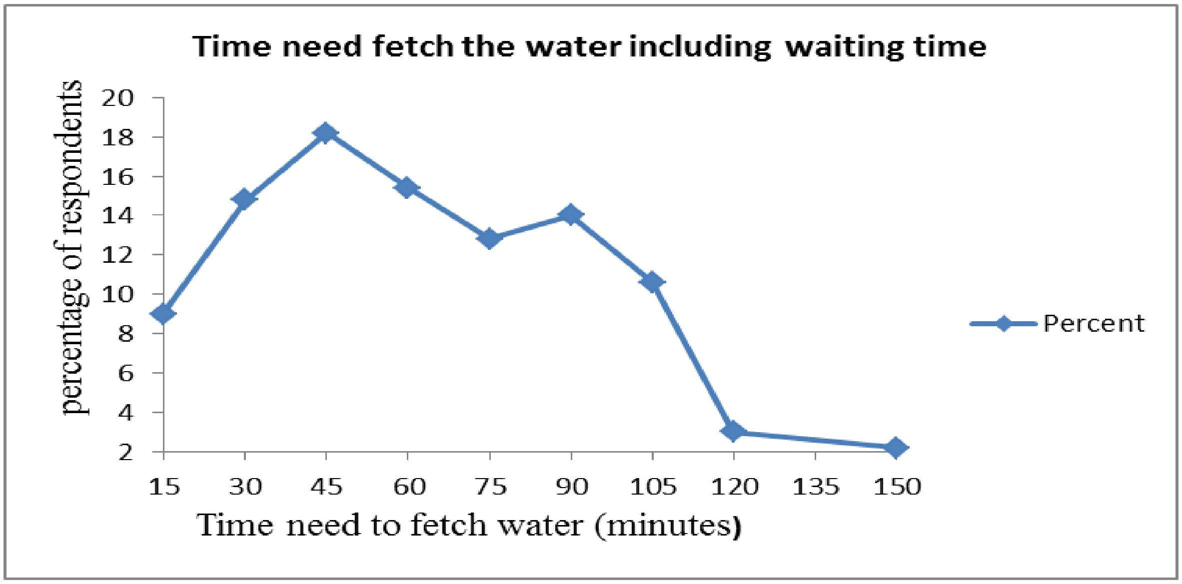


Figure4.6: Time need to fetch water from the source including waiting time

Figure4.7: Longest waiting line observed at water point in Gemesha kebele

Construction of the water supply schemes in the rural areas used to increase the access of drinking water supply. From observation point of view, most of the water supply schemes built at the center of the community and it is accessible with in the distance of 1.5 km as specifies in the UAP of the country.

From the results of the respondents, most of users (above 73%) below 1.5 km distance intervals which are accessible in concepts of construction.

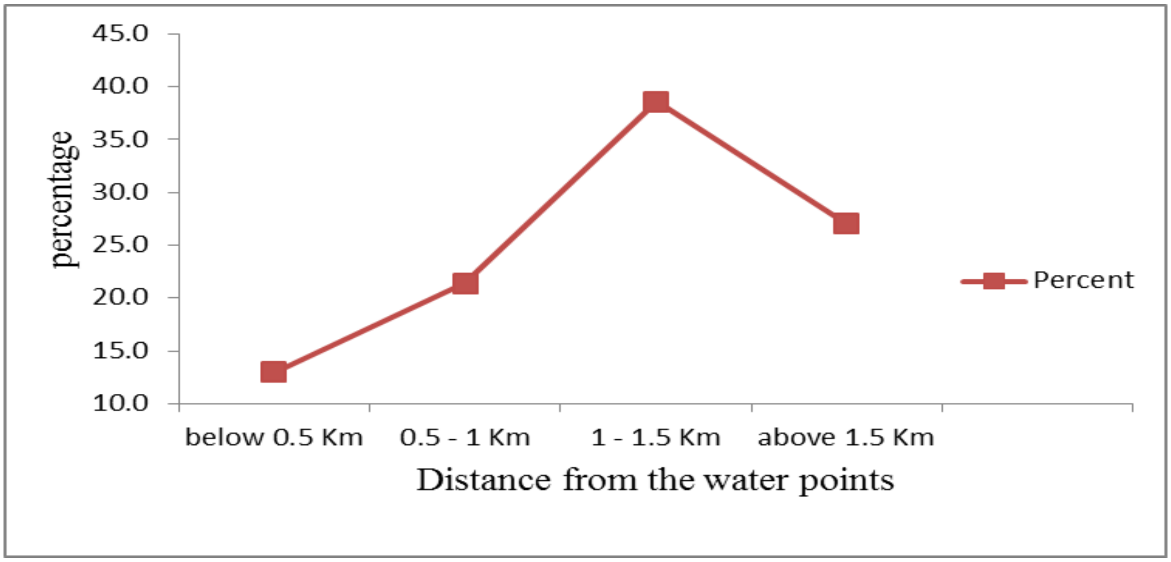


Figure4.8 Distance from the water point

II. Availability of service operator and user satisfactions

From results of the respondents above 86% explained that the service operator responsible for the water provision at the water point open twice per day (the morning and afternoon). Some water points in the area have no service operator and user not satisfied due to discharging of water point very low and huge users especially in Mino Kebele (Ololamo gote water point and Waose HDW), Walana Kebele (Arame gote shallow ell), and Gemesh Kebele (Suta 1 gote Shallow well).

Table4. 3 Availability of service operator and user satisfactions

Constraints	Choice	Frequency	Percent
Service operator responsible for service delivery	Yes	301	60.2
	No	199	39.8
Daily opening water point for the beneficiaries	One time	70	14
	Two times	430	86
Duration that users can collect once it is opened	Below half hour	62	12.4
	Up to one hour	135	27
	One and half hours	75	15
	Up two hours	170	34
	Two and half hours	58	11.6
Users satisfaction on service operator	Strongly no satisfied	34	6.8
	Not satisfied	60	12
	Fair satisfied	250	50
	Strongly satisfied	156	31.2

When the users indicate effective participation in the development of water supply projects, it is vital for beneficiaries for project acceptance. The level of user satisfaction is the pointer for sustainability of rural water supply. Also it reflects users to continue participation of the water supply schemes problems solving.

4.5.3 Water quality

Drinking water or potable water is defined as having acceptable quality in terms of its physical, chemical and bacteriological parameters so that it can be safely used for drinking and cooking (WHO, 2004). WHO defines drinking water to be safe if and only if no any significant health risks during its life span of the schemes and when it is consumed.

