Situational Analysis of Rural Water Supply Schemes: The case of Adama Woreda, Ethiopia

Arebu Aman Kedir

A Thesis Submitted to the Department of Water Resources Engineering

School of Civil Engineering & Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in water resources engineering

(Specialization in Water Supply and Environmental Engineering)

Office of Graduate Studies

Adama Science and Technology University

June, 2023

Adama, Ethiopia

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Advisor: Mesfin Benti (PhD)

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Declaration

I hereby declare that this Master Thesis “Situational Analysis of Rural Water Supply Schemes: the case of Adama Woreda, Ethiopia” is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

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Approval Page of MSc Thesis

I, the advisor of the thesis entitled "Situational Analysis of Rural Water Supply Schemes: the case of Adama Woreda, Ethiopia" and developed by Arebu Aman, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

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Major Advisor	Signature	Date

We, the undersigned, members of the Board of Examiners of the thesis by Arebu Aman have read and evaluated the thesis entitled "Situational Analysis of Rural Water Supply Schemes: the case of Adama Woreda, Ethiopia" and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in water resources engineering (Specialization in water supply and environmental engineering).

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ABRIVATIONS

ADB:	African Development Bank
ADF:	African Development Fund
CARE:	Cooperative for American Relief Everywhere
CSA:	Central Statistics Agency
EC:	Electric Conductivity
EPA:	Environmental Protection Agency
ESP:	Environmental Support Project
ESA:	Ethiopia Standard Agency
FGD:	Focus Group Discussion
HHS:	Household survey
KII:	Key Informant Interview
MDG:	Millennium Development Goal
NGO:	Non-Governmental Organization
NPS:	Non-point Source
O&M:	Operation &Maintenance
pH:	Potential Hydrogen
SDG:	Situation Development Goal
TDS:	Total Dissolved Solids
UN:	United Nations
UNDP:	United Nations Development Program
WASH:	Water Supply, Hygiene and Sanitation
WHO:	World Health Organization
UNICEF:	United Nation Children Fun

ABSTRACT

Reports showed that the rural water services in Ethiopia are non-functional due to lack of funds for operation and maintenance, inadequate community mobilization and commitment, as well as lack of spare parts. Despite the reports, less is known about the reason or factors that contributed to problem with full understanding that the factors could be different and complex. The objective of this study was to assess the situation of the rural water supply scheme in the Adama Woreda. To address the research objective: household surveys, field observation, focus group discussions, key informant interviews and relevant document reviews were analyzed. In addition, groundwater quality test was carried out for Bacteriological and for some important physicochemical parameters. Based on the study finding, currently safe drinking water access in the woreda out of the total population properly addressed only for 58.54% not addressed properly due to non-functionality for 17.07% and the remaining 24.39% was not addressed totally and option should be exploring for area not addressed totally by all concerning bodies. In the study area 12 (56%) and 4 (19%) schemes were function and non-function respectively, and also 48(68%) water points were properly functional, 11(15%) were semi functional and the remaining 12(17%) were nonfunctional, and absence of local technician, spare parts, power supply source and poor construction quality were main challenges of scheme functionalities but role of community participation have no negative impact in provision of water service level, and training for local technicians and spare parts supply by mechanism of revolving fund is be recommend to reduce the challenges. Physicochemical parameters test result shown that pH, Electrical conductivity, Total dissolved solids, Turbidity and Total hardness value were within the recommended limit but Temperature and Fluoride value were out of the recommended limit of national and WHO drinking water standard, and further detail study is recommended for dilution process by integrating of the current schemes with other schemes coming by gravity expansion to overcome health risks. regarding Bacteriological test result Total coliform were within the recommended limit but faecal coliform were out of the recommended limit of national and WHO drinking water standard and chlorination is recommended to overcome this low risk problem.

Key words: Functionality, water supply schemes, Adama woreda, community, water quality.

CHAPTER ONE: INTRODUCTION

1.1 Background

Water is crucial for all lives on the planet and is a primary thing of sustainable development and increase. In the opposite, water is the purpose of diverse disastrous phenomena which can be difficult the sector including, flooding and water borne illnesses. Further to those regarding home water deliver the depletion of freshwater assets is a large task of the state of affairs of water offerings. Moreover, fast population growth, climate exchange and lack of ok system management are retarding efforts to cope with water for all (Behailu et al., 2016). Coupled with the water sources depletion and growing demand make our destiny unpredictable. 2.3 billion People live in water-stressed countries, of which 733 million live in high and critically water-stressed countries. (UN-Water, 2009)

To deliver water for city and rural groups, there are distinctive varieties of company in exceptional nations (said, et al 2013).because of this, every minister and counter components of water have an obligation to insure equal distribution of water for all city and rural network primarily based on their interest. despite the fact that Ethiopia has been referred as "a water tower of East Africa" and proficient with numerous surface and floor water assets, it has were given little or no benefit from both of those resources (Rogers, 2007). Country's water deliver region is characterized through terrible performance due to a number of reasons. Some of the purpose are low utilization stage may be the requirement of high capital investment and rather certified skilled manpower. As a result, approximately one-fourth or greater of the citizens are getting water supply services from unprotected sources (Domínguez et al., 2019). The scenario in the take a look at region, in Oromia area East showa area of Adama District, is not different from such realities.

Even though there has been drinking water supply service since long year ago, it had not been meeting the needs of the residents in these times. Although the Woreda administration has been taking different measures in different times to change the situation, still there are many problems related to drinking water supply is intermittent. The situation clean drinking water supply service in the Woreda is unbalanced and still many people lag behind access to drinking water supply service.

In short, while a service of water supply is one that ensures adequate, affordable and equal distribution of clean water to all entire communities, technology to be installed, the way of management, considers economic of various society groups and well-functioning of the whole water supply scheme.

1.2 Statement of the problem

In Ethiopia both governmental and non-governmental development agents have been involved in order to enhance the coverage of clean water supply in different parts of the country. Many water supply schemes have failed to supply the intended benefits and many water facilities are not operating well. There is very limited data available on water service providing, it has been estimated that in most developing countries, 30–60 percent of rural water supply schemes are not functioning at any given time (Brikké and Bredero, 2003). As (ADF, 2005) reported that 33% of the rural water services in Ethiopia are non-functional due to lack of funds for operation and maintenance, inadequate community mobilization and commitment, as well as lack of spare parts. But if the current trends are allowed to continue, a minimum of 15,820 rural water facilities will be completely non-functional (ADF, 2005). As per the definition given by Ministry of Water Resources (1996) "adequate water supply to mean 20 liters of water per person per day and accessible within a range of 0.5 to 1.0 km from a dwelling place". Any improvement made in safe water access has to be measure as per this definition. Taking this definition in to account, has stated that significant proportion of households with safe drinking water access will have greater chance of not securing adequate amount of water that is quite necessary for their wellbeing. Despite the reports, less is known about the reason that contributed to problem with full understanding due to their complexity. Hence, this study was assessing the situation of rural water supply schemes of the district. Several water supply systems were constructed in rural parts of the district, however; there is not information about their situations. Therefore, the objective of this study was to assess the situations of rural water supply schemes in the study area.

1.3 Objectives of the Study

1.3.1 General objective

The overall objective of this study was to assess the situation of rural water supply schemes in Adama Woreda.

1.3.2 Specific objectives

- ✓ To analysis the situation of existing rural water supply schemes in the study area.
- ✓ To assess the role of community participation on management of rural water supply schemes in the study area.
- ✓ To evaluate ground water quality level for bacteriological and some important physicochemical parameters in the study area.

1.4 Research Questions

The study were tried to answer the following research questions:

- ✓ What is the situation of existing water supply schemes?
- ✓ To what extent the role communities participate on water supply schemes in the study area?
- ✓ Do the ground water qualities of study area fit the guidelines set in the WHO standard and that of the Ethiopian recommended guideline? If not what will be the health significance of the water on the health of the users?

1.5 Significance of the Study

This research will contribute to the better understanding of problems related to situation of rural water supply schemes. The problems those were identified in this research are systematic and common to all other related Woredas. Therefore, the recommendations made in this research study can be applicable to many other related Woredas.

The study will also inform both the academic side and the rural water sector practitioners with concrete data on situation of rural water supply schemes. Besides, the research will be likely for contributing an input towards future planning, implementation and management of drinking water supply projects.

1.6 Scope of the Study

The research focused on exploring situation of rural water supply schemes by conducting a situational analysis on existing water supply schemes, evaluate ground water quality for some important physicochemical, and bacteriological parameters and to assess the role of community participation on rural water supply scheme managements in the study area.

1.7 limitation of the Study

The research focused on assessing the situational analysis of water supply schemes in Adama Woreda but rural sanitation facilities, seasonal test, conducting an inclusive research regarding unprotected source were not included in this study. This is because; it requires additional time and budget.

CHAPER TWO: LITERATURE REVIEW

2.1 Overview of Rural Water Supply

Water via its very nature is a quintessential aid this is chargeable for sustainable livelihood and taken into consideration as a major factor for sustainable improvement. It's far a precondition that need to be in location for mankind to guide energetic and secured life and thereby materialize socio-economic development (Asia-pacific discussion board, 2002).

As per the (Millennium Development Goal, 2010) summit Report, progress on the MDG 7 target 'to reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015' is presently on pathway. However rural areas in developing countries across the world remain severely underprivileged, with eight out of ten people not having access to an improved water supply. According to (WHO/UNICEF 2008), 87% of the world population has got access to safe drinking water, a progress of 10% within the last two decades. Despite this progress, stated the same report, 884 million people worldwide, out of which 37% living in sub-Saharan Africa, are still utilize drinking water from unsafe supply spots.

Africa is lagging behind the attainment of the MDG as 340 million Africans are still in need of access to safe drinking water (UN world water, 2009). To this effect, the proportion of the African population who get accessed to safe drinking water accounts for only 60%, which is about 11% increase compared to the situation in 1990 (WHO/UNICEF 2008). As for the case of Ethiopia, the once lowest country wide secure consuming water coverage has been reversed and scaled up to 68.5% by 2010. This become attributed to bold attempt that was made in the quarter because the ultimate couple of years (ADB, 2010).

As per urban-rural disparities concerning safe drinking water access, it was estimated that of those segments of the world population who lack access to improve drinking water, 84% are living in rural areas (UN world water, 2009). Accordingly, urban safe drinking water coverage for Africa is estimated to be 85% (281 million) as compared to the rural coverage which is about 51%, representing 294 million people (WHO/UNICEF, 2008). In this respect, Ethiopia has made an encouraging progress as rural safe drinking water access has increased from 35%

in 2004/05 to 65.8% in 2009/10, and that of urban get right of entry to coverage has been increased from 80% to 91.5% for the time unique (UNDP Ethiopia, 2010).

As for the progress made regarding sanitation facilities, the situation is not that much promising as 2.6 billion people worldwide are not in a position to utilize improved sanitation facilities.

Significant proportions (72%) of those are living in Southern and Eastern Asia and the remaining segment of the population are from Sub-Saharan Africa. Africa is still lagging in the back of the attainment of the Millennium development aim as 500 million others are in terrible sanitary conditions (UN world water, 2009).

Regarding the use of improved sanitation facilities, it was estimated that 61% of the world population has been accessed so far and maximum effort need to be in place in order to meet the MDG target (WHO/UNICEF, 2008).

Out of those 2.6 billion people without improved sanitation, three out of 10 are living in urban areas while the remaining 7 reside in rural areas (UN world water, 2009). The scenario in Africa may be very disappointing in this regard, as the tradition of open defecation has been extensively practiced via widespread percentage of the rural populace (228 million) who don't have any kind of sanitation facility. To that effect, the rural sanitation coverage for Africa is only about 29% while that of urban area is 53% (WHO/UNICEF, 2008).

According with the Ethiopian context, the widespread majority of the populace are living in an average rural vicinity the intake of unprotected and infected ingesting water do contribute loads in stressful toddler and toddler mortality degrees. As a consequence, the beneath-five mortality degrees has end up 85/1,000, whilst that of toddler mortality has been rated as forty five in keeping with one thousand live births (UNDP Ethiopia, 2010).

