"Access and adequacy of potable water in Adama Town, Oromia Regional State, Ethiopia"

by: - Abebe Endale,

ID No. PGE/18850/11

A Thesis Submitted for the partial Fulfillment of the requirement for the Degree of Masters of Science in Urban Planning and Design, in the department of Architecture, Urban Design and Urban Planning

School of Civil Engineering and Architecture

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Approval of Board of Examiners

We, the undersigned, members of the Board of Examiners of the final open defense by _____ have read and evaluated his/her thesis entitled _____‖ and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirement of the Degree of Masters of Urban Planning and Design.

_____	_____	_____
Supervisor /Advisor	Signature	Date
_____	_____	_____
Chairperson	Signature	Date
_____	_____	_____
Internal Examiner	Signature	Date
_____	_____	_____
External Examiner	Signature	Date

Declaration

I, Abebe Endale, Registration I.D. Number PGE/18850/11, do hereby declare that this Thesis is my original work and that it has not been submitted partially; or in full, by any other person for an award of a degree in any other university/institution.

Abebe Endale Signature……. Date…….

This Thesis has been submitted for examination with my approval as Adama Science & Technology University, Urban Planning and Design Master's program supervisor.

Name of Advisor **Dr. Daniel Lirebo (**Assistant Professor of Urban Planning & Design)

Signature……. Date……

CERTIFICATION

I, the undersigned, certify that I read and hereby recommend for the acceptance by the Adama Science & Technology University a Thesis entitled: -"Access and adequacy of potable water in Adama Town" in partial fulfillment of a degree of Masters of Urban Planning and Design program.

……..

Dr . **Dr. Daniel Lirebo**

(Advisor)

Date: ----------

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First of all, great thanks to almighty **God /having the power to do everything**/ for his priceless help to start & to complete my thesis successfully.

This study is start with the result of cooperative efforts of many people without whom it would not be possible. Thus, in this section, I would like to acknowledge the people most directly and indirectly contributed their effort to start my thesis successfully, I hope they help me up to end for this study becoming a reality. So that, I would like to express my heartfelt and deepest gratitude to our instructors/advisors ***Professor Samson Kassahun: (Professor of Urban Planning & Development)*** **& Dr. Daniel Lirebo (Assistant Professor of Urban Planning & Design) for** their invaluable assistance, advice, constructive comments, simple way of teaching and for his guidance and constructive comments during the Urban Design & planning course & my advisor Dr. Daniel during this thesis writing period.

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Dedication

To my beloved family (kids)

July, 2020

Adama, Ethiopia

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ACRONYMS

- ACWSSSE- Adama City Water Supply and Sewerage Service Enterprise
- BWUD = Bureau of Works and Urban Development
- CBO- Community Based Organizations
- CSA = Central Statistic Agency
- CVM--contingent valuation methods
- ERA--Ethiopia Road Authority
- EIA---Environmental Impact Assessment
- EEU---Ethiopian Electric Utility
- FDRE- Federal Democratic Republic of Ethiopia
- GPS---Global Positioning System
- GTP—Growth & transformation plan
- GIS--Geographic Information System
- HDPE ---High Density Polyethylene
- LDP = local development plan
- MDGs = Millennium Development Goals
- MDD--- Maximum Day Demand
- NGO = Non-Government Organization
- NUPI = National Urban Planning Institute
- OWMEB-----Oromia Water ,Mineral &Energy Bureau
- OWWDSE-----Oromia Water Works Design and Supervision Enterprise
- PHD --- Peak hour demand
- TOR-----Terms of Reference
- UAP ---- Universal Accesses program
- WHO-- World Health Organization
- WTP--willingness to pay
- WUDD = Work and Urban Development Department

Abstract

The aims of this research is to assess the situation of the access and adequacy of Potable water in Adama Town with all possible scenario used to meet water supply with demand. Adama Town Water Supply Service and Sewerage Enterprise (AWSSSE) is responsible and committed to enhance the social welfare of the population through provision of adequate and equitable accesses/ distribution of water among the residents. The provision of this valuable service could also boost in turn socio-economic development of the city. The population and water demand projection work is one of the key elements in water supply study and design process. These population figures and data collected from CSA & municipality office were used to estimate the maximum daily water demands. The issue of potable Water supply is one of the nervous challenges in Adama Town. Hence, the author has decid4ed to ***conduct study to investigate the access and adequacy of potable water in the town.***

The study was engaged both qualitative and quantitative research approaches, mixed imbedded and used concurrently. 166 residents & households' representatives were taken as sample respondents augmented with interviews of key informants, observations and secondary data. Sample households were randomly selected from the three sub-cites purposively based on their population number. Data analysis and presentation Qualitative data was analysed & presented through description narration. Consequently, existing water supply source for Adama City is from Awash River with a yield of around ***410.94 l/s (35,505. 22 m^3/d)*** *whereas as per analysis data obtained from the thesis the required would be* ***1,045.02 l/s (90,289.85 m^3/d).*** *This amount covers only* ***40%*** *of the water demand required. Besides, there is no alternative water source for emergency case, to upgrade the need for urban development & investment required for Adama City. The existing water source, which is Awash River, cannot meet the demand of Adama City and surrounding Kebeles around this City. Hence, additional water sources from other source were proposed as the Town's water source as it has sufficient discharge and can meet demand at the current design period.*

Hence, the implementation of this thesis will be expected to ***alleviate the prevailing potable water supply shortage and improve the living conditions of inhabitants by appraising existing systems and redesigning additional new water supply system. The thesis will be aimed to formulate provide for the proper water supply system improvement.*** *Finally, the thesis author has reached to a conclusion that the implementation of new water supply project should be carried out as soon as possible in order to address current shortages of water in Adama Town.*

Keywords: Access, adequacy, potable water, Water Demand, Source, Water Supply, Adama Town,

CHAPTER ONE

1.0. INTRODUCTION

1.1. Introduction

Urbanization is the process of a population shift from rural areas to cities, often motivated by economic factors. Urbanization may be driven by local and global economic and social changes, and is generally a product of modernization and industrialization.

Urbanization occurs naturally from individual and corporative efforts to reduce time and expense in commuting, while improving opportunities for jobs, education, housing, entertainment, and transportation. Living in cities permits individuals and families to take advantage of the opportunities of proximity, diversity, and marketplace competition. Due to their high populations, urban areas can also have more diverse social communities than rural areas, allowing others to find people like them.

Ethiopia is the second most populous country in Africa next to Nigeria with a population estimated at more than 100 million out of which estimated over 19.4% live in urban and peri-urban areas. The country is predominantly rural and categorized as one of the lowest urban dwellers residence compared to many developing countries' including Sub - Saharan standards in percentage of total population residing in cities and urban settings, which also displays a rapid rate of urbanization in the pace at which people are relocating to urban centers. Urban development can play a significantly role in diversifying the economy towards industry and manufacturing growth.

Urban design is the art of creating and shaping cities and Cities. It involves the arrangement and design of buildings, public spaces, transport systems, services, and amenities. It is the process of giving form, shape, and character to groups of buildings, to whole neighborhoods, and the city. It is a framework that orders the elements into a network of streets, squares, and blocks. Urban design blends architecture, landscape architecture, and city planning together to make urban areas functional and attractive.

1.2. Background

Global urban population growth continues to outpace total population growth and, along with its corresponding development or urbanization, represents one of the greatest environmental and social challenges of this new century.

Sufficient potable water supply is one of the basic urban services, which highly affects the economic progress of towns and the health of their people. However, many urban centers around the world are

facing serious problem of water supply. The problem in most of third world countries, including Ethiopia, is particularly worst and multidimensional.

According to Ghrmawit in Pana Press (2004:2) states that the problems are further exacerbated by high population growth and mushrooming towns in Ethiopia. For instance, in 1984 there were 629 locations classified as townships and by 2000 the number had increased to 925, all in need of water supply and sanitation services.

The other issue inviting attention in access to water supply and sanitation sector in Ethiopia in general and Adama town in particular is characterized by service deficiency of physical infrastructure as well as by inadequate management capacity to handle policy and regulatory issues and to plan, operate and maintain the water supply service. Inadequate production, together with inequitable distribution system and low quality of water influence the wellbeing of people in particular and the socio-economic condition of urban areas in general. It appears to be generally true that secondary municipalities do not have adequate number of trained personnel in management, accounting and revenue collection, administration, budgeting and service delivery skills and thus unable to raise sufficient revenue to finance and sustain municipal services and urban infrastructure on their own. Thus, this paper investigates the magnitude of access and adequacy of potable water supply and its dynamics and challenges at Adama town.

Water supply plays a significant role in the social, economic and political life of people. Water supply shortages increase conflicts and public health problems, reduce food production and endanger the environment. However, the gap between water need and supply has widened steadily in Ethiopia's urban center s despite continuous efforts by the government in providing adequate potable water supply to the rapidly growing urban population. Similarly the study area, Adama Town, is in the forefront of potable water supply and distribution problem in relation to access and adequacy.

As being addressed above, this thesis presents the design of *"Access and adequacy of potable water in Adama Town"* considering the existing prevailing critical potable water supply shortage within the town. The demand area of the study has been delineated based on the critical problems prevailing in the area and the capacity of the source to supplement the existing water supply system. The total population of the study area to be benefitted from this study is estimated at 472,703 persons and the domestic, public and commercial and industrial demand including non-revenue water has been calculated in order to carry out Access and adequacy of potable water demand and supply gap analysis.

Computer model has been used to predict pressures and flows within a water distribution system to evaluate a design of each element and to compare system performance against design standards.

1.3. Statement of the Problem

Water is at the origin of life on earth; no organism can live without it. Water is life and an essential life supporting element on earth and is totally surrounded in our life backgrounds. Being an integral part of the environment, the range of services that are provided by water, dictate the economic growth and environmental sustainability. Although water is essential to human life in its many dimensions, universal access is far from being guaranteed and, near to those communities which benefit from this access, water is also far from being distributed equitably.

Ethiopia is often referred to as the "water tower" of East Africa, not all of the country's population has improved Access and adequacy of potable water access to water sources. In the country, at both the national and regional scale, the issue of potable water is recognized as critical and is reflected in national rural development policy and poverty reduction strategies. Access to safe, sufficient and affordable water is one of the basic essential human rights as well as a prerequisite for improving the overall life of a society. The provision of sufficient potable water for peoples within reasonable distances from reliable and acceptable sources is essential for people's wellbeing and sustainable economic progress. Thus, improving access and adequacy of potable water distribution programs is crucial to encouraging growth and sustaining economic development and incorporating water improvements into economic developments is necessary to end the severe problems caused by access and adequacy of potable water shortage and to improve public health and advance the economic stability of urban areas. The world's water requirement for all purposes is increasing at an alarming rate in urban areas of both developed and developing countries. The main reasons are the rise in urban population growth in practically all countries of the world, industrial growth and expansion.