I. Bacteriological drinking water quality aspects

The primary indicator of the pathogens in water is E. coil (fecal) whose presence indicates that the water sample has definitely been in contact with human or animals' fecal materials.

As the bacteriological results showed Zogoba chufo2 onspot spring (S1), Lesho shallow well (S2) Walana danshe4 small community reservoir (S4) and Mino hand dug well (S5) bacteriological average results of fecal (FC) form respectively are 2, 7, 1.5 & 11.5 and average total coliform (TC) 12.5, 16, 7, & 25 colonies per 100milliliters for E.coli exceeding the WHO standards (mean its value is zero) which do not allow any fecal or total colonies in drinking water (Annex IV). Diarrhea, cramps, nausea, vomiting, headaches; possibility of severe illness in children, the elderly, and people with immune deficiencies are the attributes of E. coli bacteria (WHO, 2004). The source of contamination may be due to the less efficiency of the treatment process.

The analyzed laboratory results taken from five sampled points from district kebeles evaluated the average mean values for each bacteriological and compared with WHO drinking water quality slandered.

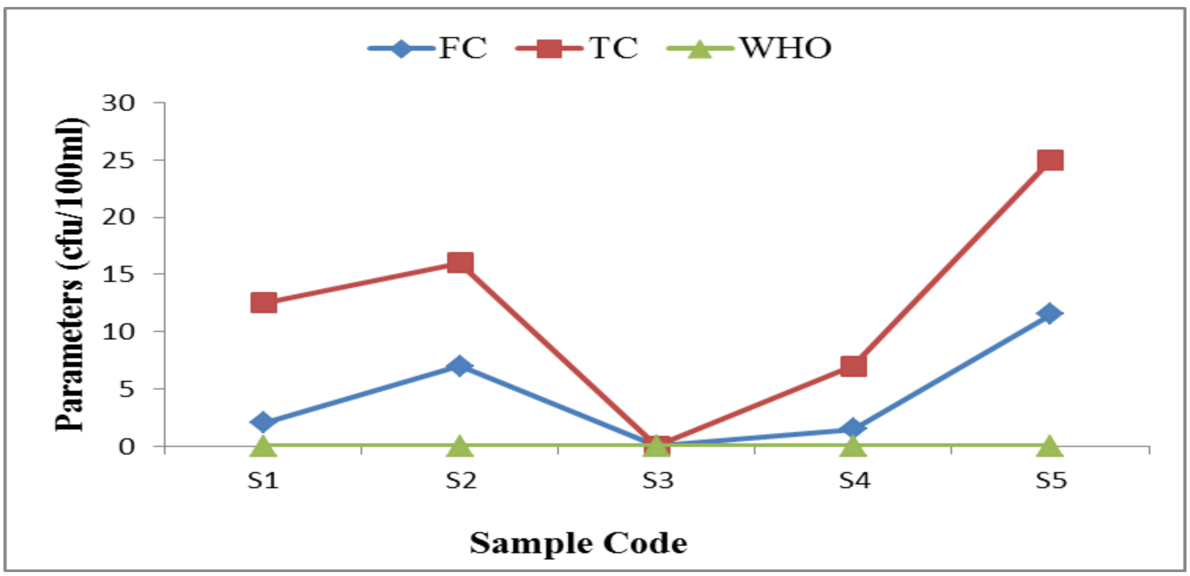


Figure4. 9 Result of bacteriological water quality

I. Community awareness and observation on water quality:

During the evaluation time of water points the physical water quality parameter of observed points are find good but Danshe Gote (water point), 4th Sigizamo Gote HDW, chafa Got onspot spring have odour, taste, colour and temperature problems. From survey results sampled household 28% of affected by seasonal water quality problem (table 4.5).

Most of the respondents answered the water quality problem occurs mostly in rain and dry season because of the high surface discharge (flooding periods) and water shortage times respectively.

There is also water point (Bono) swampy problem which causes breading place of mosquitoes in Gemesha kebele and small reservoir (storage tank) in walana Kebele with cracks & grow of algae on it causes water quality some water points.

From field visited results the causes quality problem were schemes site constructed toilet around, washing slabs proximity, crack of schemes and near agricultural land etc.

Table4.4 Water quality by community awareness and observation point of the view

Variables	Choice	Frequency	Percent
Water quality problem exist	Yes	140	28
	No	360	72
When was problem happen observed	Rain seasons	75	53.6
	Dry period	51	36.4
	Full year	14	10
Courses(reasons)of the this problems	Site schemes plant	12	8.6
	Toilet around water point	18	12.9
	Reduce of water quantity	50	35.7
	washing slab proximity	25	17.8
	cracks of schemes	20	14.3
	Near agricultural land	15	10.7

II. Sanitary situation of the water supply schemes

From the field observation and WASHCOs reports water supply schemes in the area are not in a good sanitary conditions because of some of the schemes were constructed:

- Three handdug wells are very near to agricultural land and latrine around with in ten meter of the well, without drainage channels, cracks on the slabs, need clean around and others seven hand dug well open to pollution.
- Six shallow wells are not effectively covered by slabs, exposed to contaminations and no effective back fill.
- One onspot Spring is not prevented; open to sanitary problems:-

- Polluted by surface run off or erosion
- Latrines within 30 meters upstream of the spring
- No vegetation's above the eye of spring which reduces infiltration rate and ground water recharge.

4.5.4 Reliability of water supply services

The matters functionality of water supply systems and periodical variation is an area that needs to be given greater attention. It is measured by interruption and water shortage.

I. Service interruption

About 61.6 % of sampled respondents replied service interruption by system failure and 38.4% is due to drying of water source. The minimum and maximum periods of interruption from three up to four months (13%) and two up to three months (26%), respectively.

Table4.5 Service interruption

constraints	Choice	Frequency	Percent
Service interruption from the water point	Yes	185	37
	No	315	63
periods of Service interruption in a year	one months	46	24.9
	one up to two months	33	17.8
	two up to three months	48	26
	three up to four months	24	13
	above four months	34	18.3
Reason of service interruption	System failure	114	61.6
	Drying of source	71	38.4
	Others	0	0

II. Water shortage.

The water supply schemes driest periods (HDWs and Shallow wells) from January to March their discharge rate is reduced due to ground water table reduced. In this period, users face problems such as shortage of water for domestic purpose and other uses and travel long distance to collect water from another source.

4.6 Current status of visited water supply schemes in the district

Construction of portable water supply projects in rural areas is the first step to increase community access and contribution to the health of its members.

As far as water supply services are concerned, some development activities has been done by Zonal water, irrigation and energy office bureaus, District water development office and NGO's to (World Vision Ethiopia, Intereid France and ADB) reduce the problems of portable water supply in the district. However, the problem of portable water supply is still unsolved fully the in the district.