As for the case of general morbidity and mortality rates of the population in rural Ethiopia, 70% of the cases are attributed to the consumption of contaminated water and poor sanitation practices (ADF, 2005). In this regard Africa is far behind meeting the MDG target and formidable effort need to be exerted in order to reverse the prevailing adverse situation.

2.2 Functionality status of water supply schemes in Ethiopia

The established water supply schemes aren't fully purposeful within the country due to multifaceted factors (Yitayh, 2011). For this reason, the schemes non-functionality is contributing to already present low water supply coverage. According to (MoWRD, 2005/6) annual record within the proportions of nonfunctional schemes in the country is 25% on a median. But, the fee varies from region to region (Afar, Somali, Gambela, Dire Dawa .Hareri) all are 30% in their water supply schemes are non -purposeful. In addition, 6950 present non-functional or semi-practical water schemes were maintained and rehabilitated throughout the 2005. This has reduced the percentage of rural non-functional water schemes by 5% from 30% in 2005; to 25% in 2006.

2.3 Functionality of Rural Water Supply Schemes

2.3.1 Functionality situation of existing Rural Water Supply Schemes

Rural water supply system circumstances and capability are interrelated but special performance indicators of service distribution. Functionality is an easy picture view of whether or not water delivery systems are running at the time of inspection. It cannot on its very own tell us something about the motives for the specific country that the water point is in, or why it may be supplying service, intermittent carrier or no provider in any respect.

Functionality data are of confined significance, but they may be regularly the excellent warning signs of inadequacies in provider provision (Carter et al, 2010). Even as rural water delivers scheme conditions whether or not or now not facilities provide the designed degree of provider (accessibility and potability) maintains over the designed time period (Abrams, 2013).

Functionality of water distribution schemes is whether or not benefits from the distribution satisfactorily until the end of the design life. Advantages include healthiness through distributing advanced accessibility and potability (Mebrahtu, 2012). According to (Carter et al, 2010), functionality about the inter-relationship of natural resources, physical assets and the services they provide; the people and organizations which use and manage them; and the rules and financial systems which facilitate effective management. Functionality on the other hand is about whether (and where degrees of service are possible, to what extent) a service is operating at a particular point in time. The partial functionality or non-functionality of a service may provide a trigger for more detailed investigations of functionality (Carter et al, 2010).

2.3.2 Assessment for functionality of Rural Water Supply Schemes

Despite the fact that rural water supply scheme functionality is headache for sector actors and researches confirmed this, accurate and widely accepted indicators were not set so far. In most cases functionality of water supply facilities are roughly defined based on its status at the time of inspection without deep analysis of the level of service it can deliver. As (Isayas, 1988) cited in (Sharma, 2012), the water supply system should be sufficient to meet the basic demands of communities in the project areas and water is consistently acceptable. There are four indicators of functioning of water supply facilities to manage the increased necessity of water use which are quality, quantity, reliability of water supply and convenience. However the functionality figure presented in (Sharma, 2012) is not measured accordingly. CARE, an international NGO, on its water point status assessment sheet defined functionality as ‘if a water point has been providing service in past six months’-though other proxies have been used. According to (SNV, 2013), rural water supply schemes are defined as non-functional if they fail to meet the basic level of service based on national standards. Where the levels of service are determined using quantity, quality, reliability and accessibility as indicators and the worst score of these indicators define the service level.

2.3.3 Challenges of Rural Water Supply Schemes functionality

2.3.3.1 Technical challenge

Technical problem faced includes equipment selection and acceptance of society, structure situation and spare components. As part of a demand-function method to boost society possession of hooked up water offerings, (Whittington et al, 2008) acknowledged the family unit want to involve the preference of technology therefore making sure engineering designs had been attentive to nearby desires.

2.3.3.2 Equipment selection and structure situation

The technology should fit the regionally available competencies or that can be acquired with the aid of community individuals. Generation is taken into consideration if it is socially suitable, economically feasible, technically effective and environmentally sound. According to (Musonda, 2004) groups need to have a say and participate in technology option. However, examine in Mirab Abaya, in Ethiopia has shown that water committees have by no means been participated in era choice sports (Tegegn, 2008).

Similarly to selection of appropriate technology, cautious of engineering design and structure situation of projects are crucial in rural water deliver software in particular in poor society. Regarding this poor society (Carter et al., 1999) institution indicates it may be disastrous for poor people whilst a facility breaks down and cannot be repaired because of a fault inherent within the design and structure situation of projects. If the preliminary scheme became paid for from groups users sources, they will probably be unable to make an effort a second time; if an out of doors company helped, the attitude is probably to be you have had your part, no extra now!. Similarly, the basis for era choice became that "the era chosen ought to supply the network the best service stage that it's miles willing to pay for, will advantage from and has institutional capacity to preserve"(Arlosoroff et al., 1987).

2.3.3.3 Availability of spare parts and toolkits

Appropriate tools for carrying out repairs should be made available to achieve functionality. There is also need to ensure that spare parts are affordable, because at the moment most communities cannot afford the cost of spare parts (Musonda, 2004). To support situation of rural water supply schemes, spare parts and toolkits must be available (Carter et al., 1999). In support of this, (Komives et al., 2006) stated without access to reliable supply of spare parts and some qualified person to make repairs, water supply schemes will not be functional. WAE (2004) additionally indicated lack of enter suppliers for spare elements contributes to decrease continuity of water tasks. As stated by (Musonda, 2004), availability of inexpensive spare components also taken into consideration, capability at network level to operate and hold the water deliver centers and capability of groups to contribute user fees as being important to scenario of water deliver schemes.

2.3.3.4 Technical skills needed for operation and maintenance

As stated by (Yewonwossen, 2012), operation and maintenance cautious is a key requirement of any mechanical gadget. Too many water schemes fail due to the fact the maintenance desires cannot be met (Carter et al., 1999). In his Article entitled "Operation and upkeep of Rural Water materials" have said that "…Operation refers to the direct get right of entry to the machine with the aid of the user (e.g. operating the hand-pump), to the activities of any operational team of workers (e.g. operators of motorized pumps), and to the policies or via-legal guidelines which can be devised to manipulate who can also get entry to the gadget, while, and under what situations. Maintenance, on the other hand, is to do with the technical activities, deliberate or reactive, which can be needed to preserve the gadget working. Protection tiers from preventive (e.g. greasing, tightening nuts and bolts), to reactive (restore after failure, requiring gear and spare elements), to most important rehabilitation or replacement…"

The ability of the network to function and preserve the water schemes may be very crucial aspect of sustainability. However, maximum rural communities lack technical talents to carry out principal repairs. As (MoWR, 2003) diagnosed various motives for schemes being out of operation. Terrible safeguard is the maximum essential contributor for schemes non functionality due to vulnerable supportive structures, hard get admission to spare elements, loss of experience of possession among users group and lack of qualified societies.

A key goal of any network water delivery is need to be to create projects which may be stored in right running order with the resources regarded to be to be had. In lots of growing society, O and M of small community water deliver structures has been ignored. Sanitation, mainly, is given a good deal less attention in practice, despite the fact that "water-supply and sanitation enhancements" are often referred to collectively in challenge documents (Carter et al., 1999).

2.4 Community Management Model for Rural Water Supply Schemes

Society participation on making plans and creation is a prerequisite for rural water deliver centers to be useful. There can be powerful society participation and contribution to the initial installation and operation and upkeep costs. But it doesn't assure that water deliver schemes are sustainable. Setting the precise operation and protection control model is a key to supply rural water deliver carrier on scenario foundation.

Society management version has been the familiar model used to manage rural water deliver in sub-Saharan Africa for the ultimate many years. even though it has substantial application and perceptions, the low water supply scheme state of affairs posed query whether or not this model is sustainable or dispensable (Harvey and Reed, 2007). In step with (Harvey and Reed,

2007) community controls systems have to now not be ‘one size matches all’ answer and confined to some of on-going elements together with:

- ✓ Network control frequently relies on voluntary inputs from community members, which people may do for a while but are reluctant to do within the long time; there are often no lengthy-term incentives for community individuals.
- ✓ Key people at the water committee depart the network or die, and there is no mechanism to replace them with educated people.
- ✓ The network corporation charged with handling the water deliver loses considers and appreciates of the overall community. This may be related to a lack of transparency and duty, and absence of law via a helping group (e.g. neighborhood government).
- ✓ Failure via network individuals to make a contribution preservation fees results in disillusionment among committee participants who abandon their roles. This could be due to a lack of legal reputation and authority of the water committee or loss of network brotherly love.
- ✓ Communities don't have any touch with local authorities (or the implementing business enterprise) and feel that they've abrogated responsibility for carrier provision; they consequently experience abandoned and emerge as demotivated.
- ✓ groups are too bad to update major capital items when they wreck down
- ✓ As (Schweitzer and Mihelcic, 2011), on their paper entitled ‘community managed Rural Water
- ✓ Structures: What makes them useful?’ communities using from younger and less shared water structures are greater active than the ones the usage of aged systems and abandoned guide institutions.

generally for network control to be sustainable there have to be ongoing guide from an over-seeing group to offer encouragement and motivation, tracking, participatory making plans, ability construction, and professional technical assistance (Harvey and Reed, 2007) and (Schweitzer and Mihelcic, 2011).

2.5 Drinking Water Quality and Human Health

The health of any society fully relies upon on the accessibility of ok and secure water. Consequently, water is predominantly essential for life, health and for human self-recognize.

Therefore, in addition to community health benefits, all people have the right to safe and adequate water retrieved in equitable manner for drinking, cooking, personal, and domestic hygiene. In this case, both adequacy and safety of drinking water are equally important to reduce the incidence of water-related & water borne health problems especially diseases like diarrheal (Bharti et al, 2011).

A possible contamination source that carries threats to drinking water quality are open field defecation, animal wastes, plants, economic activities (agricultural, industrial and businesses) and even wastes from residential areas as well as flooding situation of the area. Any water sources, especially older water supply systems, hand dug wells; pumped or gravity-fed systems (including treatment plants, reservoirs, pressure break tank, pipe networks, and delivery points) are vulnerable to such contamination. Particularly systems with casings or caps that are not watertight are most vulnerable. This is particularly true if the water sources are located close to surface runoff that might be able to enter the source. Additional way by which pollution reaches and enters a water supply system is through overflow or infiltration by floodwaters and inundation of waters commonly contain high levels of contaminants (Haylamichael et al., 2012).

The fitness of community extremely depends on the availability of safe and adequate water for drinking, domestic use, and personal hygiene. If public health is to be improved and maintained through provision of safe and adequate water supply the major five key elements are vital which includes quantity, quality, cost, coverage, and continuity. Most of the time the occurrence of communicable diseases in the country is related with water supply conditions in the locality. Infectious diseases affected by changes in the water supply condition are categorized as follows (Addisie, M., 2012):

- ✓ Those spread through drinking water (water borne diseases, such as typhoid, cholera, gastroenteritis etc.)
- ✓ Those transferred through aquatic vectors (water based diseases, such as schistosomiasis)
- ✓ Those spread by insects that depend on water (water related diseases, such as malaria and yellow fever)
- ✓ Those diseases produced by the lack of adequate water for personal hygiene (water washed diseases, such as scabies and trachoma).

Based on the morbidity records, there is still a high incidence of communicable diseases which most of the time is related to water supply conditions in the country among which about 60% of the top ten diseases are relate to poor quality and scarcity of household water consumption (UNICEF, 2008).

2.6 Drinking water quality

Water provision, especially in developing nations, were targeted on amount on the cost of nice, and there are requires marked development in high-quality-higher control of chemicals and microorganism content material (Barrow, 2005). However, it is critical to note, that issues of water great cannot be taken into consideration one by one from water quantity. In assessing the exceptional of consuming water, most consumers usually depend absolutely upon their senses. But, we are able to now not depend entirely upon our senses inside the matter of first-class judgment. The absence of any unfavorable sensory effects consequently does no longer guarantee the safety of drinking water.