Rapid urbanization in Ethiopia is leading to excess numbers, overcrowding, development of slums and informal settlements. They in roll inhibit the increase in the nature of challenges that slow down effective urban water supply and demand-supply consumption systems. Growing population will further increase the demand for water. The limited budget & cost effective water supply expansion options, lack of reliable estimates to forecast residential water demands, water source choice decisions and several other factors; are becoming more important for policy making in the water supply sector. Challenges of urban water supply are increasingly becoming a big problem in many cities of Ethiopia. The rapid population growth of Adama town and the change in living style of the population is putting tremendous pressures on the access & adequacy of potable water supply system of the town. To achieve sustainable urban development, it will be necessary to create a balance between demand & supply of urban disintegrated utilities like potable water supply services to more organized manner to

reduce conflicting social, economic and environmental objectives as urban planning and design, structural plan components. In this situation there is a need to mobilize the cities' resources and reinforce local self-government and general social utilities services to the public. Although the economic framework conditions and the development of society are not decided at local level, cities can nevertheless mobilize creativity and innovation in the field and can use long-term integrated strategies intelligently to make the most of their freedom of action. In the last few decades, urban development has been characterized by an alternation between systematic planning and a more situational and project related instrumentalism.

Shortage of adequate, Sufficient and clean potable water to Adama town community, invite to Poor Sanitation and Hygiene in the city and all social service area, to encourage good and standard systematic infrastructure of utilities and major social service developmental activities like Water supply , sewerage line ,School, health infrastructures , industry and roads access. Furthermore the expansion of different types of huge industries in different parts of the City and the construction of large number of market canters requires ample amount of water. The City has significant problem especially on the absence of potable and adequate water supply.

Thus, the communities of the Adama town are suffering from water borne diseases losing their productive time and their money to visit physician whenever effecting with those diseases from poor access & inadequate water.. These problems were more severe in the summer seasons, mostly girls and women spend more time fetching water. Due to this, health related problem due to water scarcity are high. The studies conducted at national level, indicated that the challenges of water supply varied from place to place based on residence and consumption. Therefore, the present study was intended to assess the magnitude of water supply and its consumption system. The challenges that are being faced by the community of the city and service providers will be addressed. The study would bridge the existing research gap and helps to plan or replicate the findings for sustainable development of urban water supply and consumption system in other parts of the country.

Therefore, "Access and adequacy of potable water supply and distribution in Adama town" has been the major concern in research area because the task of solving Access & adequacy water supply problems can hardly be separated from solving social and economic problems in a given society.

1.4. General Objective of the Study

The general objective of this study is to evaluate the level of service "Access and adequacy of potable water supply and distribution" against standard & to improve /to design the quantity and levels of

service of water supply as per the standard & to ensure the good health of the population in Adama Town.

1.4.1. Specific Objectives

The following specific objectives were assessed to attain the overall objective of the study:

- To analyze the existing potable water supply adequacy as urban planning and design sectorial elements, affecting the development of the Adama.
- To identify the challenges of "Access for potable water supply and distribution in town"
- To Examine the level of services that user communities accesses and adequacy to gain from potable water supply as per standard; and

1.4.2. Research questions

The study addressed the following research questions: Some questions asked include:

1) Do the systems provide the designed amount & required level of service of potable water?
2) What are the challenges impeding the accessibility of potable water supply and its distribution and Adama.
3) What are the existing situations in relation to adequacy of Potable water supply in Adama as urban planning and design components, affecting the development Adama?
4) Does everyone in the community have access to adequate potable water supply as per the standard?

1.5. Significance of the Study

The implementation of the proposed the research Study will bring a number of economic and social benefits. These include improved economic and nutritional status through increased and, improved access to health care and potable domestic water supply, and more productive labour, and reduction of poverty. The proposed project is highly accepted by the beneficiary community and stakeholders responsible for planning, implementation and/or facilitation of economic and social development programs in the project area. The acceptance by the local community is based on the assumption that they will have the opportunity to improve their scarcity performance of Access and adequacy of potable water supply and distribution system. It is believed that implementation of the proposed research will bring substantial improvement in the socio-economic status of the beneficiary community.

The study would bridge the existing research gap and helps to plan or replicate the findings for sustainable development of urban water supply and consumption system in other parts of the country. Therefore, "Access and adequacy of potable water supply and distribution in Adama City" has been the major concern in research area because the task of solving Access & adequacy water supply problems can hardly be separated from solving social and economic problems in a given society.

1.6. Scope of the Study

The study include all field works for the detailed urban design thesis proposal --"Access and adequacy of potable water in Adama Town", the selected design standards will be applied to carry out the objectives of the study. I tried to produce detailed urban design of water supply study, models, drawings and calculations, necessary document for the works that shall be recruited during implementation time which includes the following. Spatially; the scope covers specific geographic area: May the delineated influence area thematically; the Project deals with spatial, socio-economic and legal analysis.

The most important issues in the treatment of the drinking water supply Clarity and relationship between the existing routes Orientation to the target, Source, reservoir check & redesigned if required optional,

Order and hierarchy Rising main/Pressure main & distribution system design, ease of water supply distribution, demand-supply analysis, adequacy, accessibility, Safety and security, affordability, comfort to the community both psychological and physical

1.7. Description of the Study Area

1.7.1. General Description of the Study Area

Adama City, a capital of East Shoa zone is found 87 Km far from the Federal capital (also capital for the regional government of Oromia), Addis Ababa City in the southeast part along Ethio – Djibouti Intercontinental Highway that passes through the center of the City & along border of the City. It includes six sub cities/ Kifle Ketema/. It was founded in 1915 as an urban settlement while building the railway from Addis Ababa to Djibouti. The historical name of Adama was derived from a wild plant of the surrounding areas called cactus tree. **(Source:-** ***Computed from the city previous reports*****)**

Adama is the modern city that has road crossing to the sea port and has a rail way line. All these natural and manmade attributes make Adama and its surroundings a base for investment in several sectors, such as hotels, recreations centers, small and heavy industries and etc. That is why Adama is considered as one of the leading cities of the country.

During the regime of King Hailesilasse, in the year 1916 its original name was changed to Nazareth. However, as its proclaimed by Oromia Regional State in the year 1992, its name has been changed to its original name, Adama.

Its name was derived from Afan Oromo "Adami" which means highly dominated by cactus trees.

Figure 1: Adami Afan Oromo Adama

Adami

Source: Computed from the city previous *studies/* Adama City Administration June ,2020

Adama is situated 1600-1700 meters above sea level and in a Latitude from 8' -33.8N to 8' -36N and a Longitude from 39' 11‟ 57E to 39' 21‟15E in the Rift valley of warm climate. Its average annual weather conditions are 21 degree centigrade with small amount of rain from June to September. In general, the City has sunny and windy weather conditions.

In 1936, the municipality of Adama was accredited only for a total area of about 1340 hectares. The City has shown sustainable and fast progress and at present its total area covers about 1332.4km2. It has now decentralized its authority to 16 Kebeles of the City to facilitate the basic activities so as to bring about effective changes in offering good governance and relevant public service at all levels.

Adama City has been continuously growing in both social and economic aspects due to the following major factors.

1) The restructuring of the City by Government to the

higher level like Construction of Industry park, Ethio – Djibouti Intercontinental Highway that passes through the center of the City, near found 87 Km far from the Federal capital(inter connected by standard highway).

2) Improved lifestyle of its population

Figure 2 Some representative Photos

Source: Photo own data June,2020

Figure 3: Abba Geda near Derartu Square more Historical event for Adama City

Source: Photo own data June,2020

3) Favorable Environmental Conditions for living and investment

4) Availability of improved City infrastructures and its close proximity to 87 Km far from the Federal capital (inter connected by standard highway).

5) Availability of meeting conference rooms/hall with required infrastructures and its close proximity to 87 Km far from the Federal capital (inter connected by standard highway as shown in figure above).

6) Availability of improved City infrastructures and its close proximity to 87 Km far from the Federal Capital (inter connected by standard highway).

7) Strategic location of the City on the new highways connecting the eastern and southern part of the country; and the port of Djibouti with Addis Ababa has greatly contributed to its development.

8) The Addis Ababa --Djibuti railway passing through the City also enhances the growth.

9) The new established Industrial park , near Sodere resort area, Wonji sugar state farms , new standard commercial buildings(like Arada Gebeya) and factories

10) Memorial monument is also longing & wish more historical event for Aama City selected for new comers.

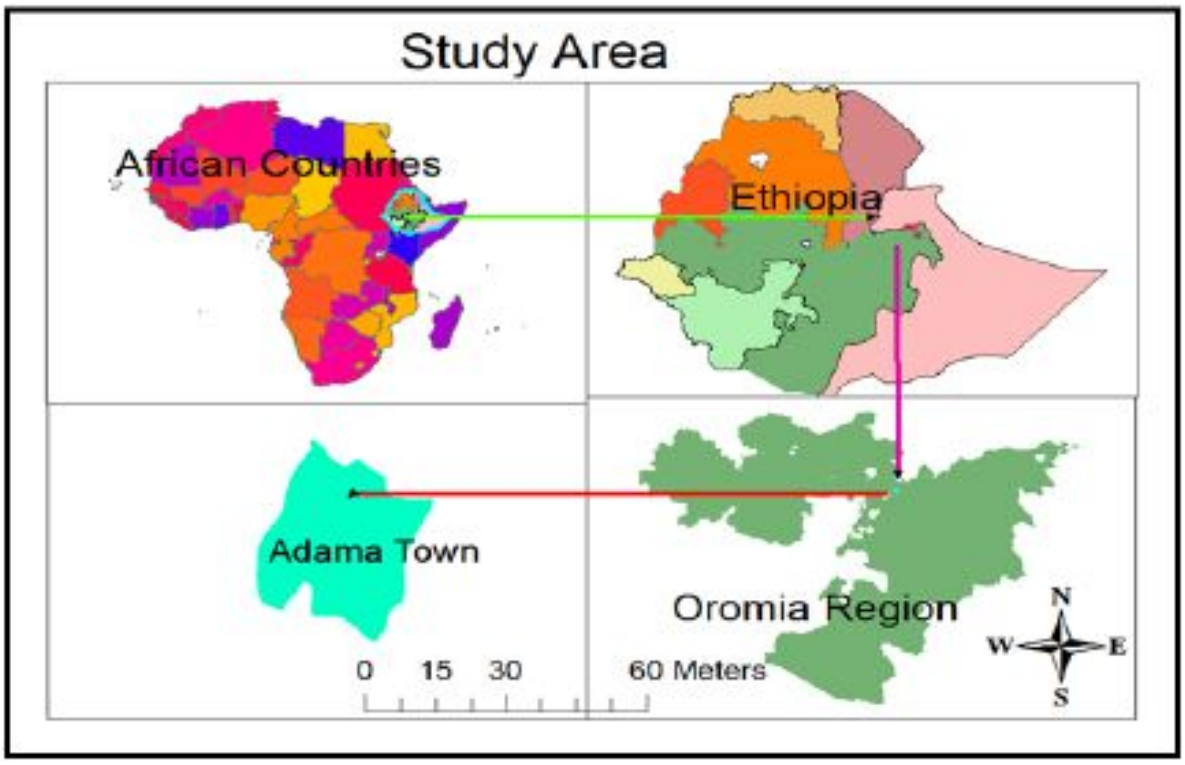
Figure 4: Memorial monument in Adama City

Source: Photo own data June,2020

As mentioned earlier the major driving forces for existing and potential development of the area, administrative restructuring to higher level, improved lifestyle of its population, availability of improved City infrastructures, its close proximity to the Federal capital(inter connected by standard highway), Strategic location of the City on the highways connecting eastern and southern parts of the country. The indicators for these socio economic developments are described above. The recently built infrastructures, particularly, Construction of Industry park, Ethio – Djibouti Intercontinental Highway that passes through the center of the City, near found 87 Km far from the Federal capital(inter connected by standard highway) are also indictors for existing and future development of the City.