In addition to this the existing water supply schemes are low service coverage, reduced service under the day from community distribution points, poor operation and maintenance.

From the field observation shallow wells and Hand dug wells less functional than springs (onspot and distributary network) because of some HDW and shallow wells fails their functions due to drying of the sources (mostly related with design, site selection and digging periods), break spares parts and quality problem (caused by, cracks, toilet around and disrepair involves mechanical problems leading to leakage of water during fetching which is causing leakage of water to flow back to the well).

Onspot springs non-functionality problems caused by breaking down or damage of the faucets and valves (example gate valve, poset valve), burst of pipes, failure of spring boxes and poor construction quality (foundation and seepage problem) are the main causes for failures. From the observation or field visit data, WASHCOs and focus group discussion pointed out that from 50 sampled schemes 64 % are functional and 36% are non-functional. The non-functional water supply schemes wouldn't delivered service to the community half of its design periods.

Table4. 6 Status of visite schemes in the study district.

Status	Number of schemes	Percent
Functional	32	64.0
Non functional	18	36.0
Total	50	100.0

4.7 Community financing for operation and maintenance of water schemes

First and foremost the appropriateness of the technology in terms of its operation and maintenance requirement should be assessed in terms of community operational skill and financing capacity in the advance prior to investment.

Further it is also vital to ensure the user community's commitment to meet all the requirements of operation and maintenance to institute consistent sound operation and maintenance practice (UAP, 2011).

For the effective maintenance of water supply schemes, management of fund by WASHCOs it based on by the opening bank account, it would be better finances collected from users' fee, monthly pays and additional contributions by users to aim at operation and maintenance should be managed for the future sustainable way.

Regular observation and evaluation of the water supply projects for its service and to get more benefit from it is necessary. Therefore, effective operation and maintenance strategy implementation is necessary to ensure the sustainability of the schemes.

I. Water tariff

Adequate tariff set in the community resolves the operation and maintenance problems efficiently.

WASHCOs absolute decides the rate of tariff payment system with community. From survey results and WASHCOs discussion, average amount of tariff payment for the household was 2.50 birr per a month. From the table 4.8 below, largest affordable price per month is 3 birr which covers more than 85% of respondents and which is more useful for operation and maintenance of the schemes for the future functionality and sustainability.

Above 75% users average charge per jarken in 10 cents which is very low price and reasonable.

II. Willingness and ability to pay

Willingness to pay the service fee of water tariff reflects the beneficiary's to ownership feeling to sustain the water supply projects. It also boosts awareness of the user community to manage and maintain their water supply schemes to ensure the future functionality and sustainability of water supply projects.

From field survey above, 91% of the respondents have willingness to pay service to fee water uses (table below 4.8).

III. Cost recovery

The majorities of the users' attitude are still to get new schemes after first scheme failure happens. If the idea is not crossed out, no sustainability in the rural water supply service systems will be expected.

One way to solve such problems is beneficiaries must to save fees as cost recovery and additional contribution in monthly or yearly to keep the failure of the project. About 54% of the respondents were to contribution additional fee for operation & maintenance of schemes when it fails. Most of respondents (65%) yearly contribute 25 to 50 birr per year (table 4.8). The rest 46% of respondents no contribute additional money do to loss of the awareness on ways operation and maintenance of the water supply schemes.

Table4. 7 Willingness and ability to pay

Variables/ constraints	Choice	Number of respondents	Percent age
Willing to pay for service	Yes	455	91
	No	45	9
Average service charge per liters jarken	10 cents	375	75
	20cents	115	23
	25 cents	10	2
Largest affordable price per month	One birr only	15	3
	Two birr only	35	7
	Three birr only	425	85
	Above three birr	25	5
Contribution of additional money for maintenance	Yes	270	54
	No	230	46
Amount of money contributed by community per a year	up to 10 birr	15	3
	10 to 25 birr	135	27
	25 to 50 birr	325	65
	50 to 100 birr	25	5
	Above 100 birr	0	0

4.8 Factors affecting efficiency of water supply projects (sustainability)

The determinants of sustainability are:

- Suitability of selected sites
- Quality of constructed facility
- Suitability of implemented technologies,
- Protections of schemes after implementation.

4.8.1 Suitability of selected sites

Correct site selection is important to efficient uses of resources, time and money to safe guard sustainability of the projects.

I. Technical

The technical criteria fulfill the following ideas such as measured discharge from the water source; distance from the contaminants would reflect selection of site for water supply schemes. Since insufficient quantity of water for the targeted beneficiaries, nearer to cultivation land, residents (home) and latrines from the water sources are concerns of poor site selection which can negatively affect sustainability of water supply schemes or target of the projects.

From field visite on averagely 32% schemes constructed (implemented) sites are not in suitable site in the district because there location is very near to agricultural field, residents' areas with contamination with latrine risks from homes flow.

Therefore, the main causes of the problems observed and discussion with water use committees are;

- Shortage of sufficient technical inputs from the experts (Either water engineer or geologist).
- Sometimes construction facilities at the construction time.

II. Social (acceptance in a community)

From the field visite, focus group discussion and survey of the respondents some of the beneficiaries raises problems related to social aspects such as various thinking on WASHCOs members elected by local leaders, no auditing of fee collected, some water points massive users and long waiting to collect water, long distance walk above 1.5 km round and not get adequate water and also between them conflicts.

II. Environmental factors

The environmental problems have been seen during field observation time study were

- Soil erosion (degradation of water shed)
- Drainage issues nearby water points
- Pollution around the HDWs which are favorable area for the breeding place of the mosquitoes and ultimately water-borne diseases.

From the observation and discussion with WASHCOs the condition and existence of drainage facility half percent sampled schemes don't have drainage problems and other percentages are under the condition of drainage problems.