In the submission on the drinking water quality control in small community supplies, WHO explains that although in the rural areas of developing countries, it is expected that a great majority of water quality problems are related to bacteriological contamination, a significant number of very serious problems may occur as a result of chemical contamination of water sources from agricultural practices and malpractices. More comprehensive indicators based on the total properties of water body must supplement the traditional emphasis on chemical indicators of water quality including chemical, physical, biological, and ecological parameters (Young, 2003). It needs to be recognized that fresh water quality is impacted directly by natural and human activities (Gordon, 2004). Such problems often require monitoring and protection at the local level, while some have significant trans boundary components, which are addressed at national and international levels (International Conference on Water and the Environment Report, 1992).

2.7 Drinking Water quality standards

The quality of water is assessed in terms of its physical, chemical, biological characteristics, and its intended uses. For example, although distilled water is physically, chemically, and bacteriological pure, its taste is rather bland and it is highly corrosive (Agunwamba, 2008).

Water quality varies with respect to purpose in every daily activity. Water standard requirements are established to determine whether is suitable for its intended use. Pot ability of water must conform to these standards. Water can be tested for thousands of possible elements or agents, but only about 100 are covered by most drinking water standard With respect to private wells, the standards of the US Environmental Protection Agency.

2.8 WHO Drinking Water Quality Standards

WHO has set guidelines for lower and upper limits of physicochemical and bacteriological concentration of drinking water. In this guide lines the concentration of various kinds of inorganic elements, compounds and bacteriological concentrations clearly specified. These guidelines have been widely used globally and used as a base for developing country specific drinking water quality standards. So that, countries are developed their own drinking water quality standards to monitor their water quality (WHO, 2017).

2.9 Ethiopian Drinking Water Quality Standards

Ethiopia has also developed its own standard derived from WHO guide lines. According to (ESA, 2013), the recent, Ethiopian Standard has been prepared under the direction of the Technical Committee for Water Quality (TC 78) and published by the Ethiopian Standards Agency (ESA).

2.10 Physicochemical parameters

Water for drinking should be free of objectionable taste, odor, color and suspended materials. These are often called aesthetic parameters. Aesthetic parameters are those detectable by using the senses, namely turbidity, shade, flavor, and scent. They’re important in tracking community water supply to be rejected. Physical parameters of water include pH, TDS, turbidity, temperature, and EC. The chemical quality influences the physical quality. The appearance, taste, odor, and ‘feel’of water determines what people experience when they drink or use water, and how they rate its quality. Turbidity should always be low, especially where disinfection is practiced (Shirin and Yadav, 2014).

2.10.1 pH

pH is a term used universally to explicit the depth of the acid or alkaline circumstance of an answer. The significance of pH lies at the truth that it affects the taste and odor of a substance extensively (Ojo et al., 2012). Further, Kanyerere et al., (2012) asserts that, low pH values can lead to fitness worries related to corrosion of the steel bins. The pH of the water coming into the distribution system should be managed to minimize the corrosion of water providing gadget. The ultimate pH required will range in distinctive resources in step with the composition of the water and the character of the construction materials used within the distribution gadget, however it is usually within the range 6.5-eight.5 (WHO, 2006).

2.10.2 Temperature

High water temperature enhances the boom of microorganisms and may increase flavor, odor, and color troubles of drinking water (Mombal et al., 2002; Agbogu et al., 2007). Temperature also affects the concentration of dissolved oxygen and can influence the activity of bacteria in a water bodies (Murphy, 2007). An aesthetic objective is set for maximum water temperature to aid in selection of the best water source or the best placement for a water intake (WHO, 1997; WHO, 2006). It is desirable that the temperature of drinking water should not exceed 15ºC because the palatability of water is enhanced by its coolness (WHO, 1997; Volk et al, 2002; Pirocheva et al., 2004). Temperatures above 15ºC can speed up the growth of nuisance organisms which include algae that could accentuate flavor, scent, and coloration troubles in consuming water (TID, 2000; Mombal et al., 2002; Agbogu et al., 2007).

2.10.3 Electrical Conductivity

Electrical conductivity is a measure ability of water to conduct electric current which is mostly influenced by dissolved salts such as sodium chloride and potassium chloride and is a useful tool to evaluate the purity of water (Acharya et al., 2008). It signifies the amount of total dissolved solid (Nafees, 2015).

2.10.4 Total Dissolved Solid

Total dissolved solid concentration is directly proportional to the electrical conductivity of water. It’s far a measure of the ability of water to conduct an electrical modern. According to some studies, the TDS is directly an average multiplication factor of 0.5 of the conductivity values measured across all the sampling points investigated. It comprises organic matter and inorganic salts (Ojo *et al*., 2012). A common expression of TDS (mg/l) = K x EC (µS/cm) where K is a constant of proportionality. The TDS-EC relationship is affected by the ionic composition of the water and the concentration of dissolved species. For most natural waters, the K value varies from 0.55 to 0.85 (Atekwana et al. 2004). TDS level beyond 500 mg/L, decreases palatability and may cause gastrointestinal irritation and constipation effects (Maiti, 2001). A higher level of dissolved solids increases the density of water, and reduces solubility of gases like oxygen, hence reduces utility of water for drinking, irrigation and industrial purposes (Maiti, 2004).

2.10.5 Turbidity

Turbidity is described because the mild scattering and soaking up property that stops mild from being transmitted in a straight trace through the sample. Turbidity may be because of organic and or inorganic ingredients (Spellman and Joanne, 2012). Turbidity affects the acceptability of water for drinking and its demand for different uses (EPA, 2001). For powerful disinfection, median turbidity needs to be under zero.1 NTU despite the fact that turbidity of much less than 5 NTU is normally perfect to purchasers (WHO, 2004).

2.10.6 Total Hardness as Calcium (Ca2+) and Magnesium (Mg2+)

Hard water is high in dissolved minerals, like calcium and magnesium. As water moves through soil and rock, it dissolves small quantities of those naturally-taking place minerals and caries them into the ground water delivery. Water is best solvent for calcium and magnesium, so if the minerals are there in the soil around the well and its water delivery, anyone can finish with hard water (properly Care, 2004).

Hard water interferes with nearly each cleaning challenge, from doing the laundry to washing dishes to getting showered. Clothes can look dirty and sense rough and scratchy. Dishes and glasses get spotted and a film may also increase on shower doorways, bathtubs, sinks and taps. Washing your hair in hard water might also go away it feeling sticky and stupid. Eventually, hard water can reason a residue to build-up in pipes that may decrease water stress at some point of the residence (well Care, 2007).

Hardness does now not pose a health threat and isn't regulated through state or federal agencies. However, hard water can be a nuisance due to the mineral build up on plumbing fixtures and negative cleaning soap and detergent overall performance. It seldom brings aesthetic problems, including an alkali flavor to the water that makes coffee taste bitter; construct-up of scale on pipes and furnishings which can result in decrease water strain; construct-up of deposits on dishes, utensils and laundry basins; difficulty in getting soap and detergent to foam; and reduced efficiency of electric water warmers (properly Care, 2007).

Several researches have indicated a hyperlink between hardness concentrations (especially calcium and magnesium) and cardiovascular diseases, Alzheimer's sickness and atopic eczema (Sengupta, 2014). Hard water is in particular caused by calcium and magnesium cautions and to a lesser quantity aluminum, iron and other cautions. Calcium and magnesium are the two foremost cautions answerable for hardness in natural water (Agostinho, et al, 2012).

Understanding the hardness of water is important when comparing its use as a home or business water supply. Difficult water interferes with laundering, washing, bathing and private grooming (Padmapriya, et al, 2015). Clothes laundered in hard water can also appearance dingy and harsh. Hard water usage in the home can result in different troubles as well. It also affects soap and detergent used for cleansing because cleaning soap used in hard water combines with the excessive amount of minerals to shape a sticky sludge. Bathing with cleaning soap in hard water can deposit this sticky residue onto the skin and can result in infection underneath barely acid conditions.

Calcium, which is essential for nervous system and for the formation of bones, is commonly present in all water bodies where it usually comes from the leaching of rocks. On the other hand, magnesium is usually less abundant in water than calcium, perhaps due to the fact that magnesium is found in the earth's crust in much lower amounts as compared to calcium (Traci, 2016). Calcium and magnesium concentrations in water have been linked to outcomes in heart diseases. There is epidemiological evidence to suggest a lower incidence of heart disease in communities with hard water (high calcium and magnesium content) (Maureen *et al.,* 2012).

2.10.7 Fluoride

Fluoride minerals are abundant in certain rock types. Immunoglobulin heavy locals' concentrations of fluoride can be released into ground waters through dissolution of these fluoride minerals, especially after prolonged contact periods within aquifers. According to WHO and Ethiopian standards the permissible range of Fluoride in drinking water should be 1.5mg/l.

2.11 Bacteriological Drinking Water Quality Parameters

The number and diversity of microbial agents that might be present in domestic waste water is important. The routine monitoring for all the possibilities is either impossible or impractical. The time required to complete most of the analyses prevents their utility as a water quality control feedback tool. The answer to the problem has been the use of indicator bacteria that would be present when probable pathogen containing material (faeces) was present. It should be emphasized that the presence of indicator bacteria does not mean the water contains pathogenic microorganisms but rather the potential exists for the presence of pathogens since the indicator bacteria point to the presence of faecal material in the sample. The number of pathogens that might be associated with the concentration of the indicator will be a function of the disease occurrence in the community at the time the faecal material was disposed.

Access to clean and safe water, good sanitation, and hygiene practices are necessary for a healthy population (Nsubuga,et al, 2014). Whereas the right to safe drinking water is a human right, one-sixth of the world's population cannot access safe drinking water, predisposing communities to the risk of waterborne diseases. Globally, 700 million people lack access to safe drinking water and half of these are in sub-Saharan Africa, where WHO estimates that 1.8 billion people drink water contaminated with Escherichia coli, which is an indicator of faecal contamination (Bain, et al, 2014). In third world countries,

80% of all diseases are directly related to poor-quality drinking water largely attributed to contaminants originating from unsanitary conditions (Mohammed et al, 2015).

Availability of healthy drinking water sources is a main concern in many countries around the world (Fard, et al 2015). Contamination of drinking water is one of the greatest public health problems worldwide particularly in developing countries (Rai et al, 2012) and may be severe at the household level (Opio, 2012, Raju, et al, 2011). If public health measures for safe drinking water and adequate sanitation are not enforced, water-related diseases such as cholera, dysentery, salmonellosis, and typhoid can erupt, especially in developing countries where millions of lives are claimed every year (Mohammed, et al, 2015). Globally, unsafe water coupled with poor sanitation kills at least 1.6 million children under the age of five years, 84% of them living in rural areas (Odeleye et al, 2016 and Olowe et al, 2016).

The results of coliform bacteria tests are generally used to monitor recreational areas, storm water out-falls, and drinking water supplies. Water is commonly tested for three types of coliform bacteria: faecal coliforms, total coliforms, and Escherichia coli (E.coli). The standards for drinking water are generally based on total coliforms. The accepted standard for drinking water is that there should be no coliforms present after the water is filtered or treated (Mengestayhu, 2007).

2.11.1 Total Coliform

Coliform organisms, better referred to as total coliforms to avoid confusion with others in the group, are not an index of faecal pollution or of health risk, but can provide basic information on source water quality. Total coliforms have long been utilized as a microbial measure of drinking water quality, largely because they are easy to detect and enumerate in water (David, 2011). They have traditionally been defined by reference to the method used for the group's enumeration and hence there have been many variations dependent on the method of culture.

In general, definitions have been based around the following characteristics: gram-negative, non-spore-forming, rod-shaped bacteria capable of growth in the presence of bile salts or other surface-active agents with similar growth-inhibiting properties, oxidase-negative, fermenting lactose at 35-370C with the production of acid, gas, and aldehyde with 24-48 hours (WHO, 1996).