Figure 5: Location Map of study area

4



Source: Compiled by Author, 2020

1.7.2. General Land Use Classification and Proportions of the Structure Plan

According to the Revised Standards for Structure Plan Preparation and Implementation, the urban land use classification that can be used during the preparation of the structure plan of any City incorporates 7 major land uses. They are: Housing / Residence ,Business and commerce/ Centers and market places, Social Services (Public facilities, cultural, archeological sites special functions, Green, recreation, sports and environmental sensitive area, Administration, Manufacturing and Adama, Infrastructure, utilities and Transportation,

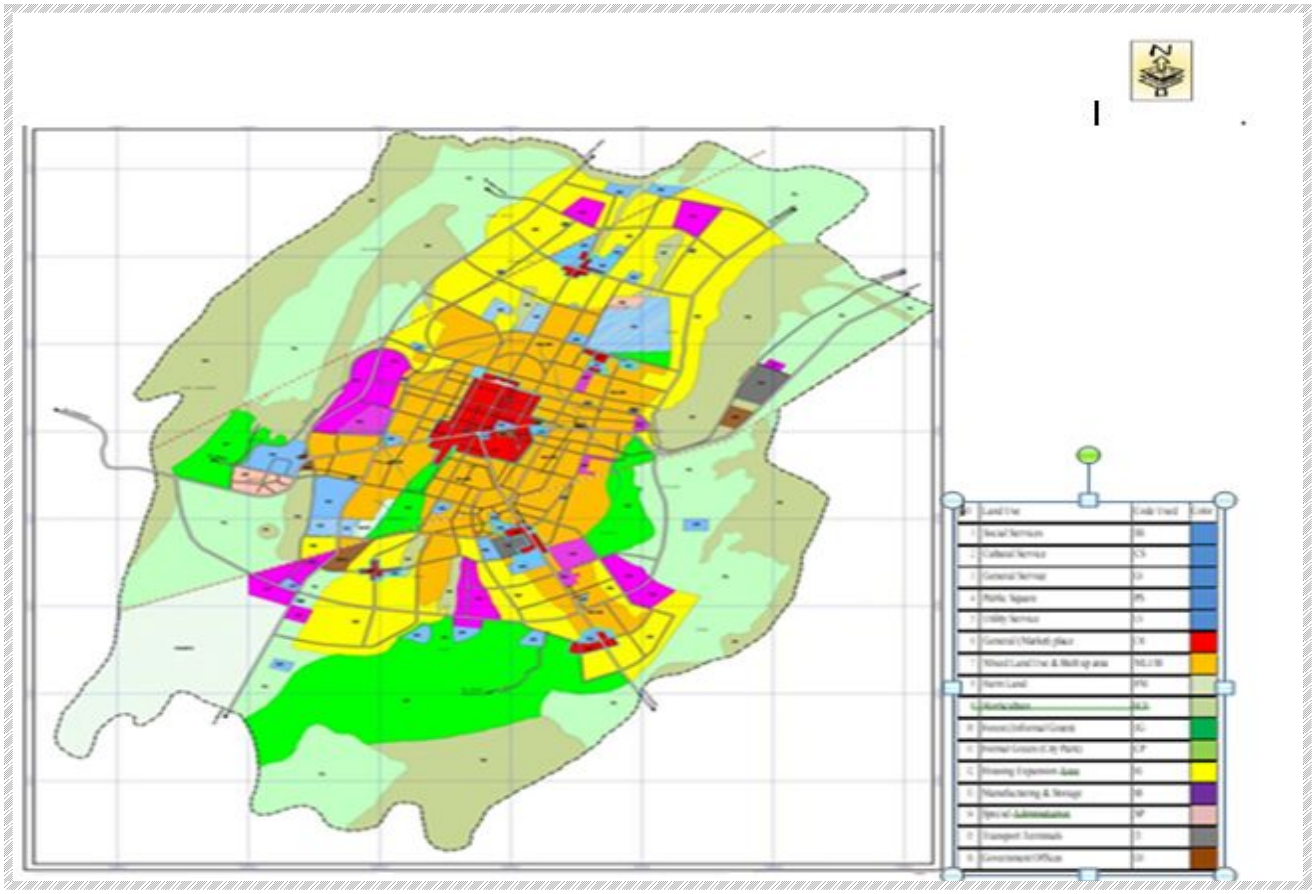
In addition, the proportion of the above each land use is summarized by table--- as indicated below.

Table 1: Land Use Summary of Structure plan Adama city

NO	General Land Use	Area (m2)	Area(Ha)	%
1	Residence	17382360.16	1738.24	13.00
2	Commerce & Business	2405927.08	240.59	1.80
3	Services (Social Service, Cultural Services, General Services, Public	5054474.56	505.45	3.78
4	Forest (Informal Green)	29438640.51	2943.86	22.02
5	Administration	837336.05	83.73	0.63
6	Manufacturing & Storage	4539447.87	453.94	3.40
7	Road & Transport	6940700.20	694.07	5.19
8	Farm & Ground Water Protection Zone	6874250.04	687.43	5.14
9	Farm Land	31782470.27	3178.25	23.78
10	Mixed Use	15167220.35	1516.72	11.35
11	Formal Green (City Park)	13242351.11	1324.24	9.91
Total		133,665,178.19	13,366.52	

Source: Computed from the city previous *studies/* Adama Town Administration

Figure 6: Structure Plan of Adama city

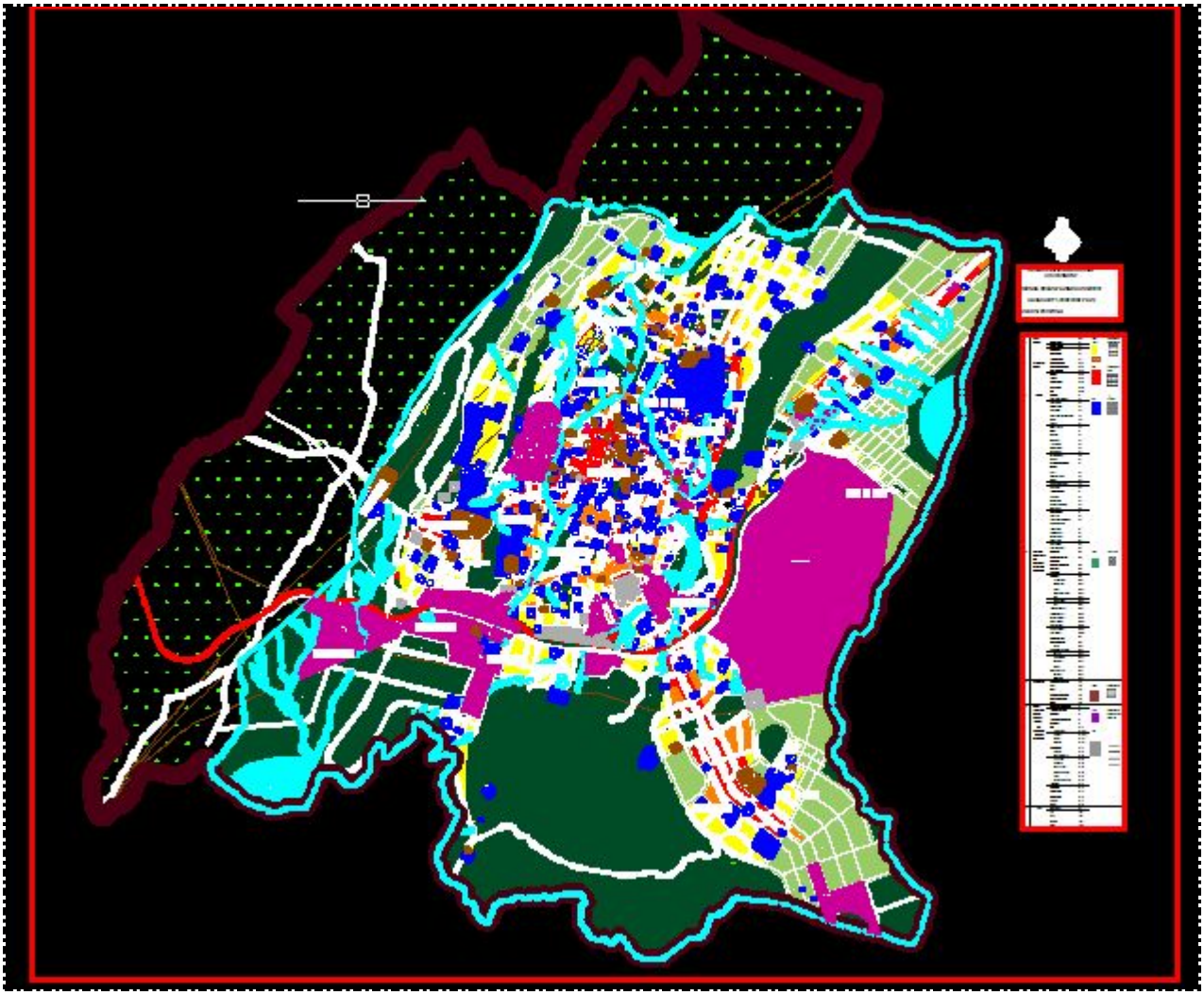


Source: Computed from the city previous *studies/* Adama City Administration. June, 2020.

1.7.3. Study Area existing situation /Existing Spatial Analysis

I shall try to perform & continue the observation of the existing situation to understand the overall situation in order to identify the shortcomings and constraints information to back up the design from services, and other secondary sources so as to quantify properly the required data thereby to produce an economical and safe recommended design.

Figure 7: Structure Plan of Adama city



Source: Computed from the city previous *studies/* Adama Town Administration.June,2020

1.7.4. Basic social services and infrastructure

A. Roads

Asphalt road that connects Adama City and around serves the area, which is usually easily accessible. This road however is currently upgrading it to an asphalt standard high way level.

B. Education

Educational institutions in the City considered consist of primary and secondary schools, preparatory level educational as well as vocational and technical education centers and Universities & colleges that belong to the government and private sector. There is an actual increase in the number of primary schools built in the recent years.

C. Health Facilities

Health institutions in the area include two hospitals, health centers), clinics and health posts found at different kebeles and urban settlements.

D. HIV/AIDS HIV/AIDS

is one of the major social and economic problems at national and regional level. It poses similar threats in the intervention areas of Adama. Adama is the trade center for the southeastern and southern part of the country with a number of passengers boarding or crossing to various destinations. This makes the City more vulnerable to the spread of the plague.

E. Transport and Communication

Transport facility in the area is mainly the road transport full of other communication like intranet, Tele etc. Energy Source of energy for household and public enterprises determine the state of access to various facilities. In areas where energy sources are get HEP from the ICS grid.

F. Water Resources

The water supply of the City is now supplied from Awash river but previously the boreholes drilled at various locations around the City in the radius of 11 km were rich in their fluoride content and children have suffered dental discolorations on top of the water scarcity due to rapid increase in water demand as the number of users frequently rises.