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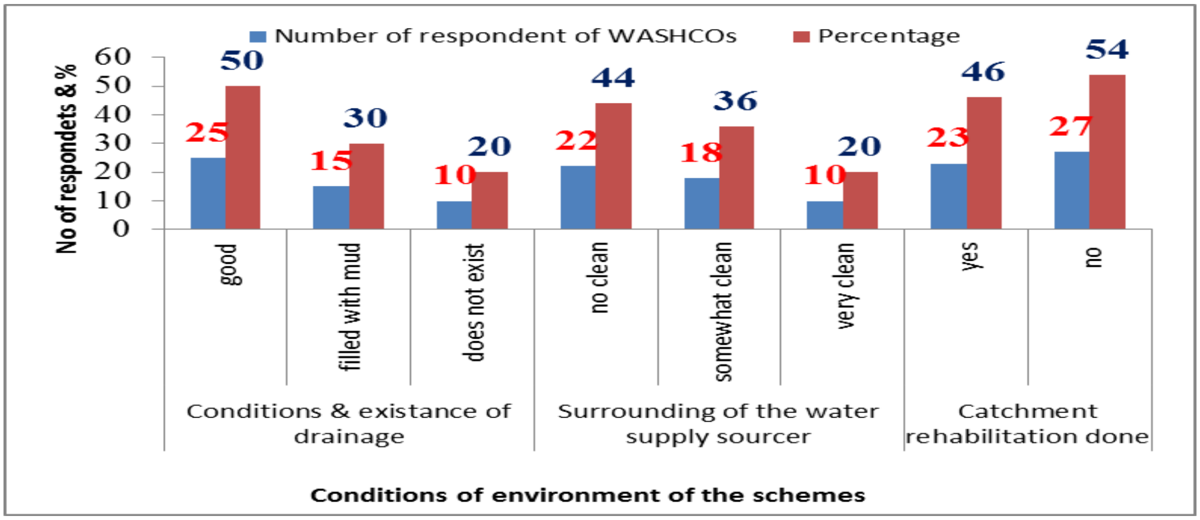

Figure4. 10 Environmental problems of rural water supply scheme

4.8.2 Suitability of technologies

Proper technology selection is important for sustainability of rural water supply schemes. These technologies are chosen based on spare parts availabilities, cost and capacity for operation and maintenance in the community.

From field visite and key informant discussions most of the technologies in the district area are Indian mark types which much expensive than as compared to Afridev marks based on their spare parts cost.

I. Spare parts availability

From focus group discussion water use committees and respondents mentioned spare parts supply were main problem to provide maintenance.

These tools are not available to the community up to now in the district. From field visit and explanation from water use committees that transportation cost and time required buying spare parts is causing difficulty to do instantaneous maintenance when schemes fail. Therefore, no spare parts distributor is available in the district.

However, the necessary spare parts for operation and maintenance of hand pumps in the annex III.

II. Availability of local skills (technicians) for maintenance
Chosen technologies should fit to locally available skilled man power for maintenance because community will be responsible for running the facilities.

From the field visite schemes (HDWs) and some shallow wells were fitted with hand pumps. But in the kebele level technicians have not yet developed skills for maintenance of pumps. In the study districts the pump maintenance totally dependent on one technician or expert from district office and the others trained from the community were not skillful.

4.8.3 Quality of construction on the developed schemes

Construction quality is one of the most important factors for functionality of water supply schemes and further useful for the future sustainability of the schemes.

From survey results, focus group and key informant discussions the construction is poor or not practical: due to without necessary construction materials and design problems, in adequate supervision during the implementation periods, absence of the administrative role in monitoring and evaluation during of schemes construction.

From this 56% of the observed water points were constructed with good quality and rest 44% within poor quality were affected by poor construction. .

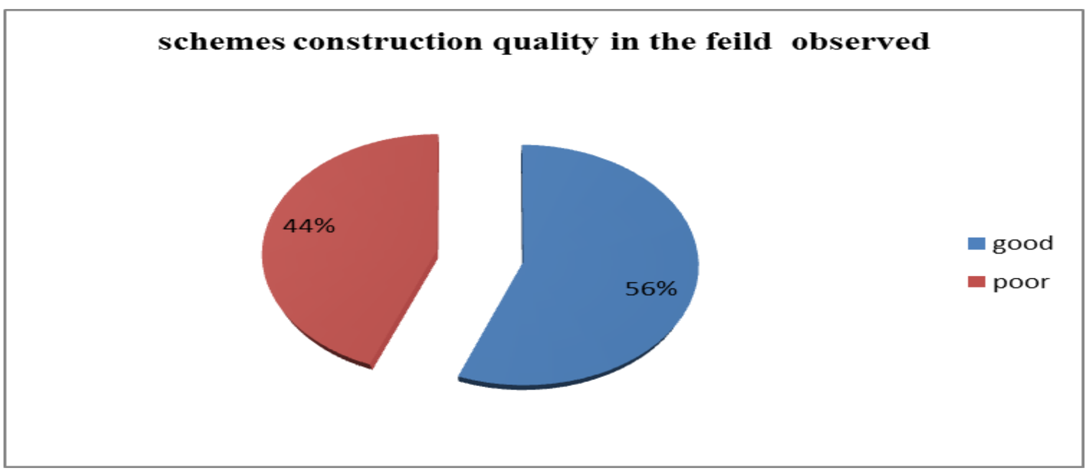

Figure4. 11 Schemes construction quality observed

4.8.4 Protection after implementation of water supply schemes

Protection of water supply schemes after implementation is important factor for the functionality and sustainability of the rural water supply schemes.

From the field observation results, 60% schemes have guard and 40 % have no guards, because of the most of water use committees are not awarded to pay this work.

In addition to 54 % of visited schemes not properly fenced and only 46% fenced, similarly visited water points ditches were filled with dirt and not draining water effectively and 16 % swampy problem around the water point (breeding sites for mosquitoes which causes malaria on the community). Therefore, the protection of schemes by guards, fencing is primary stage to keep the source from misuse and damages.

Water point with swampy and no fence

Properly fenced water point

Figure4.12 Stages of water points after construction

4.9 Institutional supports after water supply projects implemented

From the survey results of district, different NGOs are (world vision Ethiopia, Intereid France etc.) are responsible to deliver required support for development of water supply projects. District water and energy office is the collaboration with national and international organizations to assist water supply projects.

Once the WASHCOs formed the providing of technical training for effective maintenance, operation and management of water supply schemes need institutional supports such as governmental and none governmental organizations in addition to community participation is important for functionality and sustainability of the projects.

The major supports from the district experts and none governmental organizations representative by visiting the schemes and gave capacity building trainings to WASHCOs and technicians.

Additional, none governmental organizations support annual rehabilitation cost with little contribution for operation and maintenance of the constructed water supply schemes and contribution of necessary material such as manuals, guidelines useful to manage water supply the project.

From field visite and focus group discussions (WASHCOs) 84% got capacity building technical training (management, operation and maintenance) and 8% on rehabilitation cost contribution (construction) of the schemes.