Total coliform tests are used for potable water supplies. Total coliform contamination indicates inadequate disinfection of drinking water. Gastrointestinal pathogens known to have caused outbreaks of enteric disease are largely from the systematically defined family, Enterobacteriaceae, and include Salmonella, Shigella Yersinia enterocolitica, Klebsiellapneumoniae, Enterobacter and Enterotoxigenic, Escherichia Coli (ETEC). Vibrio cholera and Campylobacter jejune are two other enteric pathogens often found in contaminated water. These organisms are spread by water contaminated with faecal material from humans and other warm blooded animals (Hach, 2000). For these reasons, the microbiological quality standards for drinking water in the United States and in most developed countries are based on measuring the total coliform population (USAID, 2013).

The total coliform group has been selected as the primary indicator bacteria for the presence of disease causing organisms in drinking water. It is a primary indicator of suitability of water for consumption. If large numbers of coli forms are found in water, there is a high probability that other pathogenic bacteria or organisms exist (FDREMH, 2011).

2.11.2 Faecal Coliforms

Faecal coliforms (FC) are rod-shaped, non-spore-forming, gram-negative, oxidase-negative, aerobic or facultative anaerobic bacteria that are able to grow in the presence of bile salts or other replacement surface active agents having an analogous growth inhibitory effect and that ferment lactose with gas and acid (or aldehyde) production within 24 hr. at 44 ± 0.50C (Annie et al., 2001).

A common source of coliforms and pathogenic bacteria is raw sewage. Faecal coliform bacteria occur naturally in the digestive tract of warm-blooded animals, where they aid in the digestion of food (Payment et al., 2003).

The concentration of coliform bacteria in water is measured to determine the likelihood of contamination by microbiological organisms. While coliform bacteria are not pathogenic (disease causing), they are commonly found alongside pathogenic organisms such as those responsible for dysentery, gastroenteritis, and hepatitis A (Keller, 2009). The presence of FC bacteria in water indicates that faecal material from mammals or birds is present, so organisms that cause water borne diseases may be present as well. It is easier to test for FC than for pathogenic organisms; therefore, the presence of FC in a water sample is used to indicate potential contamination. Treated water entering the distribution system should have zero FC and zero coliform organisms per 100 ml of water (ES, 2001, WHO, 2011).

A study in rural areas of Ethiopia found that about 74% and 58% of the water samples from water sources and household storage were positive for E. coli (Amenu, 2014). In Jimma zone, oromia region, Ethiopia, among the 15 protected well water samples analyzed, 40% had bacterial count below 10 CFU/100 ml and 26.67% were free of faecal coliforms. Sixty percent of protected springs were free from faecal coliforms and 46.67% of these samples had thermotolerant coliforms (TTC) count less than 10 CFU/100 ml (Mohammed et al., 2015).

2.12 Concept of Sanitary Survey

Analysis of water quality parameters alone does not provide a complete picture of the water quality status of a community and its water supply system. Regular quality inspections are just a snapshot. Given the limited information about the source of the contamination, important seasonal quality variations can be missed. Addressing actual and potential water quality problems is only possible when information on the sources and pathways of pollutants is available, and this information can only be provided through health assessments (UNICEF, 2008). A sanitary survey is an on-site assessment by trained personnel of actual and potential hazards and pathways of contamination in and around the water system. Hazards are source of contamination that can pose risks to the water system, for example if the toilet is too close to shallow point sources or stagnant surface water. A path is a path through which contamination can occur, such as a leak in a pipe or a crack in a wellhead. Hazards and pathways may be indirect or intermittent, such as broken gates that allow animals to access well enclosures, or erosion that exposes buried pipelines. Sanitary surveys focus on sources of microbial contamination. However, in some cases, research may identify chemical hazards emanating from local industries and agricultural activities, such as intensive fertilization near surface water sources or runoff from tanneries near point water sources (UNICEF, 2008).

CHAPTER THREE: MATERIALS AND METHODS

3.1 Description of the study area

Adama Woreda is the selected study area, which is located in East Shewa Zone of Oromia Regional state in found at geographical location $8^0$10’00’’N, $39^0$25’20’’E and $8^0$50’00’’ N, $39^0$9’20’’E situated in the Great Rift Valley. It is one of the eleven woredas in the zone. The Woreda is covering a total of 968.27 km2 and bordering with districts of Lume in the north-west, Boset in the north-east, and Arsi zone in the south direction. The topography of the district lies within 1500-2300m above sea level. The woreda was divided administratively into forty-one rural kebeles and three urban areas. It is highly populated district in east Shewa zone and the total population of Adama district is 234,986 as at 2022 (CSA, 2022).

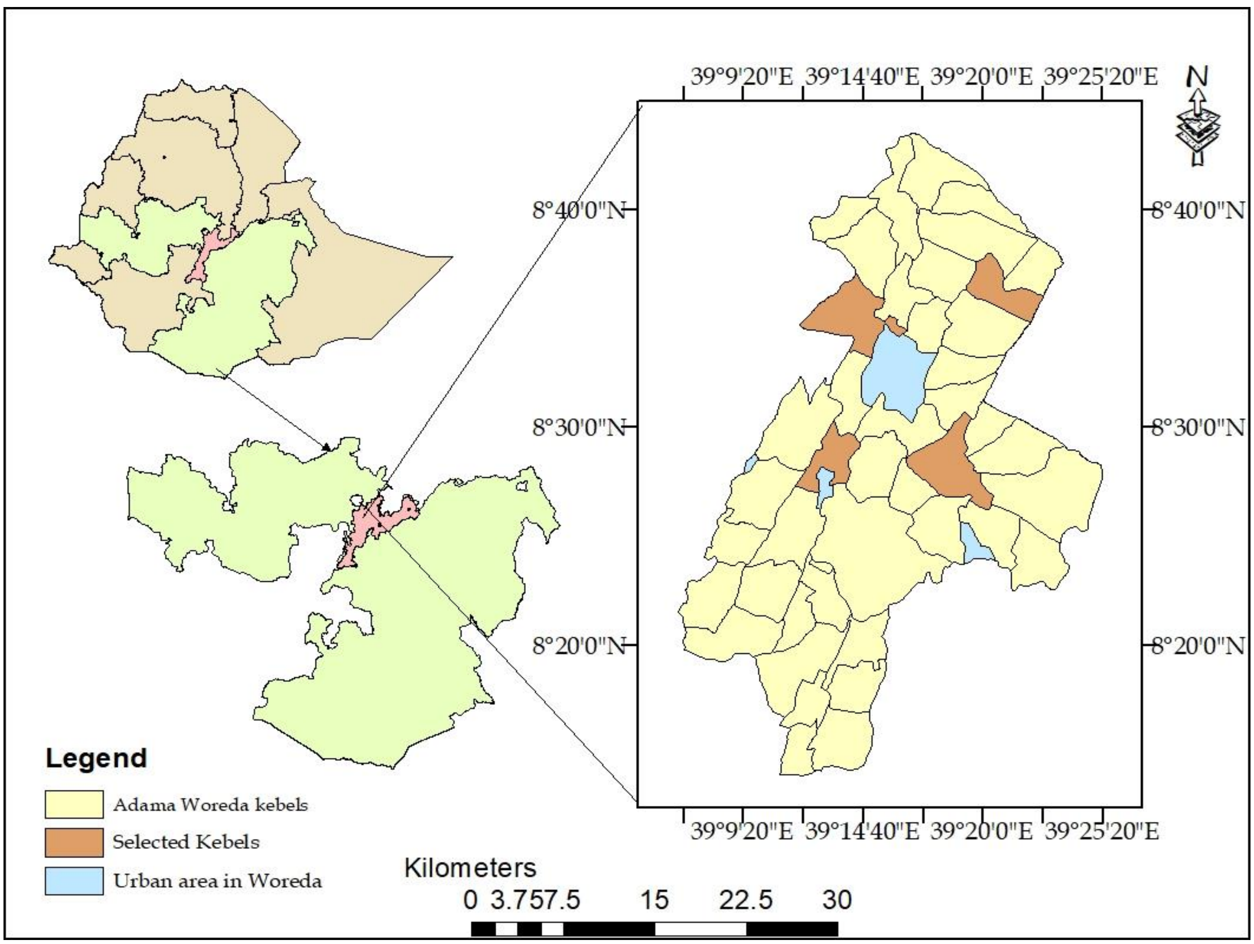

Figure 3.1: Location Map of the study area

3.2 Sampling Techniques

A simple random sampling technique was applied to select representative sample kebeles, water supply schemes and households.

3.2.1 Selection of Sampling Size (Schemes) with corresponding beneficiary kebeles

According to the Key stakeholder interviews result, four type of source used currently to supply water from the source to communities. The first two types are deep boreholes that used electric and diesel power, and the second two types are gravity expansion of urban water supply system from Adama city and neighboring woreda rural water supply schemes. Out of this existing water supply schemes in Adama district, four representative water schemes were selected based on the type of source used, geographical locations, socio economy of the people and system of operation. Accordingly, four water supply schemes with a total of 465 house hold connection and 13 public water taps were identified as unit of analysis for this research. These water supply schemes are located at four representative sample kebeles namely, Guraji Farda, Adulala hate, Kuriftu eda, and Qechema. Guraji Farda water supply scheme corresponds to those boreholes operated by diesel generator, while that of Adulala hate water supply scheme represents boreholes operated by electric power, Kuriftu eda, and Qechema kebeles were selected in order to represent gravity expansion from urbain water supply system of Adama city and Gembichu Fentale rural water supply schemes used in the respective communities.

3.2.2 Selection of Sampling Households

Households or beneficiaries were selected by using simple random sampling to give equal chance to all beneficiaries to become a sampling unit and representative sample size of households from the consumers of water supply schemes. The formula for determining households sample size provided by Yamane (1967) was used for representatives kebeles sample size calculation According to him for a 95% confidence level and maximum variability (p) =0.05, size of the sample was calculated using following equation. The data obtained from Woreda and Zonal offices, 3098 households are benefiting from four representative water schemes.

$$n = \frac{N}{1 + Ne^2}$$

Where n: Sample Size

N: Population Size

e: Level of precision

Then the samples of respondents were drawn from the beneficiary households using systematic random sampling method.

3.3 Primary data collection method

The primary data collection methods are

3.3.1 Household survey

A household survey was conducted to generate information at household level. A total of six main components such as information's about respondents, water consumption, distance travel and time taken to fetch water, technical skills for operation & maintenance, role of community participation on managements of schemes and construction quality data were collected using questionnaires developed (Appendix-1) for the purpose of collecting data from sampled households through data collectors on each four representative kebeles by guidance of a researcher.

3.3.2 Focus Group Discussions

A total of four main components (Appendix-2) such as functionality and non-functionality status of the schemes, technical skills for operation & maintenance, accessibility of spare parts and type of power supply source questionnaires checklists were established for the purpose of collecting data. The composition of (Appendix-4) twenty four in number participant were women representative, water fee collector, water committee representative, men representative, community elders and kebele representative from community. The discussion was undertaken in all four selected kebeles in order to assess ways of strategies to ensure situation of a project and the participation level of community in the course of the rural water.

3.3.3 Key informants' Interview

Appropriate checklists (Appendix-3) were established for which interviews were conducted with key informants (stakeholders) in the water supply sector of situation of rural water supply systems related to functional and developments of the water supply projects for the way forward along the water supply beneficiaries. A total of four main components such as current water supply source and coverage, functionality and non-functionality status of the schemes, technical skills for operation & maintenance, accessibility of spare parts and type of power supply source and construction quality questionnaires for the purpose of collecting data. The composition of Key stakeholders interview (Appendix-4) three in number participant were two representatives from Woreda water and one from Zonal water office professionals but the interview was done separately for woreda and zonal water office.

3.3.4 Field observation

A total of four main components (Appendix-6) such as status and location of source, storage, water points and distribution system checklists were prepared for the purpose of collecting data for field observation that helps the researcher to identify the standard of the construction, service providing status, status of the scheme regarding waiting time to fetch water and the distance between the water point and the house, and so on.

3.3.5 Collection of water samples

3.3.5.1 Field Equipment Calibration

Paline wagtech portable digital conductivity and P^H meter with temperature were calibrated by known value standard solution, at 800 μS/cm and 1413 μS/cm points for conductivity and 4.01, 7.0, 10.01 points for P^H meter with temperature, to assure field measurement accuracy at zonal water office for onsite test.