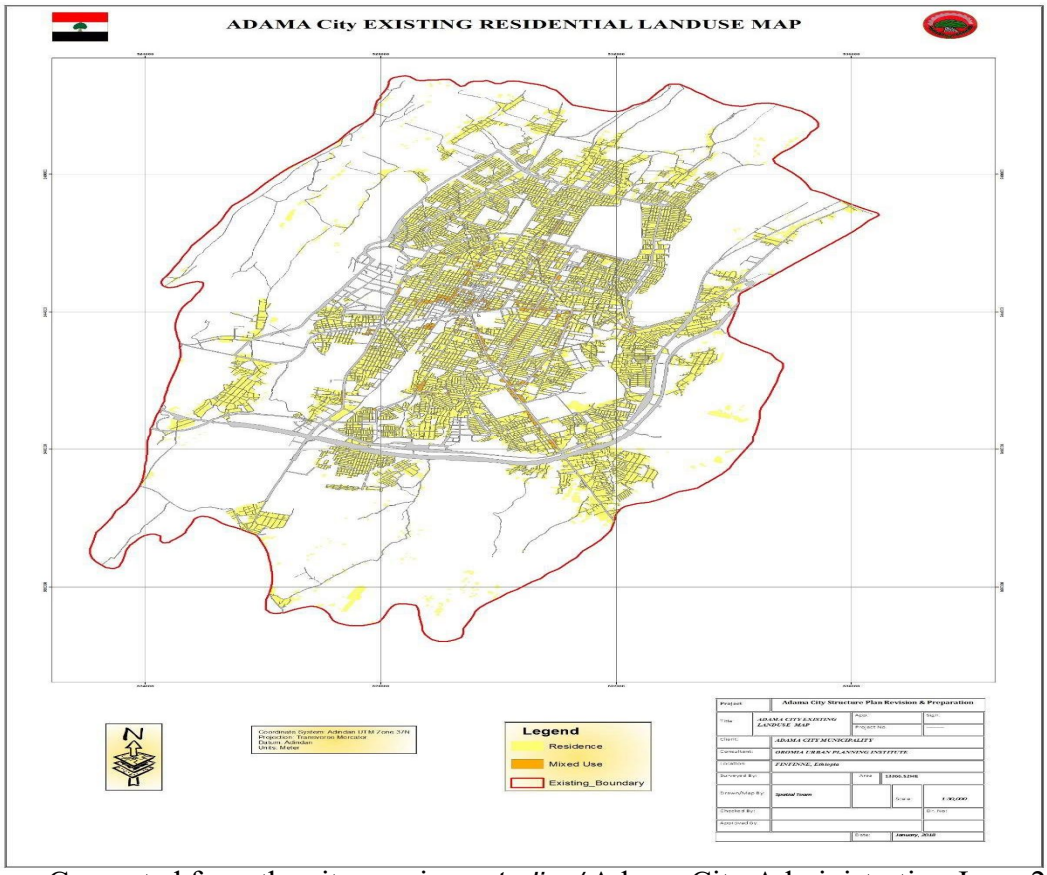
G. Market & Financial Institutions

The market centers for the area are Adama City followed by other small City is a big market that could provide better opportunity in supply of industrial materials and for sale of produces of agriculture. Formal banking institutions are found in Adama.

Residence:- is under standard in some part of the city and G+0 developments that covers estimated more % of the action area and above G+0 less % including along the main asphalt roads and within the city. According to the information gathered from the community during the regime of King Hailesilasse, before 105 years the first G+1 modern house was constructed at the center of the city within action area but last year it is demolished(Under construction). However, as its proclaimed by Oromia Regional State & Adama City Administration in the year 2009/10, its name has been changed to its original name,Adama.

Figure 8 Some under standard houses /Residence within Adama City

Figure 9: Existing Residential Land Use Map of Adama city



Source: Computed from the city previous *studies/* Adama City Administration June, 2020

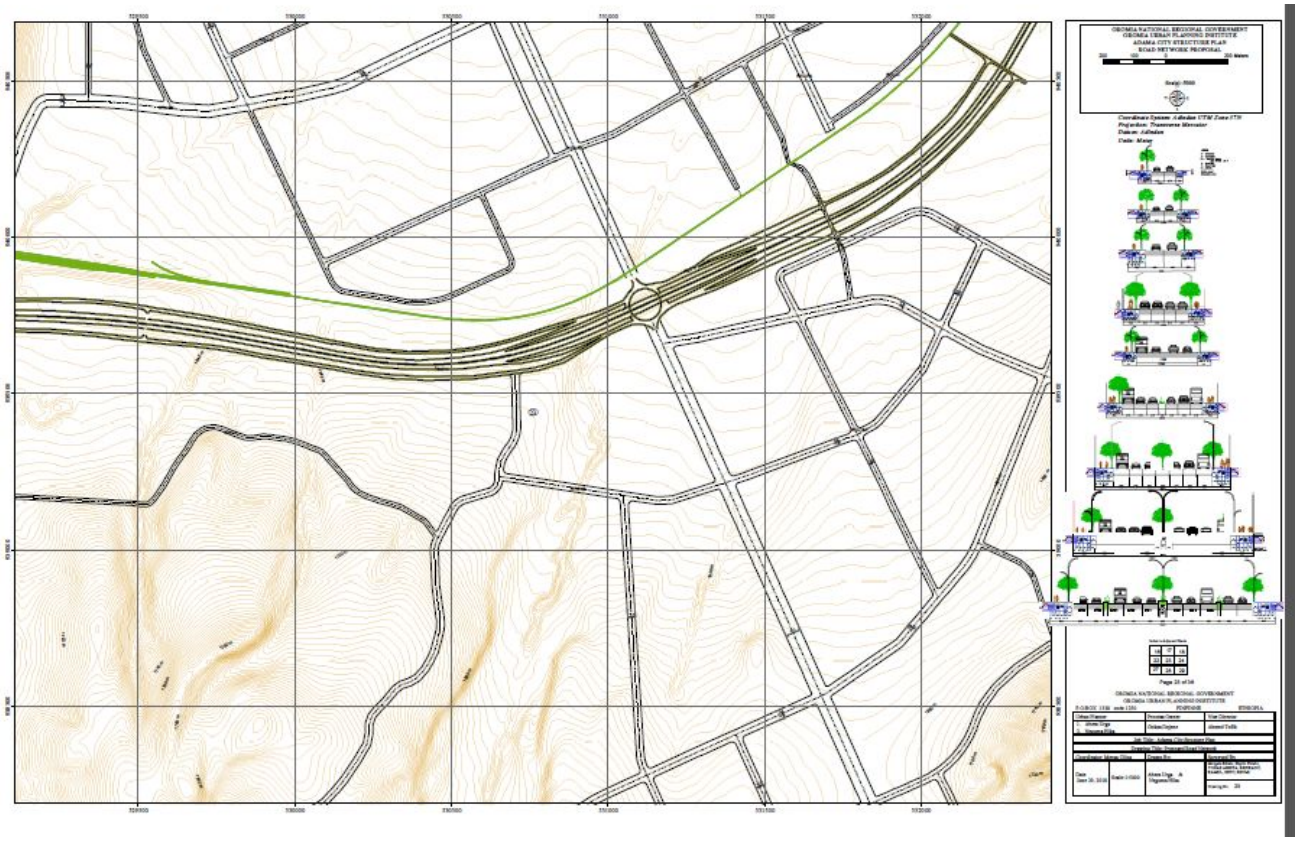
1.7.4.1. Existing Water Supply System

The water supply of the City is now supplied from Awash river but previously the boreholes drilled at various locations around the City in the radius of 11 km were rich in their fluoride content and children have suffered dental discolorations on top of the water scarcity due to rapid increase in water demand as the number of users frequently rises.

1.7.4.2. Existing Road network

Road network proposed in the structure plan for the Action Area are Asphalt road: PAS-1(Primary-arterial Street) with the width of 30m, SAS-1(Sub Arterial Street), 20m width within the site and Cobble stone road: CS-1(Collector Street) with a width of 15m. also local road with different width . Some of the existing roads in the Area have a good width and also have a connection with the main road. The local streets in the area don't follow the hierarchy. Some parts of the roads are not accessible for vehicles. There are dead end roads which impedes connection. The streets in the city have also bad junctions in some area and fragmented.

Figure 10: Sample existing Road network Map of Adama city



Source: Computed from the city previous *studies/* Adama City Administration. June, 2020.

1.7.4.3. Sewerage

One of the basic assessment I made was considering the sewerage system. I gathered data from sample site that I found on site that can be taken as the potential for the study site (See the following figures)

Figure 11 Sewerage system

Source: Own data/Photo taken April, 2020.

1.7.4.4. Solid and Liquid Waste Management System in the Action Area

1.7.4.5. Solid waste management

Based on the site visit survey, there are communal containers within the site, which is not put regularly. These containers are not managed well and wastes are disposed outside the containers while solid wastes are indiscriminately disposed of in various areas of the neighborhood, with negative implications on health and aesthetic beauty of the city(See fig).

Figure 12: Solid Wastes near Communal Containers and Disposal of Wastes in the city

Source: Own data/Photo taken April, 2020.

1.7.4.6. Liquid Waste Management

The residents in some area dispose the generated liquid wastes on open space. The majority of the respondents dispose liquid waste on open spaces. This calls for encouraging awareness of the society by health extension workers in the city

- Storm water disposal drainage lines are being used for solid waste disposals, which can lead to flooding the surrounding

1.7.4.7. Height Regulation & New Developments of the area

The site, according to the new height regulation of Adama City, is up to G+12 .New developments are taking place at some parts of the city, private investors are taking part in developing new investments

mainly in commercial and hotel .All these investments indicate that there is a demand for new development within city.

Figure 13: Some sample new developments and buildings in the city

Source: Own data/Photo taken April, 2020.

1.8. Climate and Topography

Adama is situated 1600-1700 meters above sea level and in a Latitude from 8' -33.8N to 8' -36N and a Longitude from 39' 11‟ 57E to 39' 21‟15E in the Rift valley of warm climate. Its average annual weather conditions are 21 degree centigrade with small amount of rain from June to September. In general, the City has sunny and windy weather conditions.

In 1936, the municipality of Adama was accredited only for a total area of 120 hectares. The City has shown sustainable and fast progress and at present its total area covers 32.4km2. It has now decentralized its authority to 18 Kebeles of the city to facilitate the basic activities so as to bring about effective changes in offering good governance and relevant public service at all levels.

The pattern of natural terrain of Adama city is mostly the result of volcanic eruption. Some of the present lakes are the results of these geological formations. There are many hills and mountains in the city which are concentrated at the central part. Most mountains in the city are barren and exposed for natural hazard.

1.8.1. Geology

The topography of Adama city area varies from nearly level to rolling, with some hills and old volcanic cones. Soil characteristics may be dependent upon the topographic setting of an area and type of parent material from which the soil originated and some other factors. Therefore, soil in Adama city area can be the weathered product of the volcanic rock that formed the area and that alluvial type which may be washed down from the surrounding hills and settled at lower flat surface.