Table4. 8 Institutional support after water supply projects implementation

Variables	Choice	No of WASHCOs	Percentage
Institutional supports after water supply schemes constructed received	capacity building	42	84
	Rehabilitation cost	8	16
Frequency the expert visit after construction	once in a year	10	20
	twice in a year	6	12
	when we need	9	18
	None	25	50

4.10 Summary on functionality and sustainability indicators concept

From GTP one sets target to reach 98% access to a portable water supply source yielding minimum 15 liters per person per day with in 1.5 kilometer radius from a single household for rural areas at 2015. To meet this target sustainability and functionality of the water supply schemes is very essential.

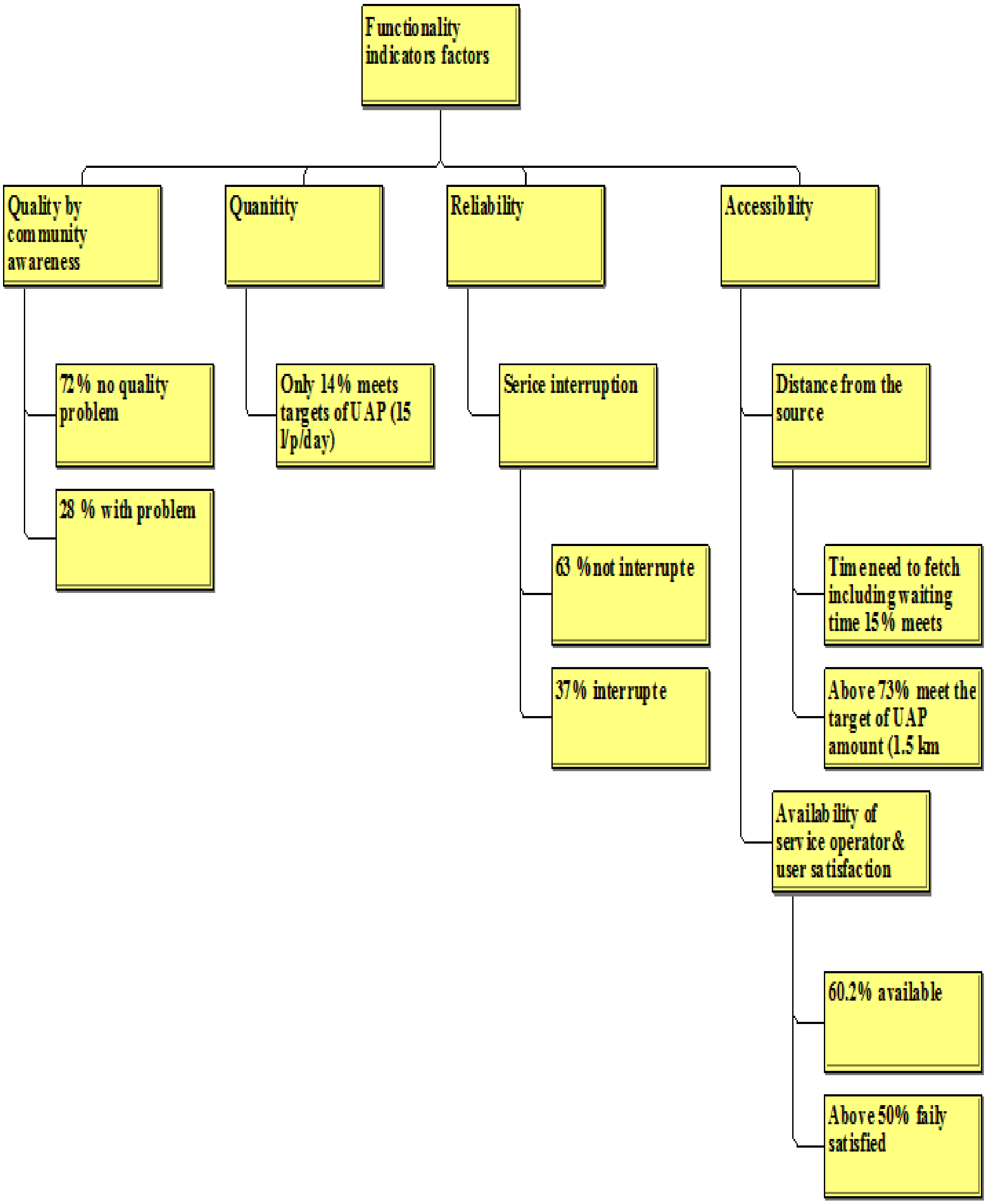

Figure4. 13 Functionality indicators of water supply schemes tree

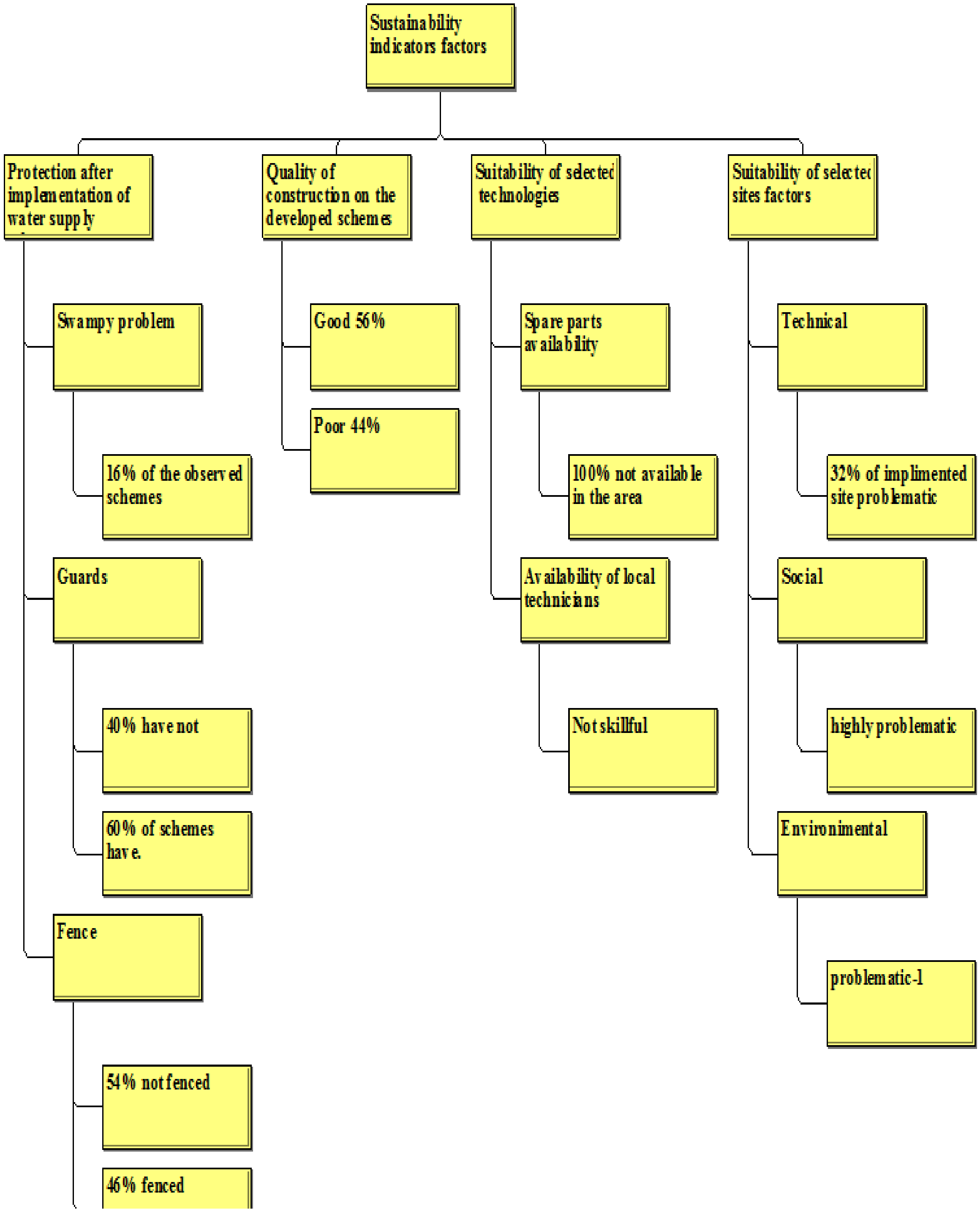

Figure4. 14 Sustainability indicators tree

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Water supply adequate in quantity and accessibility is the basic need of human being. The problems in rural areas of developing countries are particular concern as still large sections of the community are living without safe water services. The state of water supply in terms of coverage in spatial and for population accessibility is not required standard. Water quality is concerned preliminary water test resulted in a presence of pathogens bacteria Zogoba chufo onspot spring, Lesho chafa shallow well, Walana danshe small reservoir and Mino damo HDW water supply schemes. These schemes were positive for E.coli show fecal contamination and the number of coliforms was above the recommended international and national limits and it is not recommended for consumption purpose.

To solve such problems Ethiopian government set the goal and target on its Millennium Development Goals. However, it is still lacking far behind the target. From the results of the study as assessed only 14% of respondent's meets water usage of the target of UAP of 15 l/p/d. From the data indicated that most of the community in 1.5 km distance not get targeted UAP amount of the water. In the district water point's location above 73% of the total area of the covered in 1.5 km distance which is concerned efforts to meet Millennium Development Goal of water and sanitation for all by 2015 but this is only construction coverage. The Most of the rural water supply schemes in the study area were constructed by NGOs, which were mainly focused on construction of new schemes. Only little provision was made for operation and maintenance of the constructed water supply schemes. This shows that maintenance of the schemes was neglected aspect of rural water supply schemes. The existing water supply schemes in the district were characterized by low service coverage and poor operation & maintenance as only 64% of the observed schemes the fully functional and supply's water to the community.

The left 36 % of the schemes were nonfunctional due to design, environmental, technical, availability spare parts, operation & maintenance and construction problems.

Appropriate finance for the operation and maintenance of water supply schemes by water tariff collection and additional contribution of the community and it is inefficient. Finally, institutional support is especially in necessary to beneficiaries' capacity building on operation and maintenance of schemes and little rehabilitation cost contribution. But more capacity building training is essential to increase capacity of WASHCOs and technicians of the community on the base of operation and maintenance and Managements of schemes.

5.2 Recommendations

The following recommendation is be useful in achieving more effective and efficient provision of water supply in the study district.

- Take priorities to damaged water supply projects rehabilitation; it saves time, money and resource
- Chlorinating, boiling and filtering those sources before consumption purpose use.
- Effective capacity building training give to WASHCOs on concept of schemes management, operation & maintenance, fee collection ways from the users, management of sanitation problems and community participations.