3.3.5.2 Samples Collection

The drinking water samples were collected in labeled pre-cleaned plastic containers and three liters by volume water samples were taken from both selected well field boreholes. In the field, the sampling bottles and caps were washed three times with sampling water before sampling. All water samplings were collected during morning and the samples were subsequently stored in an ice chest containing ice cube and transported to the Adama public health research & referral laboratory center for bacteriological and some important physicochemical such as Fluoride, Hardness, Total dissolved solids and Turbidity parameters samples analysis in the laboratory. Parameters with extremely low stability such as pH, electrical conductivity and temperature were measured on the field using field kit.

3.4 Secondary data collection method

Secondary data collection are other main tools for research work, for which the researcher used journal, governmental and non- governmental publication , previous studies, internet, available books, annual and inventory report from Woreda and Zonal offices of water resource.

3.5 Method of data analysis and quality management

In order to assure quality of data taken, much precision was taken in arranging final checklist stating the desired points to be short and precise. To eliminate weak questions, we ran our tests using a checklist. Oral trainings were given to data collectors and partial involvement in the data collecting process and also insured the quality of data gathered. Prior to the actual data analysis and interpretation, preparatory works that involve data editing has been employed in order to minimize irregularities and maximize accuracy. To this effect, manual data editing has been conducted in order to avoid problems.

Data collected and organized was both in terms of quantitative and qualitative. After sorting out the effective data, the numerical portion of the data was analyzed MS excel and Descriptive statistics (frequencies, percentages and means) were produced for the quantitative data depending on the nature of data collected.

Accordingly, report produced on the results of the study. The qualitative data collected through the key informant interviews, focus group discussions, and observations made were used to triangulate the findings of the quantitative survey. Some of the study findings are presented using pictures, diagrams, tables, and charts.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Demography's of respondents

4.1.1 Sex of respondents

According to the household survey result as shown in the Table 4.1, out of the total 55.56% were female and 44.44% were male respondents, to get reliable information selection of more female than males because women have a good experience, practice and knowledge upon water supply schemes sources and management (Tesfaye, 2011).

Table 4.1 Sex of respondents

Sex of respondents	Frequency	Percent
Male	160	44.44
Female	200	55.56
Total	360	100

Source: own computation from the household survey result

4.1.2 Age of respondents

According to the household survey result as shown in the Table 4.2, out of the total of the about 12.22% of the respondents were found in the age interval of 18-30 years, about 32.22% were in the age interval of 31-40 and another 37.78% were in the age interval of 41-50 the remaining 12.22% and 5.56% were fallen in the range of 51-60 and above 60 years old respectively. As (Kaliba *et al.*, 2002) effect of higher age group (above 60 years) on willingness to pay for maintenance and operation for the improved water supply service negative impact, this is because older people are more likely to choose to maintain the status as they are less likely to be directly involved in water collection activities.

Table 4.2 Age of respondents

Age interval respondents	Frequency	Percent
18-30	44	12.22
31-40	116	32.22
41-50	136	37.78
51-60	44	12.22
> 60	20	5.56
Total	360	100

Source: own computation from the household survey result

4.1.3 Educational Level

According to the household survey result as shown in the Table 4.3, out of the total respondents 17.5% could not read and write (illiterate) and those who can only read and write were 30%. Similarly 37% of the respondents had completed primary school (1-8), only 12.5% of the respondents had completed secondary school level of education (9-12), 2.5% of the respondents had completed college level of education and no respondents had completed university level of education. As (Yitayh, 2011) confirmed that willingness to pay for improved water services was expected to have positive relationship with level of education. Because, respondents with higher education have more awareness of the value of improved water services and also may have higher opportunity cost of time spent for water fetching.

Table 4.3 Educational status of the respondent's

Educational Level	Frequency	Percentage
Illiterate	63	17.50
Read and write	108	30.00
Primary	135	37.50
Secondary	45	12.50
College	9	2.50
Total	360	100

Source: own computation from the household survey result

On the basis of the above findings, it can be concluded that the sex, age and illiteracy level were not turn to be the main reason for poor management of rural water supply schemes.

4.2 Situation of existing schemes

4.2.1 Current water supply source and coverage

According to KI-interviews result as shown in Table 4.4 four type of source have used currently to supply water from the source to communities. The first two types were deep boreholes that used electric and diesel power, and the second two types were gravity expansion of urban water supply system from Adama city and rural water supply schemes from Gembichu-Fentale and Sire-Dodota (Arsi zone) neighboring woreda's. Concerning safe drinking water access or level of coverage of the Woreda rural area were deep borehole that used electrically powered was covered 24.39%, deep borehole that used diesel powered was covered 14.63%, gravity expansion of urban water supply system from Adama city was covered 14.63%, rural water supply schemes from Gembichu-Fentale and Sire-Dodota (Arsi zone) were covered 7.32% and 14.63% respectively and the remaining unprotected sources Awash river, Koka lake and local ponds covered 24.39%.

Table 4.4: Water supply coverage in the study area

No	Type of source	Coverage from all sources (%)	Functional schemes coverage (%)	Non-functional schemes coverage (%)
1	Deep bore holes used Electric power	24.39	37.80	9.45
2	Deep bore holes used Diesel power	14.63	18.90	9.45
3	Expansion Gembichu Fentale scheme	7.32		
4	Expansion from Arsi zone scheme	14.63		
5	Expansion from Adama city system	14.63		
6	Awash River, local pond, koka lake	24.39		
	Total	100	56.70	18.90

Source: own computation from the result of KII

On the basis of the above findings, it can be concluded that in the study area currently safe drinking water access out of the total population addressed only for 56.70%, due to non-functionality 18.90% not properly addressed and the remaining 24.39% was not addressed totally.

4.2.2 Water consumption

According to the household survey result as shown in the Table 4.5, the majorities 55% of the respondents consume 41-60 and above liters of water per day per household, and 30% consume 21-40 liter and the remaining 15% consume 1-20 liter per day per household. Regarding the amount of water consumed per household per day, by adding the total amount consumed by all HH respondents is 17,280 liters per day. To get the average amount of water consumed per day per HH, 17280/360=48 liter per HH per day. Similarly, to compute per capita consumption average amount of water consumed per day per HH divided by average family size =48/6.85= 7.0 liter per person per day. This finding is far from the WHO's (2003), statement which stated that basic access can be defined as the availability of water at least 25 liters per day per person.

Table 4.5 Amount of water consumed per day

Amount of water consumed per day	Frequency	Percent
1-20 liters	54	15
21-40 liters	108	30
41-60 liters and above	198	55
Total	360	100

Source: own computation from HH survey result

Based on the finding was to say that per capita water consumption of the study area 7 l/c/d were much less than the minimum amount of recommended by WHO 25 l/c/d

4.2.3 Distance travel and time taken to fetch water

According to the household survey result as shown in the Table 4.6 out of the total respondents, the majority 65% responded that the current water service was located at an estimated distance of less than 1km and the remaining 35% responded more than 1km in sampled kebele. Regarding the average time taken to fetch water from the current water service as shown that 30% of the total respondents spend on an average approximately 30 minutes or less and 70% spend on an average approximately more than 30 minutes in sampled kebele.

Table 4.6 Distance travel and time taken to fetch water

Distance travel	Frequency	Percentage	Time taken	Frequency	Percentage
< 0.5km	126	35.00	< 15 min	45	12.50
0.5-1km	108	30.00	15 - 30 min	63	17.50
1-1.5km	90	25.00	30 min - 1 hr.	126	35.00
1.5-2km	18	5.00	1 - 2 hr.	117	32.50
> 2km	18	5.00	> 2 hr.	9	2.50
Total	360	100		360	100

Source: own computation from HH survey result

WHO/UNICEF Joint Water Supply and Sanitation Monitoring Program, 2014, states that "Access to drinking water means that the service is less than 1 kilometer away from its place of use and that it is possible to reliably obtain at least 20 liters per member of a household per day." For the post-2015 SDG's, access to basic drinking water is proposed to be defined as "using an improved service with a total fetching time of 30 minutes or less for a round-trip including queuing."

On the basis of the findings, it was concluded that 65% the current water service was located in WHO standard and 35% is out of the standard. Regarding time taken to fetch water 30% the current water service was located in WHO standard and 70% is out of the standard.

4.2.4 Functionality and non-functionality status of the schemes

As result obtained from KI-interview about the water supply coverage, and they indicated that currently, the overall coverage of the improved water supply in the study area is about 60%. Additionally, they explained about the low coverage status of potable water supply and improvement of the problem of rural water supply schemes. Accordingly, there is need of additional water point but due to different problems like, lack of budget, it is impossible to construct additional water schemes. But, they said, the Woreda water office has planned to construct number of different schemes and rehabilitation of nonfunctional water supply schemes within the next year. Both KI-interview and the participants of FG-discussion confirmed that there is unfair distribution of the schemes within kebeles of the Woreda because of inaccessibility of some kebeles to the Woreda center. Most of the water supply schemes are concentrated in the kebeles that were accessible to the roads, and Woreda centers. This problem mainly arises out of several factors simultaneously financial and so on.

The development and continuous service delivery of improved water supply projects are two important issues of adequate water supply to the target community. Unless properly managed; investing on water supply projects cannot accomplish the aims. As information gathered from KI-interview and field observation made by the researcher during the time of survey, the physical status of rural water supply schemes in the sample area have been identified as functional, semi-functional and nonfunctional. This nonfunctional of the developed water supply projects are not only lowers the water supply coverage of the Woreda but also forced the beneficiaries of these nonfunctional schemes to fetch water from unprotected sources.

During field observation as shown in Table 4.9 in sampled Kebeles, 13 water points were observed, 10(77%) were properly functional, 1 (8%) was semi functional and the remaining 2(15%) were nonfunctional. This result was in line with the opinions of the KI-interview as shown in Table 4.8, 48(68%) were properly functional, 11(15%) was semi functional and the remaining 12(17%) were nonfunctional, and also 12 (56%) and 4 (19%) schemes were function and non-function respectively, failure to provide proper service is a common feature of Rural Water Supply Schemes, particularly in developing countries like Ethiopia. Such failures of projects not only compromise with the goal of potable water provisions to all but also force the community to look for alternative water sources. Thus, assessing the status of the developed water supply schemes and the availability of alternative sources that can be used in case of systems failure and insufficiency is important in rural areas.

Table 4.7 Functional Status of water point in selected kebels

No	Scheme Name	Status of WP		
		Functional	Semi-functional	Non-functional
1	Adulala Hate	4	1	1
2	Guraji Farda	2	-	-
3	Qechema	2	-	1
4	Kuriftu Eda	2	-	-
	Total	10	1	2

Source: own computation from the result of field observation

Table 4.8 Functional Status of rural water supply schemes in the study area

No	Type of source	Status of source		Status of WP		
		F*	NF*	F	SF*	NF
1	Deep bore holes used Electric power	8	2	18	4	4
2	Deep bore holes used Diesel power	4	2	8	1	-
3	Expansion from Gembichu Fentale scheme	ND*		6	3	4
4	Expansion from Arsi zone scheme	ND		7	3	4
5	Expansion from Adama city system	ND		9	-	-
	Total	12	4	48	11	12

Source: own computation from the result of KII and field observation

* NF: nonfunctional, F: functional, ND: Not define

On the basis of the above findings, it can be concluded that in the study area currently 12 (56%) and 4 (19%) schemes were function and non-function respectively, and also 48(68%) water points were properly functional, 11(15%) were semi functional and the remaining 12(17%) were nonfunctional.

4.3. Challenges of Rural Water Supply Schemes functionality

Technical issues were related to technical skills needed for operations and maintenances, selection of appropriate technology, availability, accessibility and affordability of spare parts, poor construction quality or the use of low-grade materials may lead to the failure of the water system before the end of its designed life span.