Soil characteristics of the Adama city area observed in the field were integrated with the analysis of some previous studies. On the basis of the physical characteristics observed on surface along farm

lands, valleys, gorges, etc., the soil around Adama city are primarily gray to very dark gray, or black clays or clay loams. In some areas there are brown to reddish brown clay soils. The slopes of the hills are often reddish brown and in the lower areas the soils are dark colored clays.

The physical and chemical analysis made in the laboratory of Adama city Agricultural Research Center shows that the soil type in Adama city area is dark clay and very dark gray clay with high organic content and hence, good agricultural potential.

To the contrary, the dark gray to black clay soil has high swelling and shrinkage properties and hence, not good for engineering construction activities. Therefore, this soil layer needs to be removed to the required depth during the construction of huge engineering structures.

1.8.2. Hydrology

Surface water hydrology relates the dynamics of flow in surface water systems. It also includes the relation between rainfall and surface runoff; this relationship is an important aspect of water resources for sewerage (wastewater) or drinking water, agriculture, environmental protection, and for flood control.

The hydro geological conditions which exist in the country are highly varied as a result of the complexity in geology, physiographic, and climate. The study area being located in the Rift Valley region, one of the three major physiographic regions of Ethiopia has defined hydro geological characteristics. The hydro geological characteristics of the Adama city area can be described based upon the geologic, topographic and climatic conditions of the interest area.

In the aquifer classification which accounts for the aquifer types and the aquifer productivity, Adama city and its surrounding are included in the areas of "Extensive Aquifers with Fracture Permeability (volcanic rocks: basalts, royalties, trachyte's and ignimbrites)." Hydro geological field observations such as the distribution and magnitude of spring discharges, the degree of fracturing of the rock units, the thickness of the formations, and the extent of weathering are some of the significant field observations which provided indirect evidence as to whether a rock unit is likely to be an aquifer of low, moderate or high productivity.

1.9. Operational definitions

Water Supply Service: Providing water for domestic, commercial, industrial and social use.

Domestic Use: Water used for drinking, cooking, sanitation or for other similar purposes.

Industrial Use: Putting water to industrial uses and includes use of water for the production of industrial inputs, making and assembly of products.

Commercial use: Putting water to business related activities such as hotels, bars, recreational areas, markets, car washing, gardens and watering animals.

Access to Water-- is defined as having a source of safe water within 1 kilometer of the dwelling. ... **Most unimproved sources**—for example, surface water or unprotected wells or springs—and many improved water sources are located away from the home and publicly shared.

Adequate water supply", as defined by law passed by the Arizona Legislature, is a "sufficient quantity of suitable quality **water** that is physically, legally, and continuously available for 100 years to satisfy the **water** demands of a proposed subdivision."

Social Use: Putting water to social purposes and includes the use of water in hospitals, in religious institutions, educational institutions and government institutions.

Municipal Use: use of water in cities for purposes other than commercial use, domestic use industrial use and social use.

Improved Water Supply: Provision of water in good quality or safe for health, good quantity or the required amount of water is available for use any time throughout the year; and collection of water need not take much of your time and effort.

Safe Water: the water protected from contamination.

Potable Water: also known as drinking Water is water that is safe to drink or to use for food preparation.

Price Fairness of the price: the level of price that makes the community to be able to buy water supply services.

Operation and Maintenance (O&M) Costs: Operation costs include fuel, staff salaries for the water point, and cost of water treatment chemicals etc. whereas maintenance costs include labor, tools, equipment, spare parts, etc. costs.

Coverage: refers to the proportion of people served with the adequate levels of water supply.

Full Cost Recovery: Covering operation and maintenance, debt servicing and depreciation costs of water supply scheme.

Partial Cost Recovery: Covering operation and maintenance costs of water supply scheme.

Household: any unit of habitual residence where some consumption and/or production may be undertaken in common and where some members may recognize culturally defined relationships of kinship and/or affinity where the members are related in some way.

Kebele: the smallest administrative unit under city or town administration.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1. The rationales of adequate urban water supply

As Cited in Assefa D. (2006), Water is crucial for human survival and economic development. The provision of adequate supply of potable water in urban areas in both developed and developing countries is essential for life. In relation to this, Alebel (2004) and Churchill (1987) mentioned that in developing countries the provision of adequate potable water in addition to drinking, cleaning etc. improves health by reducing incidence of water related illnesses such as diarrhea, cholera, and the like. This also helps to reduce both the mortality and morbidity rates and the number of working days lost and increases the GDP. Reducing the incidence of illness will help to slash demand for improved medicine and eases balance of payment problem facing least developing countries. As such, available evidence suggests that there is a very tenuous link between improvements in health and investments in water supply and sanitation services.

In addition to health improvement, studies by Mekonnin (1983), Hofkes, (1986) WHO (1986) in Yimer (1992:3) have shown that the provision of sufficient potable water for people within reasonably short distance from a reliable and acceptable source is a precondition for the people's well being and sustainable economic progress. Hofkes Stated:

> *Factors such as time and energy saving in the collection of drinking water and a substantial reduction in the incidence of disease can contribute to development, provided that the time and energy gained are utilized economically…. As many of 80 per cent of all diseases in the world are associated with unsafe water (p.3 - 5)*

Therefore, safe, adequate and accessible supply of water together with proper sanitation is surely basic needs and essential components of primary health care. In addition to that Deieter and Hedeerson in Yimer (1992:4) stated that:

> *Because of an inadequate and undesirable water supply economic loss may result, man power may be wasted, production of consumer goods and food may decline, fire protection may become impossible and schemes for urban improvement.*

2.2. Approaches to Access and Adequacy of water supply

2.2.1. Supply oriented approach

The supply oriented water supply approach focuses on technical elements and monopolistic public service delivery (Mani; 2000:20). This had failed to deliver the required levels of services and adherently resulted in the use of several alternatives to substitute and augment the piped water

supply. It is now realized that the conventional "supply oriented" planning has aggravated the gaps in service delivery. As stated by Mani (2000), supply orientation is found to be:

Economically inefficient, as low-income countries find it impossible to recover the costs of large-scale piped networks, high costs are incurred in pumping and transferring water over long distances and a growing demand is created for more government subsidies. Moreover, piped services are priced well below the full costs of service provision, there by subsidizing the affluent, and leading to chronic budget deficits and dependence on external finance.

Socially inequitable, as certain consumers, generally the poor and low income groups residing in the slums and urban fringe areas, are excluded from the use of these services; and **Environmentally hazardous**, as supply orientation in the water sector stresses the hydrological limits of the region and inflicts environmental costs. Water supply and sewerage are customarily planned for large, centrally controlled, technology-intensive piped networks with a greater emphasis on production and distribution of water than on maintenance of the system and analogous construction of sewerage facilities. Regarding this, Howe and Dixon in (Mani, 2000:20) identified donor lender and host country factors as follows:

Donor-lender factors are the bias towards construction, desire to sell available technology and maximize aid flow, failure to provide training for O&M and inadequate budgets for post project evaluation; host-country factors are the desire for prestige, opportunities for corruption, lack of inputs from consumers, lack of adequate skills in the construction and operation and maintenance, lack of accountability, inefficient service charging, and shortage of personnel for monitoring.

2.2.2. Demand oriented approach

A demand orientation with a focus on service consumers' needs and willingness to pay (WTP) full costs of services, competitive markets, and broader participation of the private sector, non-governmental organizations (NGOs) and community-based organizations (CBOs) is now being incorporated into water supply and sanitation strategies. The demand orientation is potentially more economically efficient as demand oriented infrastructure delivery consists of competitive markets, and broader participation of the private sector, or water surrogates. Social responsibility also increases as demand orientation requires greater responsiveness to users' needs and fairness, and participation of the private sector, Non-Governmental Organizations (NGOs) and Community-Based Organizations (CBOs) in service delivery. Environmental degradation is minimized as a demand management in the water sector is valuable in ensuring that a limited supply of water distributed to match the optimal use pattern for the resources.

Mani (2000:21) identified the significant differences between traditional systems of planning service coverage and emerging patterns of service consumption; prevailing service pricing and expenditure and WTP for services; and mandated institutional arrangements for service delivery and emerging partnerships with NGOs, CBOs, and the private sector. To achieve a demand orientation, these differences need to be bridged. Planning for service coverage can be improved by considering the economic, social, and environmental impacts of heterogeneous consumption along with assessing consumer needs for services.

Service charging must be based on consumption and WTP while discouraging the use of alternatives and incorporating negative externalities on the environment. Partnerships with NGOs, CBOs, and the private sector must be further emphasized through clear definition of roles and responsibilities and mitigation of financial and political risks. A demand orientation can be achieved through policy reform as well as training for changing roles and responsibilities.

2.3. Domestic access and adequacy of potable water and Health

Water is of a fundamental requirement for human life without which, life cannot be sustain long. Lack of access to adequate potable water supply leads human life to multidimensional problems. It affects different aspects of human life including their social, economic, health, education and dignity. The spread of water related and water borne diseases is associated with poor access and adequacy of potable water, sanitation and hygiene. Women and children bear the greatest burden related with inadequate access of potable water. The per-capita domestic water demand for various mode of service varies depending on the various climatic, social and economic factors explained in previous section. According to (MW, 2006, p. 14). Design criteria the initial and final stage of demand for mode of service is summarized as shown below.

Table 2: Domestic water requirement, by mode of service

Categories of consumer	Stage 1	Stage 2
- House connection (HC).	50 l/c/day	70 l/c/day
- Yard connection, own (YCO).	25 l/c/day	30 l/c/day
- Yard connection, shared (YCS).	30 l/c/day	40 l/c/day
- Public tap supplies (PT).	20 l/c/day	25 l/c/day

Source: MWR, 2006, Urban water supply design criteria

The WHO/UNICEF JMP report of 2015 indicated that the improved water coverage in Ethiopia was found to be 93 and 49% in urban and rural areas, respectively. The country coverage of improved water source usage reached 57%. On the other hand, 30% of the total Ethiopian citizens rely on

unimproved drinking water sources.. Water supply systems in urban areas are often unable to meet existing demands and are not available to everyone, rather some consumers take disproportionate amounts of water and the poor is the first victim of the problem (Bereket, 2006).

Hunter et al. (2010) reported that a poor water supply impacts human health by causing diarrhoea and non-diarrheal disease, customers, respectively. According to WHO and UNICEF (2013), there is a considerable funding gap to achieve full coverage; hence, Table shown , the piped water coverage increment is very more has to be invested in developing sector capacity through strengthening institutional structures especially at city at all, sub city/kebeles and community levels. Based on Schuster-Wallace et al. (2008), water has suffered from severe under financing. This result from inadequate internal financial capacity in the poor countries to achieve water goals, poor management decisions for allocation of development aid, an overall reduction over time in development aid, and the limited cost recovery potential in poverty stricken regions. Evidence from empirical research (Vasquez et al., 2009) indicates that improved water supply schemes in many developing countries are not functioning properly. There have been similar studies carried out in some of Ethiopian Citys. Generally, the studies revealed that the water demand is more than the supply. Challa (2011) and Reda (2012) reported that there is low water coverage and frequent interruption. To expand water supply to urban areas, implementing proper demand management strategies is required. Pertinent information on the residential water demand of households is necessary to properly assess the factors that affect residential water demand (Arbués et al., 2003).