- The implementation agencies mainly took attention on sustainability of water supply projects by creating spare parts availability for the maintenance with involvement of private sectors.
- Watershed protection or schemes catchment protection by reforestation, land degradation (erosion and flooding) protection. It is useful to increase the ground water recharge.
- Government and non-government organization (NGOs) focuses on the improving coverage water supply. But, due attention is necessary to address the problems that recover the sustainability, such as introducing new and modifying previous technologies.
- Appropriate design consideration during construction

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Annexes
Annex I
A. Questionnaire for Household Survey

Background

1. Name of interviewer ________2. Date of interview ______Name of kebele_________Village/Got Questionnaire identification number_____
2. Sex of the respondent: Male Female
3. Educational level: a. Illiterate b. First cycle c. second cycle d. High school complete e. Diploma and above
4. What is your major occupation? a. Farming b. employee c. daily lab our d. Business e. Specify, if other_______________.
5. Any source of income additional to your major income_________________
6. How many family members you have in your house including you________________.
7. What is your main source of water supply? a. Hand dug b. well protected Springs c. on spot spring d. deep well e. water point f. Shallow well g. any other

Water service level, users' satisfaction, community participation and commitment

1. Have you participated in the development of the water supply scheme? A. yes B. no

- If your answer for „Q 2 „is „Yes", at which development stage you have participated?
  a. inception b. planning c. construction d. scheme management
- If your answer for „Q 2" is „No", what is your reason for not participating? a. not asked b. lack of awareness c. cannot lived here before d. everything done by implementing agency e. Specify, other_________________

2. What was your contribution for the provision of water supply scheme? a. Lab our b. Money c. Local material d. all e. specify, other
3. Who owns the water scheme? a. community b. government (woreda) c. NGOs
4. How much water do you or your family collect on average each day in a week from the water point? Amount in litters or local materials (10 or 25 liters jar can)

5. For what purpose do you use the water from the water supply scheme in addition to domestic uses? a. Washing cloth b. animal watering c. Gardening d. Small scale irrigation Specify, if other___________________.
6. How far is the water point from your house? a. Below 0.25km b. 0.25 to 0.5km c. 0.5 to 1km d. above 1km
7. How long does it take (in minutes) to go to your principal water source and come back?
8. How long is the average waiting time (in minutes) at the water source?
9. Does the source get dry during some periods in a year? A. yes B. no

- If your answer for „Q 9" is „Yes", when does it dry? a. winter (Jan - march) b. Summer (Jun -august) c. autumn (Sep-Dec) d. spring (April-June)

10. Is there a person responsible for service delivery? A. yes B. no

- If your answer for „Q 10" is „Yes",
  1. How many times a day the water point open for beneficiaries? ___________
  2. For how many hours beneficiaries collect once it is opened? _____________
  3. What is your satisfaction about the responsiveness of service operator? a. Strongly not satisfied b. not satisfied c. fair satisfied d. strongly satisfied

11. Do you think the water you are getting from the water point has quality problem (with in community perception)? a. yes b. no

- If you say for „Q 11" is „Yes",
  1. What type of water quality problem you observed or tasted? ____________
  2. When was the problem started? _____________________________________
  3. Have you told the problem to the WASHCOs? a. yes b. no
  4. What do you think the reason for the problem? ____________________

12. Has there been any service interruption from the water point? a. yes b. no

- If you say for „Q 12" is „Yes",
  1. How many times in a year was the service interrupted? ______________
  2. What is the main reason for the service interruption? a. System failure b. Drying of the source c. Specify, if other____________.