4.3.1 Technical skills needed for operation and maintenance

According to the household survey result as shown in the Table 4.10 all respondents confirmed that the operation and maintenance activities had been done by woreda and zonal water office experts. According to FGD, all of the participants asserted that they did not know or habit of community technicians activity within themselves and they recommend that local technicians are very important but they did not have. Local technicians are needed because they understand any issues in the area and can easily follow water schedules. A shortage of local technicians can therefore affect the water supply system. According to KII, operation and maintenance work was carried out by experts from the Woreda Water Authority, while major repairs were carried out by experts or engineers from zonal and regional experts. They also pointed out that the Water committee and communities do not have efficient technical skills as Woreda Water Office has not provided sufficient technical training to them. This was due to the small number of Woreda technicians, who were unable to organize adequate training for the Water committee and the community as a whole. In line with this finding, Getachew (2002) cited in Tesfaye (2011), however, most rural communities lack technical skills to carry out major repairs.

Table 4.9 Respondent's opinion about technicians for O&M

Have the scheme local technicians for O&M	Frequency	Percentage
Yes	0	0
No	360	100.00
	360	100

Source: own computation from HH survey result**.**

On the basis of the above findings, it can be concluded that absence of local technician for O&M is one of the hindering issues for technical challenges faced by the community in the study area.

4.3.2 Accessibility of spare parts

According to FGD result with regard to assess accessibility of spare parts at community level has confirmed that the spare parts are not readily and easily available. As a result, it turned out that spare parts are not available for the community in the study area. The FGD participants from the Water committee of Non-Functioning Systems identified the lack of spare parts as a major problem in repairing systems when failures occur. They further stated that even when they want to buy the inexpensive spare parts were not easily available and even rarely available from private sector or business man and also they cost more than ten times the normal cost. As a result of these their water supply schemes were in state of nonfunctional for long period of time and others as their water supply system is providing service with problems.

The response of interview made with zonal water sector experts; they all indicated that there is shortage of spare parts at zonal and even regional level. The result of key informant interview held with Adama woreda water office staff members also shows that neither of the regional water bureau nor Adama woreda water office has provided an appropriate budget for spare parts and ensured availability of spare parts to the community. As they pointed out, there is no spare part whenever maintenance is needed to increase the functionality of the water project. In line with this finding, Komiveset al., (2006) stated that without access to a reliable supply of spare parts, water supply schemes will not be functional.

On the basis of the above findings, it can be concluded that absence of spare parts for the scheme was one of the hindering issues for technical challenges faced by the community in the study area.

4.3.3 Type of power supply source

As result obtained from KI-interview about the power supply used and they indicated that currently about 24.39% and 14.63% water supply schemes get their power from electric and diesel respectively. From the results of FG-discussions revealed that the communities were not given the alternative power supply to choose from. The participant further mentioned that in the case of failure of the diesel power supply options difficult to be repaired by local technician and even it is beyond the ability of the woreda technicians. As a result, the committee disclosed that power supply options were supplied by the implementing agencies without any consultation and/or participation of the community. Contrary to this result, Whittington et al, (2008), identified that the need to involve communities in the choice of technology thus ensuring engineering designs were responsive to local needs.

From the above discussions, one can conclude that type of technology in general and power supply option in particular was delivered and supplied without considering the technical capacities of community to be operated and managed. This might have contributed to non-functionality of systems of rural water supply at large.

4.3.4 Construction quality

According to the household survey result as shown in the Table 4.11, out of total 47.5% and 52.5% respondents confirmed that the quality of construction schemes were fair and poor respectively but no one confirmed that the quality of construction schemes was good.

As evidenced by the key informants, most of the water supply schemes were poorly constructed due to shortage of time, poor supervision and late budget release and shortage of budget. The discussion held with focus group revealed that the woreda water resource office rarely visited the water supply points. This is because a larger percentage of respondents feel that functional systems are of better build quality compared to non-functional systems. In relation to this finding, Carter et al.,(1999), shows that it may be disastrous for poor people when a facility breaks down and cannot be repaired because of a fault inherent in the design or construction.

Table: 4.10 Evaluation construction quality of the scheme

Evaluation construction quality of the scheme	Frequency	Percentage
Good	0	0.00
Fair	171	47.50
Poor	189	52.50
Total	360	100

Source: own computation from HH survey result

On the basis of the above findings, it can be concluded that construction quality was another hindering issues for technical challenges faced by the community in the study area

4.4. Role of community participation on managements of schemes

4.4.1 Community participation during the project development, planning and implementation process

According to the household and focus group discussion survey result as shown in the tables 4.12 with regarding community participation during the project development, planning and implementation process the largest percentage of the respondents 57.5% confirmed that the participation were very good and the remaining 42.5% good respectively.

Table 4.11 Community participation during the project planning and implementation

Community participation during the project development, planning and implementation process	Frequency	Percentage
Very good	207	57.50
Good	153	42.50
Fair	-	-
Poor	-	-
Very poor	-	-
Total	360	100

Source: own computation from HH survey result**.**

4.4.2 Types of contribution by community in scheme development

The other main issues that assessed during household and focus group discussion survey on community participation was types of contribution by community in scheme development and as shown in the tables 4.13 from survey results the largest percentage of the respondents 95% and 5% confirmed that the community were participated on supply labor during the construction and in election of water committees members respectively.

Table 4.12 Types of contribution by community in scheme development

Types of contribution by community in scheme development	Frequency	Percentage
Money		
Supply labor during the construction	342	95.00
Local materials (Stone, Sand, Wood)		
Participation in meetings		
Information provision during in site selection		
In election of water committees members	18	5.00
No participation		
Total	360	100

Source: own computation from HH survey result**.**

4.4.3 Trust of community on water management committee

The other main issues that assessed during household and focus group discussion survey on community participation was trust of community on water management committee and as shown in the tables 4.13 from survey results the all percentage of the respondents 100% confirmed that the community was trust on water management committee.

Table 4.13 Trust of community on water management committee

Trust of community on water management committee	Frequency	Percentage
No trust at all		
Fair trust		
Good trust	360	100.00
Very good trust		
if others		
Total	360	100

Source: own computation from HH survey result**.**

4.4.4 Women's participate in planning and management of the scheme

The other main issues that assessed during household and focus group discussion survey on community participation was women's participate in planning and management of the scheme and as shown in the tables 4.14 from survey results the largest percentage of the respondents 55% confirmed that the women's participation were good, 40% fair and the remaining 5% poor respectively.

Table 4.14 Women's participate in planning and management of the scheme

Women's participate in planning and management of the scheme	Frequency	Percentage
Very good		
Good	198	55.00
Fair	144	40.00
Poor	18	5.00
Very poor	-	-
Total	360	100

Source: own computation from HH survey result**.**

From the above finding it can be concluded that role of community participation have no negative impact in provision of water service.

4.4.5 Distribution of water collection task in the family's

According to the household survey result as shown in the Table 4.7 the largest percentage of the respondents 53% confirmed that female and children were responsible for water collection in the family and the remaining 47% was covered by female and male

Table 4.15 Distribution of water collection task in the families

Water collection task	Frequency	Percentage
Female	0	0.00
Female and Male	171	47.50
Female and children	189	52.50
Girls	0	0.00
Total	360	100

Source: own computation from HH survey result**.**

Based on the finding was to say that water collection was mainly the responsibility of women and girls in the study area.

4.5.Ground Water Quality Analysis

4.5.1 Physicochemical parameters test analysis

The physicochemical parameters directly related to the safety of the drinking water to human consumption. The physicochemical water quality parameters provide important information about the health of a water body. These parameters are used to find out the quality of water for drinking purpose. Parameters with extremely low stability such as pH, electrical conductivity and temperature were measured on the field using field kit and some important physicochemical such as Turbidity, Fluoride, Hardness and Total dissolved solids parameters samples analysis in the Adama public health research & referral laboratory center.

4.5.1.1 Temperature

Temperature measurements are very useful in understanding the trend of physical, chemical and biological activities whether high or slow by the variation of temperature. In this study the sampled water temperature mean value were recorded 28.8°C and 24.3°C for Adulala hate and Guraja furda well field boreholes respectively.

They value were beyond recommended unit of WHO <15°C, this maybe the climatic of Rift valley area making the temperature to be high and it has no guideline value nationally. If the temperature is high have negatively impact water quality by enhancing the growth of micro-organisms which may increase taste, odor, color and corrosion problems (UNICEF, 2008).

4.5.1.2 pH

pH is an index of the amount of hydrogen in (H+) which indicates acidity and alkalinity of a substance. In this study the sampled water P^H mean value were recorded 7.7 and 7.3 for Adulala hate and Guraja furda well field boreholes respectively. They value were within the recommended limit for Ethiopia Standard Agency and WHO drinking water standard and hence the water has low tendency for acidity or alkalinity.

4.5.1.3 Electrical Conductivity

Pure water is not good conductor of electricity, but it is good insulator. It is the amount of dissolved solids in water that determines the electrical conductivity. Electrical conductivity (EC) is the actual measurement of the ionic processes through which a solution conducts electricity. In this study the sampled water EC mean value were recorded 1046 µS/cm and 1037 µS/cm for Adulala hate and Guraja furda well field boreholes respectively. They value were out of the recommended limit of WHO drinking water standard and nationally it has no guideline value. The results clearly indicated that water in study areas was considerably ionized and has the higher level of ionic concentration activity due to excessive dissolve solids. Similarly study conducted in A'ada Woreda in the same zone, shows that the EC of study area were range from 672-712 µS/cm (Daba Desissa, 2016).

Table 4.16 on site water samples analysis result for physicochemical parameter.

Parameters	Adulala hate	Guraja furda	Eth (ESA)	WHO	Remark
Samples	Mean value	Mean value			
Temp (oC)	28.8	24.3		< 15	
pH	7.7	7.3	6.5 to 8.5	6.5 to 8.5	
EC (µS/cm)	1045.7	1037.3		< 400	

Source: own computation from WQ test survey result**.**

4.5.1.4 Turbidity

Turbidity is the unity of measurement for the qualifying the degree to which light traveling through a water column is scattered by the suspended organic (including algae) and inorganic particles. In this study the sampled water turbidity mean value were reported in the laboratory test result 1 NTU and 1.7 NTU for Adulala hate and Guraja furda well field boreholes respectively. In this study both water samples were within the limit of national and WHO (2008) standard of less than 5NTU. Similarly study conducted in A'ada Woreda in the same zone, shows that the turbidity of study area were range from 0.47-2.54NTU (Daba Desissa, 2016).

4.5.1.5 Total Dissolved solids

Total dissolved solids in drinking water are from inorganic salts and small amounts of organic matter. The contributing ions are mainly carbonate, bicarbonate, chloride, sulfate, nitrate, potassium, calcium and magnesium. Most of the total amount of dissolved solids in water comes from natural contact with rocks and soil. Although the contribution to TDS is small, it is due to pollution such as urban runoff. In this study the sampled water TDS mean value was reported in the laboratory test result 315mg/l and 153 mg/l for Adulala hate and Guraja furda well field boreholes respectively. In this study both water samples were within the limit of national and WHO (2008) standard of less than 1000 mg/l, this show that health risks was not significant.

4.5.1.6 Total Hardness

Hard water is characterized with high mineral contents that are usually not harmful for humans. It is often measured as calcium carbonate (CaCO3) because it consist mainly calcium and carbonates the most dissolved ions in hard water. In this study the sampled water total harness mean values were reported in the laboratory test result 156 mg/l and 85 mg/l for Adulala hate and Guraja furda well field boreholes respectively. Hardness of study area 156mg/l and 85 mg/l which were categorized as hard water and moderately hard water according to discussed in different literature review as shown in Table 4.17. Therefore, the average value of both sites was 120.5 mg/l. hence, as per the above discussion hardness of study area which is categorized as moderately hard water which is not harmful for consumers according to the national and WHO standards.

Table 4.17: Classification of Water Based On Hardness

No.	Hardness mg/l as CaCO3	Water Class
1	0-75	Soft Water
2	75-150	Moderately Hard Water
3	150-300	Hard Water
4	Above 300	Very Hard Water

(Source:-Sawyer and McCarty, 1987)

4.5.1.7 Fluoride

Excessive fluoride intake is associated with dental and skeletal fluorosis, which can cause severe deformities and disabilities in susceptible individuals, a common situation in many countries of the world. WHO has set a health-related guideline value for fluoride of 1.5 mg/l (WHO, 2011a). Long-term exposure to fluoride in water has serious health effects. Higher amounts of fluoride between 1.5 – 4.0 mg/L can cause dental fluorosis. Very high amounts of fluoride greater than 10.0 mg/L can lead to skeletal fluorosis. This is why the WHO suggests that drinking water should not have more than 1.5 mg/L of fluoride.