2.4. Factors affecting access to potable water supply and adequacy

There are various factors affecting access to potable water supply and adequacy. These factors are influenced by social and economic factors for **of Adama Town** summarized as: **unexpected population growth** of community, iindustrialization and commercialization, social development level, environmental impacts, natural disasters, hydrologic variability, climate change, environmental degradation and the like.

2.5. Link between accessibility and water quantity

Water use for effective hygiene is important for controlling disease and lack of access may hamper its use which in turn adversely affects health. Availability of water significantly influences individual's hygienic behaviors'. Review of literatures by WHO (2003) & Gleick, (1996) suggest that increased in accessibility of water equates to increased volume of water used and benefits from increased quantity of water is only felt in relation to the gross differences between service levels. Use of water sources for economic activities exceeds its use for access and adequacy of domestic

potable water, thought it may compromise the ability of resource to meet basic needs through over consumption or quality deterioration. Households in low-income areas use domestic water at household level for productive purpose including: brewing, small scale food production, gardening and household construction. Productive uses of water have particular value for low-income households and communities and have health and well-being benefits.

Generally adequate and safe access of potable water should be assured for basic consumption (drinking and cooking), hygiene and household productive uses in order to achieve health benefits that could be obtained from access and adequacy of potable water. The quantity of water that households collect and use is primarily dependent on accessibility though cost and system reliability may also have significant influences. Health benefits gained from access and adequacy of potable water are more dependent not on the quantities of water rather on the level of service which in turn inform the likely volume of water that can be collected and used. Maximum health benefits are ensured from proper water usage and good hygiene behaviors' and simple provision of infrastructure alone is unlikely to maximize health gains.

2.6. Experience of developing countries

The growing population of most developing countries is disproportional in urban areas. This places considerable pressure on already overburdened budgets to increase the water supply and waste water infrastructure. Moreover, little or no resources are left to supply, let alone, improve rural water supply. To add to the problems, money is spent on studies that would not be implemented. Projects are constructed, but never been implemented (J.Helweg, 2000:1).

As a result, the water supply and sanitation in the developing world is still very inadequate. In Africa for example more than 47 per cent of urban households are without access to safe water. The condition is even worse in rural areas (Grace 2003). In Nigeria cost estimates and household willingness to pay (WTP) estimates are used to determine what proportion of households would sign-up for each service level at various prices, given the household income (IBID).

Global Water and Sanitation Assessment Report (2000) also estimated that over one-third of the urban water supply in Africa, Latin America and Caribbean and more than that, half of those in Asia, operate intermittently. Intermittent water supply is a significant constraint to the availability of water for hygiene and encourages the low income urban population to turn to alternatives such as water vendors. These water vendors often charge many times more than the formal water tariff for water that often is of doubtful quality and not available in adequate amount.

In India the government also tried to provide water supply based on the demand orientation. The India Infrastructure Report, a recent authoritative document on approaches to infrastructure provision in the country acknowledges the benefits of a demand orientation in infrastructure provision consisting improved assessment of users' needs for the services and demand management. In rural water supply and sanitation, the demand-responsive approach is already being implemented in some parts of the country with elements such as self-selection of service types, participation of NGOs, CBOs, and increased participation of women in the community (Mani; 2000:21).

The Swajal project undertaken in Uttar Pradesh state offers the following lessons:

- Cost recovery improves with greater community participation;
- The government is learning to play facilitative and partnership role;
- Weakly formed CBOs are less successful;
- NGOs need time to build effective CBOs;
- Delineating the tasks of NGOs in community organizations and service delivery minimizes the risks and of mutli-stakeholder participation; and
- Integration of water and sanitation services is increasing.

However, in the urban areas, the demand responsive approach has so far been limited to a few programs such as the slum-networking program targeting the poor living in slums and squatter settlements. Mani (2000:22) identified elements of demand orientation from traditional demand estimations as demand estimations are traditionally based on population levels, current consumption levels, patterns of service consumption, and household characteristics.

Demand projections are made according to past trends of water consumption and population growth. While these give quantitative estimates of the water supply required, other dimensions of demand remain neglected. Therefore, willingness to pay (WTP) and revealed preference studies for new or improved service have been found more useful in demand assessment in spite of the shortcomings of the contingent valuation methods (CVM) upon which they rely.

2.7. Policy and Legal Issues Reviewed

The very relevant and appropriate policies and legal provisions on access and adequacy of potable water at country and regional level were reviewed in the process of the socioeconomic survey. Such review works are very essential to identify and forward the type and level of access and adequacy of potable water and the responsibilities of the government and beneficiary communities as well as the stakeholders in the area of water resource development.

2.7.1. The Ethiopian Constitution

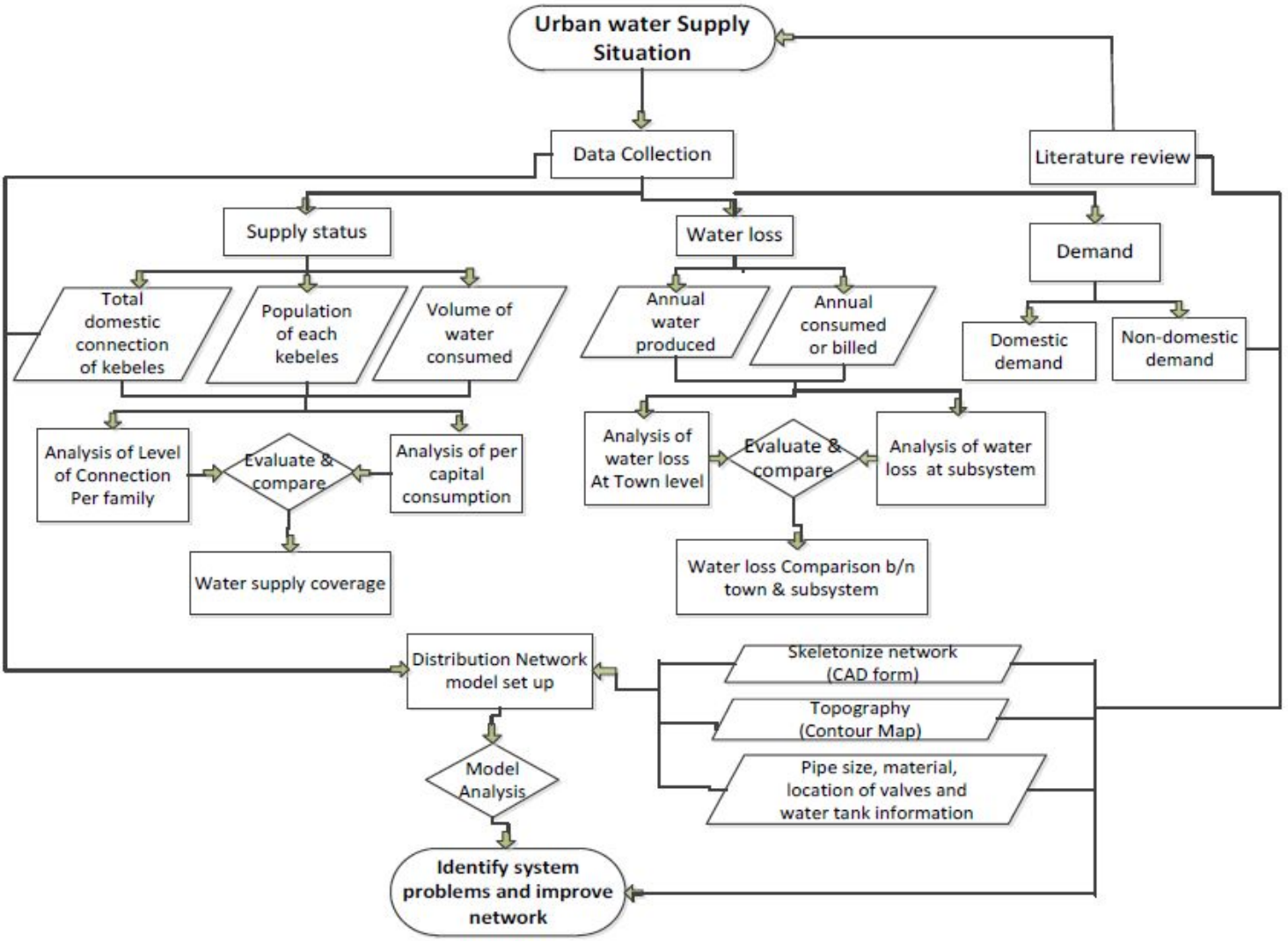
The constitution which is the base of other legal provisions in the country has recognized various rights of the citizens. Article 41 the constitution recognizes the Economic, Social and Cultural Rights of citizens stating that every Ethiopian national has the right to equal access to publicly funded social services. Social services are varied and interdependent each other among others is the right to get access for sufficient and quality water for domestic and personal use. The constitution clearly decides that the State has the obligation to allocate an ever increasing resource to provide to the public health, education and other social services including access and adequacy of potable water.

CHAPTER THREE

3. RESEARCH METHODOLOGY

All methods for this final research and thesis -"Access and adequacy of potable water in Adama City" include ,but not limited to the following

Figure 2. *Research process flow diagram*



Source: Adapted from Siraj Abduro, 2006

3.1. General Approach to the Project

The approaches described in the check list correctly define & the objective and the processes required to achieve each task. It also arranged in a logical order of activities. I have thus fully devoted to adopt it and implement the assignments in accordance with the approaches described in the document. The major components/phases of the project are the following.

3.2. Data Collection, field investigation and Analysis

Using formulation of the planning and design criteria, data on Socioeconomic Condition and Population, data on the existing routes sources reservoirs data on rising main/Pressure main and distribution system design, data on demand-supply potable water, profile and Topographic Surveying, data on adequacy, accessibility, Safety etc.

3.3. General

The study of thesis --"Access and adequacy of potable water in Adama City" indicated the work shall be carried out with the appropriate Standards.

3.4. Data Sources

The study is conducted based on both primary and secondary sources of data, data source and method of data collection. The survey utilized both quantitative and qualitative methods to explain concepts and measures to demonstrate implications of the issue under question. Primary data was collected from respondents using questionnaires and personal field observation was employed to supplement respondents' response. Secondary data was collected from related literatures. Structured and semi structured questionnaire were prepared for the survey. The questionnaire included an introductory part, questions on the characteristics of the respondents, water sources and accessibility, potable water coverage and water supply satisfaction. Data collection was undertaken by both the researcher and enumerators.

3.4.1. Primary sources of data

Associated to primary data collection, checklist questions were designed and used to collect information from Adama City. Checklist questions were also prepared to obtain the necessary data from different sector offices of the study area (Adama Town WSSSE, 2020,). Data were also collected through unstructured interviews from some district sector offices officials and key informants. Data triangulation method which combines both conventional and non-conventional methods of data collection was used primarily to ensure the reliability of the data. As well data were collected through key informant interviews concerning the positive and negative impacts of the project.

The major data collection tools for socio-economic feasibility studies were site observation, and questionnaire. Site observation some of the information which have been collected through site observation include land use, road network and housing condition of the site, discussion there was a discussion with officials. then different problems and issues were identified, household

questionnaire survey a sample has been taken into account by considering systematic sampling technique to select the households.