13. Are schemes in implemented sites cultural suitability/acceptable/ for users? A. yes B. no

- If your answer is no, reason

Community's participation financing and operation & maintenance of the scheme

1. Do you willing pay for the water service? A. yes B. no

- If yes, 1. What is the charge (25 liters jar ken)? ________________

  2. What is your attitude toward the costs? A. affordable B. not affordable

  3. Do you know how the tariff money collected used? A. yes B. no

- If no, why? ___________________________________

  4. How much is the largest affordable price for you? _____________

2. Have you ever been asked to contribute additional money for maintenance?

   A. yes B. no

- If yes, 1. When was it? A. Before B. after breakdown

  2. Are you willing to contribute? A. yes B. no

- If No, why? _____

  3. How much Birr you contribute in a year? a. 10 b. 25 c. 50 d. 100

3. Are there efforts made to maintain water supply facilities when they break down?

   A. yes B. no If No, why? ___________________

4. How do you think funds should be obtained for water system repaired a. Tariff and additional contribution by users" b. local government c. NGOs d. other
5. Have you acquired the relevant skill about the operation and maintenance of water Supply facilities? A. yes B. no
6. Currently does the water system need repair? A. yes B. no
7. How many times in a year does your water source need repair? a. once in a year

   b. twice a year c. three times a year d. more than three times a year e. no need

8. Is there management plan for your water supply scheme? A. yes B. no

- If yes, describe the main parts of a simple management plan?

9. How is the annual operation and maintenance cost covered?______

B. Observation Check List or physical condition

General:

1. Location

Kebelle __________________ Gote Name ______________________

GPS coordinate: X- coordinate_______ Y- coordinate _________ Altitude ______

2. Year of construction _______________________________________

3. Type of water source? a.HDW b. shallow well c. spring development d. deep well e. others

   3.1 what is the current water yield in l/second?

   3.2 Number of households using the scheme

4. Type of water lifting/ distribution a. Hand pump b. Motorized pump c. Other ________

5. Type of distribution system a. On spot b. Gravity c. Other __________________

6. Type of power supply source for the pump ________________________

7. Functionality of water source / current status of protected water supply schemes

   1. Non-functioning at all 2. Functioning with some problems

   3. Well-functioning without any disrepair

   7.1 If the observed functionality is „1", the main disrepairs are: _________________

   7.2 If the observed functionality is „2", the main disrepairs are: ___________________

8. Protection for water Points after construction (by fencing, guard, Free of swampy surrounding)

9. Availability of local skill for maintenance

10. Technical adequacy for desired level of service______________________

Technical and social acceptance:

Source Location:

1. Proximity from area of residence of users/ Distance from the nearest household _____

2. Proximity from latrines ____________________________________

3. Proximity from the nearest agricultural lands ________________________

4. Is the area flood prone? a. yes b. no

   If yes, is source protected from flooding and erosion? Yes or No

5. Schemes constructed site social acceptance

6. Match between population size and the available water supply facilities

7. Sanitary situations of the area

Storage:

1. Type of storage or reservoir material _____________________________

2. Condition of well or other storage components cracks or leakage _______

Pump:

1. Type of pump ____
2. Pump condition ____
3. Type of power supply ____
4. Condition of the power supply ___________________________________
5. Discharge (l/sec) ____

Quality of built facility

1. Head wall condition =good or cracked
2. Apron condition= good or cracked
3. Slab covers condition= good or cracked
4. Water point condition= good or cracked
5. Any others problems specify

Distribution system (if any):

1. Type of pipe material ____
2. Construction, properly buried/ exposed __________________________
3. Leakage, yes or no

Out let:

1. Is it easy to access and operate for children and disabled? ____________
2. Does it provide convenient container placing? _____________________

Environmental issues

1. Condition and existence of drainage facilities

   1. Good 2. Filled with mud 3.Does not exist 4. Other ____________
2. . Is catchments rehabilitation done? Yes or No
3. Surrounding of the water supply source:

   1. Not clean at all 2. Somewhat clean 3. Very clean

C. Key informant interview

1. What are the main objectives of your organization regarding to rural water supply?
2. Which implementation approach does your organization using for rural water supply provision? Is your implementation approach standardized? What are basic features?
3. Do you give support for the community members after construction of the project?

4. What is your planned service value for rural water supply?

   Quantity

   Quality

   Accessibility

   Reliability and how do you monitor it?

5. What are the institutional supports given for rural communities /WASHCOs from your organization during?

   Planning

   Construction

   After construction

6. Is there any water point inventory done by your organization? How frequent is it?

   Example what is your definition of functionality? What lessons learned from the previous inventory?

7. What are the major factors affecting planned rural water supply services value and scheme sustainability identified by your organization? What are strategies your organization using to alleviate such problems and ensure rural water supply scheme sustainability?
8. How is the operation and maintenance of the water points addressed in your approach? What kind of capacity building do the communities receive in order to maintain the water points?
9. How is the availability and procurement of spare parts organized?

   What types of problems are related to the supply chains of spare parts?

10. What kind of suggestions do you have to improve the operation and maintenance of the water points (schemes)?

D. **Discussion with water committees (WASHCOs)**

Date of discussion____________ Kebele__________ village (got) _________

1. How many household are using the schemes?
2. Year of construction
3. Who select the water committee members?
4. When did the committee get established? a. before scheme construction b. during scheme construction c. after scheme construction
5. How the water committee selected?