In this study the sampled water fluoride mean value were reported in the laboratory test result 2.9 mg/l and 1.43 mg/l for Adulala hate and Guraja furda well field boreholes respectively and the average value of both sites was 2.16 mg/l. The result clearly shown that in the range of higher amounts of fluoride between 1.5 – 4.0 mg/L can cause dental fluorosis according to WHO health-based guideline value as discussed above. As reported (Tekle-Haimanot et al. 2006), 44.5% of 668 wells (deep and shallow wells) analyzed for fluoride content in the Rift Valley region of Ethiopia exceeded 1.5 mg/l. Hence, this show that health risks was significant for dental fluorosis.

Table 4.18 Laboratory water samples analysis result for physicochemical parameter.

Parameters	Adulala hate	Guraja furda	ESA (Eth)	WHO	Remark
Samples	Mean value	Mean value			
Fluoride (mg/l)	2.9	1.43	1.5	1.5	
$CaCo_3$(mg/l)	155.7	85.33	300	300	
TDS (mg/l)	314.7	152.7	1000	1000	
Turbidity	1.7	1	5	5	

Source: own computation from WQ test survey result**.**

4.5.2 Bacteriological test analysis

The WHO (2004) and Federal Democratic Republic of Ethiopia Ministry of Water Resources (2002) bacteriological guidelines for drinking water recommend that water sources be free of total bacterial counts and fecal coliform CFU per 100 ml of water. In this study the sampled

water Total coliform and faecal coliform value were reported in the laboratory test result 0/100ml and 5/100ml mg/l for Adulala hate and Guraja furda well field respectively.
According to the national and WHO standards no coliform should be detected at all in any 100 mL of drinking water. The contamination was contributed by several linking factors, such as the depth of the well, the number and separating distance of septic tanks surrounding wells, poor construction well with a cracked apron and entry of drainage of water into the well. The results showed that Guraja furda deep wells were highly contaminated than Adulala hate deep wells. Similarly study conducted in A'ada Woreda in the same zone, shows that the 0/100ml and 0/100ml mg/l for total coliforms and faecal coliforms for three deep wells respectively (Daba Desissa, 2016).
This low risk result indicates that needs immediate treatment to be applied to assure a better quality of drinking water.

Table 4.19 Laboratory water samples analysis result for bacteriological parameter.

Parameters	Adulala hate	Guraja furda	ESA (Eth)	WHO	Remark
Fecal coliform (per100ml)	0/100ml	5/100ml	Must not be detectable	Must not be detectable	Low risk
Total coliform (per100ml)	0/100ml	5/100ml			Low risk
Escherichil coli (per/100ml)	0/100ml	0/100ml			No risk

Source: own computation from WQ test survey result**.**

5. Prevalence of the water associated diseases on the public health

The importance of water to human well-being cannot be overemphasized. The normal functioning of the human body is completely dependent on adequate quantity and quality of water. However, if the water is from contaminated sources, it causes numerous water-associated diseases. In the developing country, the majority of people are without a safe water supply and adequate sanitation. According to WHO surveillance highlighted each day, 30,000 people die and 80% of all illnesses in developing countries from water-associated diseases collaboration with the Ethiopia Public Training Initiative (Zeyede & Tesfaye, 2004).
Depending on findings out of top ten diseases recorded by Woreda Health office as shown in Table 4.20, Diarrhea and Dental disorder were matched with water associated diseases which were discussed early.

Table 4 20: Top ten diseases in Adama woreda, in year 2022

No.	Top ten diseases	Number of patient	%age
1	Respiratory infection (acute upper respiratory infection unspecified)	9,176	23.03
2	Pneumonia (bacterial pneumonia)	4,274	10.73
3	Diarrhea (functional Diarrhea)	4,189	10.51
4	Tonsillitis (acute pharyngitis unspecified)	4,185	10.50
5	Dyspepsia (inability to swallow)	3,585	9.00
6	Severe fever disease (others specified disease)	3,464	8.69
7	Infection (bacterial intestinal infection unspecified)	3,014	7.57
8	Bronchitis (acute bronchitis)	2,988	7.50
9	Urinary tract infection (urinary tract infection)	2,570	6.45
10	Dental disorder (dental caries)	2,395	6.01
	Total	39,840	100

Source: From Adama Woreda Health office 2022 yearly report

6. Sanitary inspection analysis at source

A sanitary inspection is an on-site inspection of a water supply facility to identify actual and potential source of contamination. The physical structure and operation of the system and external environmental factors (such as latrine location) are evaluated. This information can be used to select appropriate corrective actions to improve or protect water supplies. From then on, inspection will be at the source only, using a simple and clear reporting form. These forms consist of a series of questions that can be answered "yes" or "no". The question is structured so that a 'yes' answer indicates a risk of contamination and a 'no' answer indicates no risk exists. One point is awarded for each "yes" answer and zero points for each "no" answer. At the end of the inspection the points are added up and the higher the total of identified risks and the greater the risk of contamination.

In the study area, sanitary inspection result at source as shown in Table 20 has low risk which was not significant.

Table 4.21: Sanitary inspection result at source

Deep well	Adulala hate	Guraja furda
Is there a latrine within 10m Deep Well?	0= Low (0-3)	0= Low (0-3)
Is there a latrine uphill of the Deep Well?	0= Low (0-3	0= Low (0-3
Are there any other sources of pollution with 10m Deep Well? (E.g. animal breeding. Cultivation, roads, industry, etc.)	Medium = (3-5), agriculture	0= Low (0-3
Is there drainage faulty allowing ponding within 2m of Deep Well?	0= low (0-3)	0= low (0-3)
Is there drainage channel cracked, broken or need cleaning?	0= low (0-3)	0= low (0-3)
Is there the fence missing or faulty?	Medium = (3-5), No fence	0= low (0-3)

Risk score: 9-10=very high; 6-8=High; 3-5= Medium; 0-3=low

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This research was conducted in Adama woreda to demonstrate situation of rural water supply scheme in provision of safe drinking water. For achieving the objective, a mixed approach to both qualitative and quantitative research methods was employed to collect the relevant and the required information about the woreda water supply schemes, and also experimental study method was used to assess bacteriological and some important physicochemical water quality parameters for groundwater sources.

Current safe drinking water access out of the total population addressed only for 56.70%, due to non-functionality 18.90% not properly addressed and the remaining 24.39% was not addressed totally. The per capita water consumption of the study area 7 l/c/d was much less than the minimum amount of recommended by WHO 25 l/c/d and also 65% the current water service was located in WHO standard and 35% is out of the standard, regarding time taken to fetch water 30% the current water service was located in WHO standard and 70% is out of the standard.

In the study area 12 (56%) and 4 (19%) schemes were function and non-function respectively, and also 48(68%) water points were properly functional, 11(15%) were semi functional and the remaining 12(17%) were nonfunctional and absence of local technician, spare parts, power supply technology and poor construction quality were main challenges of scheme functionalities but role of community participation have no negative impact in provision of water service.

The conducted physicochemical parameters test result shown that pH, Electrical conductivity, Total dissolved solids, Turbidity and Total hardness value were within the recommended limit but Temperature and Fluoride value were out of the recommended limit of national and WHO drinking water standard, regarding Bacteriological test result Total coliform were within the recommended limit but faecal coliform were out of the recommended limit of national and WHO drinking water standard.

Regarding prevalence of the water associated diseases on the public health, out of top ten diseases recorded by Woreda Health office Dental disorder due to higher amounts of fluoride was matched with with findings of this study.

5.2 Recommendations

The following recommendations were given based on the study result, in order to increase service level rural water supply schemes in Adama woreda.

- Option should be exploring for community that safe drinking water accesses were not addressed totally by all stakeholders.
- To increase provision of water service and to reduce distance travel and time taken to fetch water: rehabilitation and maintenance of non-functional schemes, replacement of schemes that are beyond their design period which are not currently providing a service, construction of new water point where there is high water demand but limited in numbers will be recommended.
- The choice of technology for power supply source influences the Operation and Maintenance of the scheme. It should then be noted that in the design and study periods, its spare parts and all necessary items must be included in order to facilitate for post construction operation and maintenance activities that would be carried out by the community.
- To avoid construction quality problem strict supervision will be requiring during the design and implementation of newly constructed schemes.
- Technical skill training for local technicians will be recommended in order to reduce long time to repair in case of breakdown, lack of skilled person to carry out operation & maintenance for schemes. However, the possibility for refresher training is unthinkable in most cases due to the budget constraint at the Woreda level. Therefore, financial and technical support is required not only at community level but also at Zonal & district levels.
- Spare parts supply shops that operate on a revolving fund will be recommending at woreda levels and this will facilitate availability of spare parts and required components at localities of the scheme.
- To overcome low risk problems due to faecal coliforms regular chlorination will be recommended in storage area before water released to community.
- To overcome for higher amounts of fluoride that cause significant health risks further detail study will be recommended for dilution process by integrating of the current schemes with other schemes coming by gravity expansion.

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APPENDICES

Appendix 1: Household Survey Questionnaire

Background Information

1. Date ____________
2. Age__________
3. Sex M F____________
4. Household family size A.1- 4 B. 5-8 C. 9-12and above
5. Current marital status A. Single B. Divorced C. Married D. Widowed
6. Educational level?

A. unable to read and write C. some primary school (1-8) grade

B. Can only read and write D. 9-12 preparatory and above

7. Current occupation

A. farming B commercial /Trade C. Government employee D. Daily labor E.farming and trade

F. farming and Daily labor G. If other, please specify

8. What is/are your current main/primary sources of water?

A. unprotected spring C. rivers E. shallow well

B. unprotected traditional well D. Protected hand dug well F. If other, please specify.

9. If your answer for question 10 is unprotected sources, what is/are the reason behind?

10. Is /are there alternative sources of water in your locality?

A. yes B. No

11. If your answer for question 11 is yes, what is/are the disadvantage of using these sources?

12. How many meters do you travel to fetch water?

A. up to 500 meters B. 501-1000 meters C. 1001-1500 meters D. if others please specify.

13. What is/are the alternative sources of water during the occurrence of shortage of water from the primary sources?

A. Unprotected streams.   B. Rivers   C. Unprotected traditional hand dug well.

D. Shallow well.   E. If others please specify.

14. How many liters of water do you consume per day?

A. 1-20 liters   B. 21-40 liters   C. 41-60 liters and above

15. How many minutes (times) do you wait to fetch water (queue)?

A. 1-30 minutes   B. 30-60 minutes   C. 60-90 minutes   D. if others, please specify.

16. Is your water source is functional currently?   A. yes   B. No

17. If your answer for question 15 is no, how long is it stay in state of nonfunctional?

A. less than a year   B. more than a year   C. if other please specify.

18. Have you participated in the installation of the water point? What is your level of participation in all level of participation in all phases of improved water point installation?

A. very low   B. low   C. high   D. very high

19. Did you interested on the construction of the improved water point in your locality?

A. yes   B. no

20. Do you have an ownership feeling towards improved water supply projects?

A. yes   B. no

21. Who manage the water project in your locality?

A. Water committee   B. Woreda water office   C. If other, please specify

22. If your answer for question 20 is water committee, have they an ability to manage the water project (scheme) properly?