3.4.2. Interviews and Discussion

The study and discussions were made with concerned officials about the prevailing water accesses and adequacy situations. The offices consulted during field work are given in the table below.

Table 3: Key personnel consulted and offices visited

S.N.	Name of contact person	Address	Organization and Responsibility	Telephone No
1	Engineer Kedir Abdella	Addis A	OWMEB Water supply Engineer	0913469008
2	Engineer Biruk Asrat	Addis A	OWWDSE Water supply process Owner	0911776295
3	Engineer Endalkachew G	Addis A	OWWDSE Water supply Project Manager	0929494604
4	Engineer Hasen	Adama	Adama city WSSS EEnterprise Deputy Head	0913348571

Source: Own data/Computed on May, 2020.

3.4.3. Materials Used

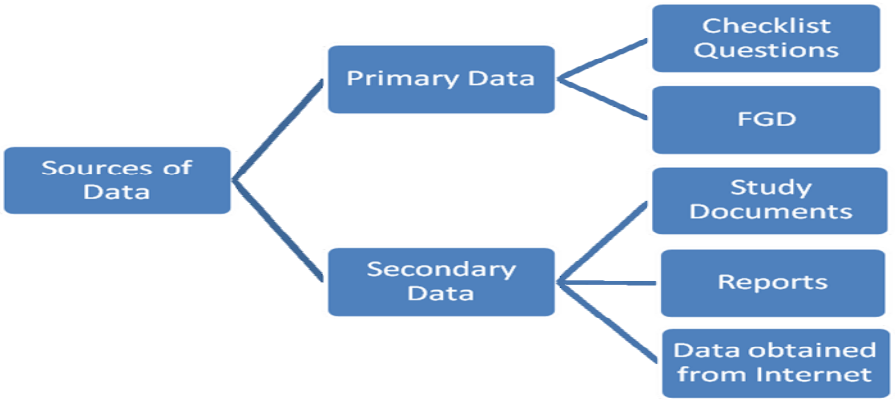
The following materials were used during the study GPS (Datum: ADINDAN); tape meter (5m and 50m); topographic maps (Scale: 1:250000), Scanned 1:50000 topographic map (part of the project site), and 1:50000 scale Ortho photo graphs (part of the project area); digital Elevation Model (30 m resolution); mosaic land sat Image northern Ethiopia; different software like GIS (ArcGIS), Global Map per, and AutoCAD and Water CAD etc.

3.4.4. Secondary sources of data

The secondary data sources employed on the other hand include maps, books, reports and relevant information from the internet including background of the city.

Secondary data sources were obtained from maps, books, reports and relevant information from the internet including background of the city, study documents, reports and various documents from the internet, etc. were reviewed to validate and enrich the socioeconomic study targeting the project areas. In this regard, different relevant socioeconomic reports pertaining to the study areas were reviewed. Other relatable reports and documents had also been reviewed to verify the socioeconomic study of the development project.

Figure 14: Data Triangulation for Socio-Economic Study



Source: Own data/Computed on June, 2020.

3.5. Methodology Used

The collected data has been organized, classified, tabulated and presented in a suitable and manageable form using AutoCAD, ARCGIS, and Water Cad and excel. Other software for 3D modelling of the proposal, to this end, the following tasks was performed: the variables of the data were given code; data was entered in to computer; and the data was processed by using excel & other software to generate different tables, graphs, charts, etc.t the proposed urban design of the action area will be delivered in 2D, 3D and model (optional).

In order to abstract significant facts from the collected data, appropriate quantitative method (percentages, ratio, etc) have been employed. The quantitative methods was used to estimate local population size, social services, housing units, etc which would be required for the population that is expected to settle in the LDP areas.

The methods used in this study include Documents review, consultation and discussion with relevant office staff and management of the water service, collection of relevant data from concerned office.

Furthermore, I am try to visited a number of offices pertinent to the study and discussions were held with concerned officials about the prevailing water supply situations through field visit to the project City and source area.

The following are stakeholders which were consulted on the water supply system of the City:

OWMEB Water supply Engineer, OWWDSE Water supply process Owner, OWWDSE Water supply Project Manager, Adama city WSSS Enterprise office technical workers etc. During the Discussion with the above concerned bodies concerning the project were discussed. Some of the

points raised during the discussion are: Options for developing water from other sources, Current population of the city, existing Water production accesses, adequacy and quality of the city, Water demand of the city and generally about the existing water supply conditions of the city were among points raised

3.6. Sample Site Selection criteria

The rationale for the selection of the action area among others includes the following:

- *Based on its representativeness to the whole part of the City*
- *Being the existence of city.*
- *Based on check list provide(own data)*
- *The impact of the project to promote public use design for all etc*
- *Capacity of the site to create sound social and economic return and synergetic effect of the project after implementation. & Future potential of the site.*

3.6.1. Sample size and sampling method

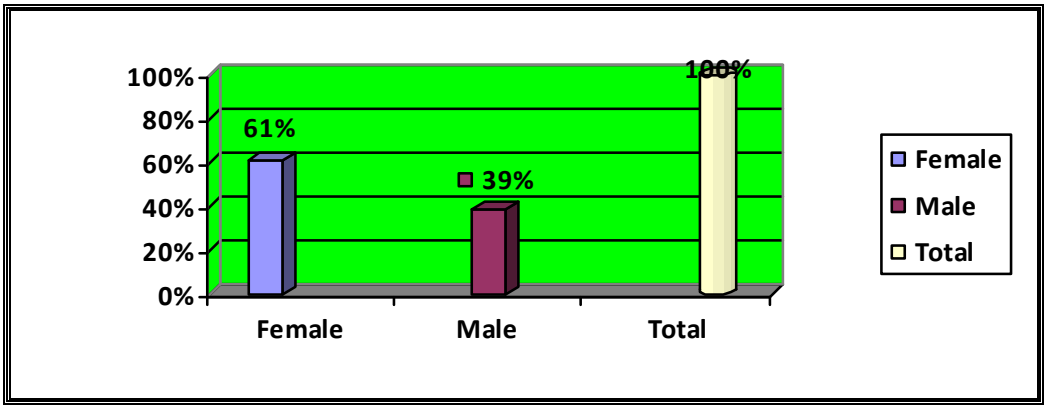
In order to determine the sample size that represents the population, a mathematical formula suggested by Fink and Kosecoff (1995) as presented. Therefore, 166 residence & households representatives were taken as sample respondents. Since the city is classified into six sub cities, sample households were randomly selected from the three sub-cites purposively based on their population number. Data analysis and presentation Qualitative data was analysed and presented through description narration and interpretation of the situations contextually. Whereas quantitative data were analysed and presented using tables, frequency and percentages were used to give clear understanding of the issue quantitatively. The Micro soft Excel was used to analyse the data.

Table 4 Sample households' characteristics (sex & Educational),

Item category	Variables	Frequency	Percent
Sex	Female	102	61%
	Male	64	39%
Educational level	Literate/formal	122	73%
	Illiterate	3	2%
	Informal	41	25%

Source: Sample survey. June 2020

Figure 15 Chart shows Sample households' characteristics (sex),



Source: Sample survey. June 2020

Table 5 Sample households' characteristics (Age),

Item category	Variables	Frequency	Percent
Age	20-30	27	16%
		51	31%
	>41	88	53%

Source: Sample survey. June 2020

3.7. Limitations

Limitations of the study can be written with the followings:

The limitation of the study is outdate information acquire from the Municipality, limitation of time, money may require, nature of the sample may need especial instruments, nature of the data complicated , nature of the instruments used and the limited time allocated for the design compared to the overall output may happen. Compensatory measures taken to mitigate effects of the above limitations by fast action to get data, use simple instruments etc; Time constraint, budget; The compensation payment do not rewarding yet around Sole Kebele, consequently recently under construction housing units are widely observed in the site; The reluctance, unwillingness and the dalliance in response of perspective parties to provide data needed for the study.

CHAPTER FOUR

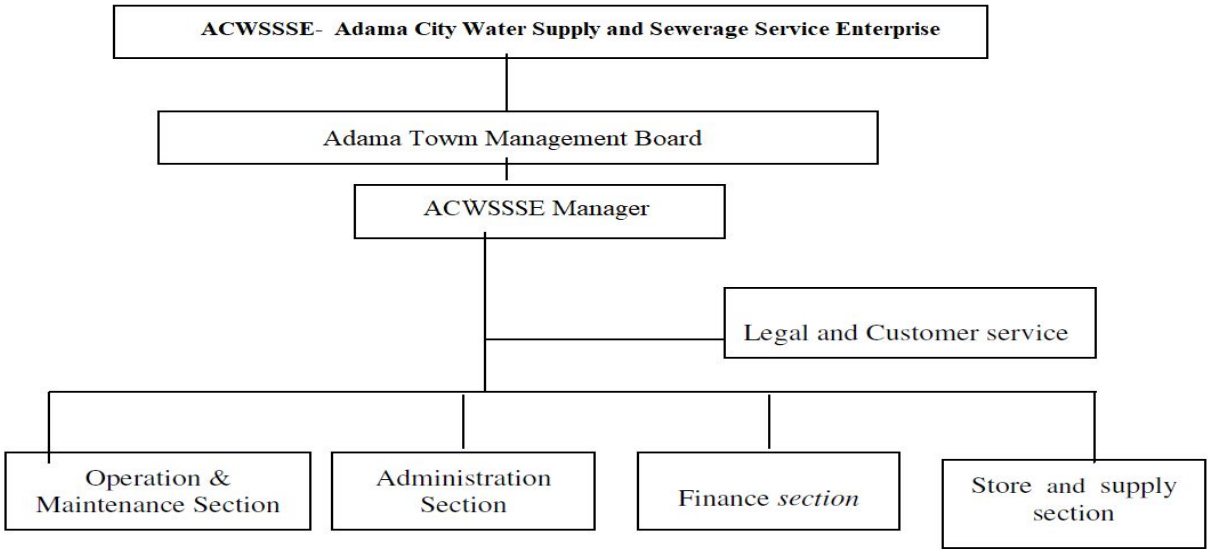
4. RESULTS AND INTERPRETATIONS

4.1. Institutional set up of ACWSSSE

The urban water supply and sewerage service of Adama town is the responsible government organ for the delivery of water supply service. Not only the organizational capacity of WSS office but also the capacity of the Municipality of the town is an important factor in bringing about remarkable revamp in the area under discussion. However, the municipality did not involve in water supply activities except the head of office who served as Board member and technical leader of the extension of pipelines in accordance with Structural Plan of the town. The sustainability of the Po0table water supply scheme is mainly dependent on the effectiveness of management unit to operate, manage and maintain the implemented scheme.

The Adama Water Supply and Sewerage Service Enterprise (ACWSSSE) is responsible for the operation, maintenance and management of the already constructed water supply structures of the town. The scheme is of course demand responsive and hence the benefiting community should have a great role in all matters of the project. In 2014 the Water Management Board that can represent the community and enhance community's participation was setup. The Water Management Board comprises two community representative members, the Municipality head, Water Resources Mines and Energy Bureau head and head of Water Supply and Sewerage Service Enterprise. The chart below depicts organizational structure of ACWSSSE office of Adama town.