6. How many members exist in the committee? Male ______Female _____ total _____
7. What are the External (intuitional) supports you get after water supply schemes constructed?
   a. Capacity building and trainings b. Post construction support
8. At what frequency the woreda supervisors visit after construction of the schemes?
   a. none b. once in a year c. twice in a year d. when we need help
9. Is the water committee equipped with necessary materials, manuals and working guidelines?
10. What kind of support provided by the bureau to committee members?
    a. technical b. monthly salary c. capacity building d. no support
11. Who designs the water tariff rate? A. Community b. water committee alone c. implementing agency d. woreda water office, if other, ____________
12. Are the users pay user fees regularly? a. yes b. no

- If "No" what do you think the reasons and what measures have been taken to alleviate the problem?

13. Who under take operation and maintenance? a. local technicians b. woreda water office c. both d. no maintenance work so far, if other specify_____________
14. From where did the committee get spare parts and maintenance tool kits? a. woreda water office b. purchase from private service providers, if others, specify__________
15. Does the water committee have a bank account? a. Yes b. No
16. How much money is collected and saved in the WASHCos account? How much do you pay per month on average? How do you see the adequacy of the saved money for purchasing necessary spare parts in case of break-downs?
17. How does the committee evaluate community participation in general and women's participation in particular at all phase (pre-implementation, during implementation, post-implementation) of the schemes?
18. From your experience, what major problems are encountered in relation to water supply schemes?
19. What solutions do you recommend in order to alleviate the problems and to sustain the functionality of the schemes?
20. What kind of solutions would you suggest in order to lengthen the operational life time of the water point?

Annex-II
Status of observed water points

General information about water supply schemes in the study area							
Kebele	Gott/village	GPS Coordinate			Scheme type	Current status	Constructed by
		X	Y	Z			
Mino	Ololamo	357291	798893	1903	WP	FN	World vision Ethiopia
	Lamarada	358997	797243	1855	WP	FN	Government
	Waose	359291	799240	1925	HDW	NF	Government
	Ontoza	359715	799882	1921	HDW	NF	World vision Ethiopia
	Gebaya area	359785	799560	1924	WP	NF	Government
	Lege	361507	792766	1857	WP	FN	Inrteraid France
	Malge Sefar	361558	792530	1897	WP	FN	Inrteraid France
	Wamisho	361679	797756	1872	WP	NF	Inrteraid France
	Garawamo	361740	799651	1861	SW	NF	Government
	Lower damo	360988	801773	2233	WP	FN	Government
	Upper damo	369583	801693	2146	WP	FN	World vision Ethiopia
	Medium damo	366516	801717	2075	HDW	FN	Government
Walana	Era one	360050	793236	1713	HDW	NF	World vision Ethiopia
	Danshe	359794	793383	1708	WP	FN	Inrteraid France
	3rd danshe	359420	794629	1692	HDW	NF	World vision Ethiopia

	4th danshe	359417	793610	1719	HDW	FN	World vision Ethiopia
	2nd danshe	359427	793093	1712	HDW	NF	Government
	Era 2	359289	793400	1709	WP	FN	World vision Ethiopia
	Largade	358863	793093	1700	WP	FN	World vision Ethiopia
	Arame	360791	794919	1707	SW	NF	World vision Ethiopia
	Mitame	360699	794421	1723	SW	NF	Government
	Suta	360799	794994	1741	HDW	FN	World vision Ethiopia
Lesho	denama 1	359714	795646	1750	WP	FN	Government
	denama 2	358872	794983	1707	WP	FN	World vision Ethiopia
	borkosha 1	359376	795607	1765	WP	FN	Government
	borkosh 2	359445	796064	1787	WP	NF	World vision Ethiopia
	fesha 1	358940	796399	1776	SW	NF	Government
	chafa 1	359481	795703	1761	SW	FN	Inrteraid France
	fesha 21	359409	796566	1810	WP	NF	World vision Ethiopia
	chafa 2	358331	796609	1982	SW	FN	Inrteraid France
Gemesh	chafa 3	358911	796063	1784	ONSP	NF	Inrteraid France
	1st borkosha	361199	797178	1712	HDW	FN	Government
	Ufute 1	361700	797431	1744	WP	FN	World vision Ethiopia
	Ufute 2	363359	798765	1823	SW	FN	Government
	1 st sigzamo	362205	796966	1787	WP	FN	Government
	3rd sigzamo	362994	799127	1870	WP	FN	Inrteraid France
	Suta 1	363037	798463	1857	SW	FN	Inrteraid France
	Suta 2	363632	797943	1838	ONSP	FN	Government

	4th sigzamo	362844	797326	1825	HDW	NF	Government
	2nd borkosha	362789	796806	1811	SW	FN	Inrteraid France
Zogoba	1st washo	363033	802751	2212	WP	FN	Government
	2nd washo	363139	802254	2190	WP	FN	Government
	1st babate	363622	801781	2164	HDW	FN	World vision Ethiopia
	2nd babate	363246	802824	2151	WP	NF	Inrteraid France
	1st gamamo	364173	800681	1936	ONSP	FN	Inrteraid France
	2nd gamamo	364233	800619	1927	WP	NF	Government
	Chufo 1	364098	800066	1902	SW	NF	Inrteraid France
	Chufo 2	363881	799547	1893	ONSP	FN	Government
	Utuge	363769	803721	2290	SW	FN	World vision Ethiopia
	Reja	363106	800364	1891	ONSP	NF	World vision Ethiopia

Annex- III

Necessary spare parts used to repairs dug wells			
Pump types			
A. Afridev Mark		B. Indian Mark	
Name of change spare part	Current cost range in birr	Name of change spare part	Current cost range in birr
O-ring	27-42	Chain	350-510
U-seal	28-43	Piston	1065-1550
Bobbin	27-42	Bearing	360-530
Plunger	216-231	Cylinder	1770-2400
Foot valve	181-196	Rubber sealing	75-150
Bush bearing	22-37	Socket or coupling	30-65
Rod centralizer	22-37	Sealing ring	80-150
Fulcrum pin	215-231	Upper foot valve	535-850
Cylinder assembly	1887-1902	Head bolt, nut, check nut	40-60
PVC pipes	228-243	Hexogen coupling	40-60
Coupling for PVC pipes	76-78	GI pipe	320-560
Rod hanger pin	228-243	Rod	205-360
Nylon rope	274-289	Cup seal	130-
Cement solver	39-45		
Solver cleaner	39-45		
PVC pipe centralizer	22-37		

ANNEX-IV

Bacteriological sample point results

parameters	S1	S2	S3	S4	S5
FC	3	6	0	1	13
	1	8	0	2	10
Average	2	7	0	1.5	11.5
TC	12	14	0	8	24
	13	18	0	6	26
Average	12.5	16	0	7	25
WHO standard	0	0	0	0	0