A. Yes   B. no   C. I do not know.

23. Have you been paying monthly water fee regularly?

A. Yes   B. no

24. If your answer for question 22 is no, what is/are your reasons? If yes how many?
25. Do you think that this amount of money is adequate to cover cost or operation and maintenance?
    A. Yes B. No C. I do not know
26. Who is the operator and maintaining body of the water point during nonfunctional?
    A. Woreda water office. C. I do not know. C. If others, please specify.
    B. Zonal experts.
27. Is there an accessibility of spare parts during operation time?
    A. Yes B. no
28. Who select the type of water scheme (project)?
    A. Implementing agency C. Community
    B. Implementing agency and community
29. If the community did not select the technology (scheme type), who select the water scheme? A, Implementing agencies B. Both implementing agencies and community C. community D. If other, please specify
30. How do you evaluate the construction quality of the water point?
    A. Very poor B. poor C. good D. very good
31. Is the water supply adequate?
    A. Yes B. NO
32. Is there institutional support given from woreda, zone and regional level?
    A. Yes B. No
33. If your answer for question 30 is how do evaluate the level of institutional support?
    A. Very poor B. Poor C. Fair D. Good E. If other, please specify
34. Is there any training program given to the community or water committee?
    A. yes B. no

Appendix 2: Checklists for Focus Group Discussion

1. Can you tell me about income of the community and its impact on water supply service provisions?
2. How can you evaluate the relationship between waters supply service provisions and educational level of the community?
3. How the existing rural water situation (status) of the Woreda including its distribution and functionality looks like?
4. How and by whom was the scheme established?
5. How many percent of water project is nonfunctional?
6. What are the major problem concerning the water points?
7. How do you evaluate the distribution of water supply projects?
8. How do you evaluate the level of community participation during construction, operation and maintenance?
9. How do you explain the demand (interest) of the community for the construction of the water project in their locality?
10. If there is no community participation, what are the reasons behind?
11. How do you evaluate the sense of ownership of the community towards the water supply system?
12. Do you think that you are managing the water scheme properly?
13. If your answer for question number 9 is no, what are the reasons?
14. How do you evaluate the monthly fee of users for operation and maintenance?
15. Do you think that the amount of money paid is adequate to cover the cost of operation and maintenance? Explain.
16. How do you explain the operation and maintenance of the water point and the reaction of the woreda water office when you request to for maintenance (response from the woreda water office)?
17. What is your opinion about the financial management system of the water scheme?
18. Do you discharge your responsibility properly? If your answer is no what are the factors that hinder you not to manage well?
19. Can you explain the existence and the importance of the local technician?

20. How do you evaluate the availability of spare parts? Explain.
21. Can you tell me about the construction quality and its consequence on the water supply sustainability?
22. Explain the adequacy of water supply and its consequence on the management of the water point.
23. How do you explain the institutional support given from woreda or zone water office?
24. Is there any training given for the community and water committee? If your answer is yes, explain its adequacy.
25. Discuss the level of coordination between stakeholders to improve water supply in Adama Woreda.

Appendix 3: Checklist for Key stakeholder interviews

• Date of interview

• Name of the organization represented

• Position of the respondent

1. Can you tell me about income of the community and its impact on water supply service provisions?
2. How can you evaluate the relationship between water supply service provisions and educational level of the community?
3. How the existing rural water situation (status) of the Woreda including its distribution and functionality looks like?
4. If there is unfair distribution, what are the reasons behind?
5. How do you evaluate the demand (interest) of the community for improved water supply?
6. Can you tell me about the community's sense of ownership towards the improved water points?
7. How do you evaluate the rate of payment and its regularity?
8. How many improved water supply schemes are there in the Woreda
9. How many percent of people uses protected water source (coverage)?
10. What is status (functional and nonfunctional) of existing water schemes in the Woreda?
11. Who is the implementing agency of improved rural water supply in DDW?
12. What are the primary and secondary sources of water in the woreda?
13. How do you see the use and reliability of both protected and unprotected water sources (during wet and dry season) in the Woreda?
14. Are spare parts, tool, kits, etc. readily available at community level? Yes/No if yes, where do you get? If the answer is no how do you manage it?
15. What is your opinion about the support that the water office provide to sustain the water supply?
16. Who conduct the operation and maintenance of the water projects?
17. Can you tell me about the existence and importance of water committee local technician for operation and maintenance of the water project?

18. How do you explain the allocation of budget and its adequacy for rural water supply?
19. Explain the adequacy of water supply and its reasons.
20. Do you give training to households and water committee in the rural water supply management, operation and maintenances?
21. What type of support do you give for the users or for the water committee?
22. Have you ever given (arrange) adequate training for the users including water water committee?
23. Explain the coordination and participation of different stakeholders to improve water supply in Adama Woreda.

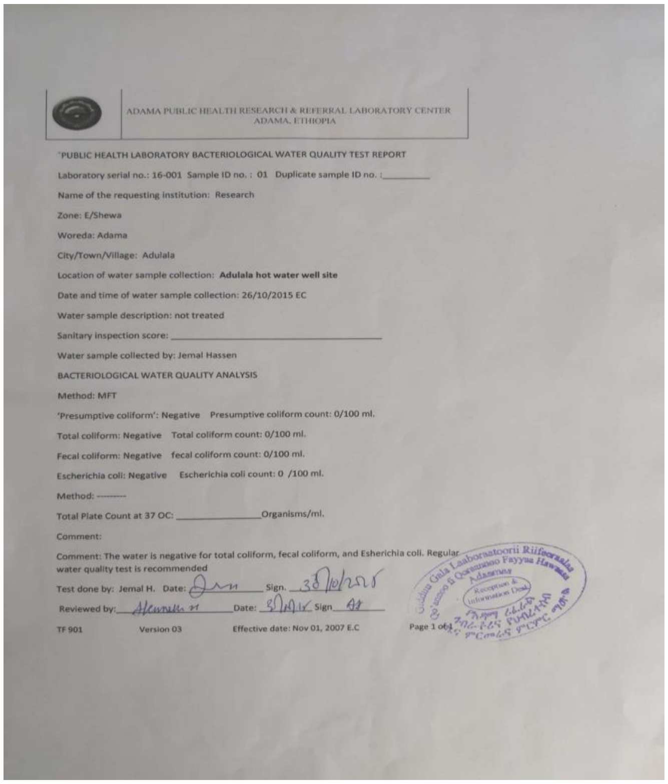
Appendix 4: Composition of FGD and KII Representative

S. No.	Representative	Adulala Hate		Guraja Furda		Kechma		Kuriftu Eda		Total	
		M	F	M	F	M	F	M	F	M	F
1	Women representative from community	-	1	-	1	-	1	-	1	-	4
2	Men representative from community	1	-	1	-	1	-		-	3	-
3	Water committee representative	1	-	1	-	1	-	1	-	4	-
4	Water fee collector	-	1	-	1	-	1	-	1	4	-
5	Community elders	1	-	1	-		-	1	-	3	-
6	Kebele representative	-	1	1	-	-	1	1		2	2
Total										**16**	**6**

Appendix 5: Composition of KII Representative

S. No.	Representative	Male	Female	Total
1	Representative from Woreda Water Office	2	-	2
2	Representative from Zonal Water Office	-	1	1
Total				**3**

Appendix 6: Laboratory test result for water quality analysis



ADAMA PUBLIC HEALTH RESEARCH & REFERRAL LABORATORY CENTER
ADAMA, ETHIOPIA

'PUBLIC HEALTH LABORATORY BACTERIOLOGICAL WATER QUALITY TEST REPORT

Laboratory serial no.: 16-001 Sample ID no. : 01 Duplicate sample ID no. :________

Name of the requesting institution: Research

Zone: E/Shewa

Woreda: Adama

City/Town/Village: Adulala

Location of water sample collection: **Adulala hot water well site**

Date and time of water sample collection: 26/10/2015 EC

Water sample description: not treated

Sanitary inspection score: ______________________________

Water sample collected by: Jemal Hassen

BACTERIOLOGICAL WATER QUALITY ANALYSIS

Method: MFT

'Presumptive coliform': Negative Presumptive coliform count: 0/100 ml.

Total coliform: Negative Total coliform count: 0/100 ml.

Fecal coliform: Negative fecal coliform count: 0/100 ml.

Escherichia coli: Negative Escherichia coli count: 0 /100 ml.

Method: ---------

Total Plate Count at 37 OC: ______________Organisms/ml.

Comment:

Comment: The water is negative for total coliform, fecal coliform, and Esherichia coli. Regular water quality test is recommended

Test done by: Jemal H. Date: ________ Sign. ________

Reviewed by: ________ Date: ________ Sign ________

TF 901 Version 03 Effective date: Nov 01, 2007 E.C Page 1 of 1

ADAMA PUBLIC HEALTH RESEARCH & REFERRAL LABORATORY CENTER
ADAMA, ETHIOPIA

PUBLIC HEALTH LABORATORY BACTERIOLOGICAL WATER QUALITY TEST REPORT

Laboratory serial no.: 16-002 Sample ID no. : 02 Duplicate sample ID no. :________

Name of the requesting institution: Research

Zone: E/Shewa

Woreda: Adama

City/Town/Village: ---

Location of water sample collection: **Guraja furda water well site**

Date and time of water sample collection: 26/10/2015

Water sample description: Untreated

Sanitary inspection score: ______________________________

Water sample collected by: Jemal H

BACTERIOLOGICAL WATER QUALITY ANALYSIS

Method: MFT

'Presumptive coliform': Positive Presumptive coliform count: 5/100 ml.

Total coliform: Positive Total coliform count: 5/100 ml.

Fecal coliform: Positive fecal coliform count: 5/100 ml.

Escherichia coli: Negative Escherichia coli count: 0 /100 ml.

Comment: The water source is found to be contaminated with feacal material. Immediate treatment of water is necessary before distribution to the public and re test is advised after treatment.

Test done by: Jemal H. Date: ________ Sign. ________

Reviewed by: ________ Date: ________ Sign ________

TF 901 Version 03 Effective date: Nov 01, 2007 E.C Page 1 of 1

ADAMA PUBLIC HEALTH RESEARCH & REFERRAL LABORATORY CENTER
ADAMA, ETHIOPIA

'PUBLIC HEALTH LABORATORY BACTERIOLOGICAL WATER QUALITY TEST REPORT

Laboratory serial no.: Sample ID no. : Duplicate sample ID no. :________

Name of the requesting institution: Research

Zone: E/Shewa

Woreda: Adama

City/Town/Village: Adulala

Location of water sample collection: **Adulala hot water well site and Guraja furda water well site**

Date and time of water sample collection: 26/10/2015 EC

Water sample description: not treated

Sanitary inspection score: ______________________________

Water sample collected by: Jemal Hassen

Water Chemical test analysis

S. No	Test Parameter	Unit	Max Permissible level	Adulala hot water well site			Guraja furda water well			Remark
				M1	M2	M3	M1	M2	M3	
1.	Fluoride	Mg/l	1.5	2.9	2.8	3.0	1.5	1.4	1.4	
2.	CaCO3	Mg/l	300	152	160	155	85	85	86	
3.	PH	-	6.5-8.5	7.9	7.8	8.0	7.4	7.5	7.4	
4.	TDS	Mg/l	1000	315	315	314	152	152	154	
5.	Turbidity	NTU	5	2	1	2	1	1	1	

Test done by: Jemal H. Date: ________ Sign. ________

Reviewed by: ________ Date: ________ Sign ________

TF 901 Version 03 Effective date: Nov 01, 2007 E.C Page 1 of 1

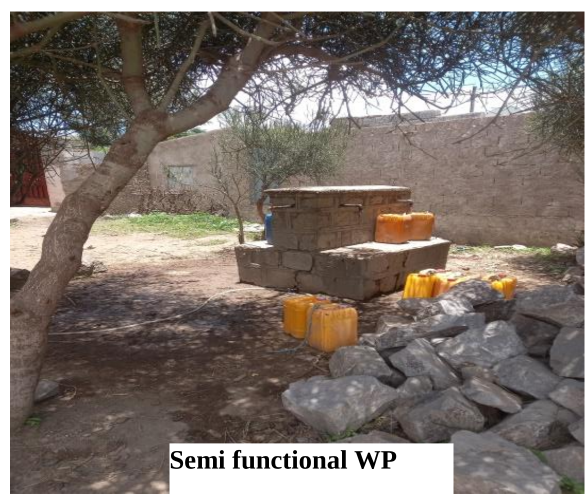
Appendix 7: Photos taken during field observation.

Non-functional WP

Well field site

On site test

FG-Discussion



Semi functional WP