Figure 16 : Organizational Structure



Source: Compiled by Author, 2020

4.2. Social Aspects: for Water Supply System design

A fundamental consideration for sizing of any potable water supply system or its component parts is an estimate of the amount of water expected to be used by the customers on from the system. The total water requirement of a project was normally estimated by its uses for domestic purposes such as drinking, cooking, ablution, washing clothes and utensils and cleaning houses, and for non-domestic purposes such as public, commercial, industrial and fire fighting institutions, and livestock watering. In addition unaccounted for water was considered while calculating the total water requirement of the system.

4.3. Factors affecting Population Growth

There are various factors affecting the population growth of community and various factors associated with population size, distribution and growth rate are births, deaths and migration. These factors are influenced by social and economic factors. Factors for unexpected population growth of Adama City summarized as: Social development level, medical facility development and advancement, natural disasters, educational level, industrialization and commercialization etc.

4.4. Population Projection

Consequently the design population can be calculated by multiplying the present population with a population growth factor as follows: Knowing the current population of the City is the basics for population projection process. The water supply system network design will be affected in two ways unless the right estimate of base population is considered for the design the first one is uunderestimations base population, this will lead to the phase of the new project before the design period, meaning the demand surpasses the supply before reaching final design period and secondly over estimating the base population: in contrary to the previous case higher base population means high implementation cost in return the cost recovery might be unachievable for the utility.

The table below show total population collected from different sources.

No	Adama City population from different Source for 2017				
	City	Previous study	CSA	Adama municipal	Adama Planning office
1	Adama City	342,569	368,231	373,661	391597
2	Settlers from Somali Region	6,695	6,695	6,695	6695
3	Adama University	16,959	16,959	16,959	16,959
4	Floating	24,084	24,754	25,697	26,628
Adama Industrial park : estimated around 25,000 to be added at this year					

Table 6: Population of the City

Source: Computed/ reorganized from Adama Town Administration

As entry to the feasibility design the population project is projected over the design period. Population growth is not a linear phenomenon and depends on interaction between population and environment. This interaction are very complex and mathematical growth models used to study the population growth rate, among which Exponential growth ,Geometric growth and Logistic growth are most applicable to date. In Ethiopia, the geometric growth rate widely used to determine population project and the formula reads:

$$P = P_o\left(1 + \frac{r}{100}\right)^t$$

Where: P= projected population in time t

P_o= Base Population at time o

r = annual growth rate

t = time in years

The CSA has established growth rates at five years interval that can be used for urban population projection of all regions in the country starting from year 1995 up to 2030. The CSA has also produced three alternative scenarios with high, medium and low growth rates. The efforts of implementing government policies on population regulation (family planning) in the Oromia Region

are anticipated to be successful to a moderate extent. Hence, the population of Adama City is expected to show a medium growth rate. Hence, from the three variants set by CSA for City's in Oromia Region, the median variant is applied for the population projection of the study City. Since there are differences in the figures of the population given from different sources, the data obtained from the CSA is recommended to avoid over investment as well as water demand under estimation to be used in water demand projection and expected beneficiaries of the water supply project to be implemented. The exponential growth rate was used to calculate populations based on the base population data obtained from CSA, (2007).

Population figures are available from the 2007 population and housing census of Ethiopia, published by the Central Statistical Authority CSA (2007), Office of Population and Housing Census Commission. For the purpose of designing future water demand of the project area target population (Adama City), data of 2007 year was projected to 2020 is used as a base population taken from CSA, 2007 census data of project area. In projecting the population of a particular area of the city, it is very important to analyze the overall city's resources, public institutions and commercial service providing bodies and capacity so as to avoid the risks of either under designed system resulting in a reduced system capacity or over designed system resulting in incurring a heavier investment cost influencing the socio-economic conditions of the residents of the city.

Table 7: Population of the City

Table 9.1. Population, Households and Housing Units
for Urban Kebeles by Sex: 2007

Geographical Area	Population			Number of households	Number of Housing units
	Both Sexes	Male	Female		
KEBELE 01	6,358	3,378	2,980	1,691	1,623
KEBELE 02	4,982	2,509	2,473	1,150	1,101
KEBELE 03	4,594	2,319	2,275	1,165	1,139
KEBELE 04	7,004	3,500	3,504	1,858	1,785
ADAMA SPECIAL-ZONE	220,212	108,872	111,340	62,259	60,157
ADAMA-TOWN	220,212	108,872	111,340	62,259	60,157
KEBELE 01	18,818	9,112	9,706	5,281	5,103
KEBELE 02	13,443	6,685	6,758	3,750	3,604
KEBELE 03	19,638	9,844	9,794	5,485	5,290
KEBELE 04	20,028	9,505	10,523	6,400	6,197
KEBELE 05	18,908	9,814	9,094	5,239	5,088
KEBELE 06	6,967	3,355	3,612	1,830	1,784
KEBELE 07	11,493	5,902	5,591	3,037	2,941
KEBELE 08	10,852	5,556	5,296	2,810	2,667
KEBELE 09	21,784	10,711	11,073	7,293	7,093
KEBELE 10	17,634	8,473	9,161	4,574	4,437
KEBELE 11	18,529	9,054	9,475	5,100	4,900
KEBELE 12	10,596	4,960	5,636	3,147	3,058
KEBELE 13	10,766	5,405	5,361	2,923	2,834
KEBELE 14	20,756	10,496	10,260	5,390	5,161

Source: CSA 2007.

Table 8: Adama City population projection

■ Table :- POPULATION GROWTH RATE AS ESTABLISHE BY CSA OF OROMIA (CSA 1994)

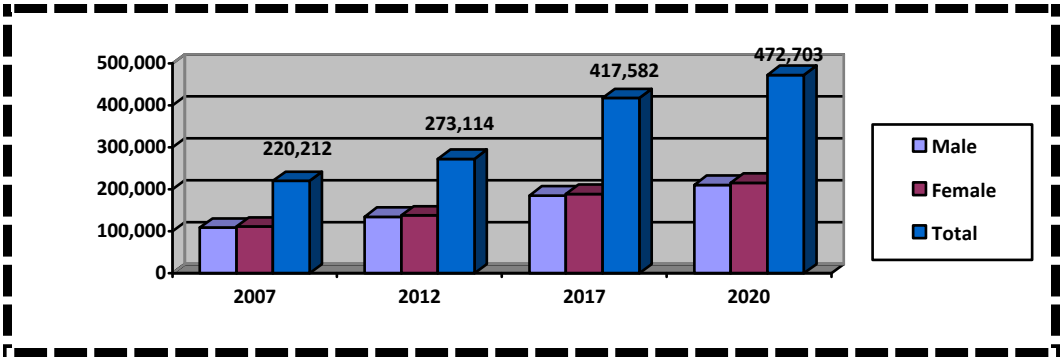
Category	Years							
	Growth rate in percent (%)							
	1995 - 2000	2000 - 2005	2005 - 2010	2010 - 2015	2015 - 2020	2020 - 2025	2025 – 2030	2030 – 2035
Urban	5.1	4.7	4.6	4.4	4.2	4.0	3.8	3.6*
Rural	2.8	2.6	2.4	2.2	2.0	1.7	1.4	1.1*

Adama City Total population projection					
Population	Unit	Year			
		2007	2012	2017	2020
Male	No	108,872	135,026	185,565	211,153
Female	No	111,340	138,087	189,361	215,473
SUM Residing in Adama	No	220,212	273,114	374,926	426,626
Rural and Floating				25,697	28,593
Adama University				16,959	17,484
SUM		**220,212**	**273,114**	**417,582**	**472,703**

Source: Computed/ reorganized from CSA 2007. June 2020

- N.B. But an official data was shows Adama City population was estimated more than half Million.The growth rate is considered to be 4.2 to 4.6 % in five years

Figure 17: Chart shows Adama City population projection



Source: Computed/ reorganized from CSA 2007. June 2020

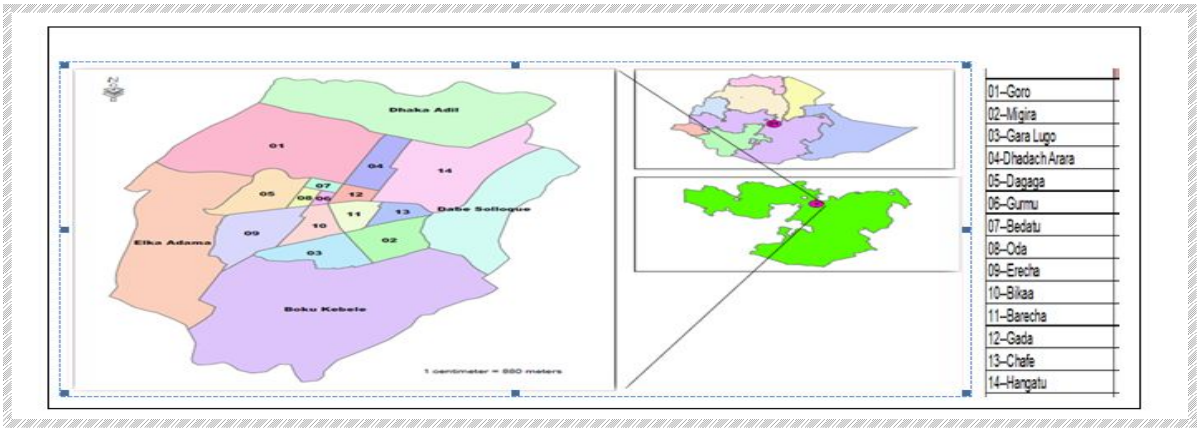
Table 9: Adama City population projection by Kebeles/Gendas

KEBELES		YEAR/POPULATION				
	2007			2012	2017	2020
	Male	Female	TOTAL	TOTAL	TOTAL	TOTAL
01--Goro	9,112	9,706	18,818	23,339	28,945	32,937
02--Migira	6,685	6,758	13,443	16,672	20,678	23,529
03--Gara Lugo	9,844	9,794	19,638	24,356	30,207	34,372
04-Dhadach Arara	9,505	10,523	20,028	24,839	30,807	35,055
05--Dagaga	9,814	9,094	18,908	23,450	29,084	33,094
06--Gurmu	3,355	3,612	6,967	8,641	10,716	12,194
07--Bedatu	5,902	5,591	11,493	14,254	17,678	20,116
08--Oda	5,556	5,296	10,852	13,459	16,692	18,994
09--Erecha	10,711	11,073	21,784	27,017	33,508	38,128
10--Bikaa	8,473	9,161	17,634	21,870	27,124	30,864
11--Barecha	9,054	9,475	18,529	22,980	28,501	32,431
12--Gada	4,960	5,636	10,596	13,141	16,298	18,546
13--Chafe	5,405	5,361	10,766	13,352	16,560	18,843
14--Hangatu	10,496	10,260	20,756	25,742	31,926	36,329
Dhaka Adi					8,027	9,134
Boku					8,458	9,624
Dabe Soloke					9,858	11,217
Elka Adama					9,859	11,218
SUM Residing in Adama	**108,872**	**111,340**	**220,212**	**273,114**	**374,926**	**426,626**
Rural and Floating					25,697	28,593
Adama University					16,959	17,484
SUM	**108,872**	**111,340**	**220,212**	**273,114**	**417,582**	**472,703**

Source: Computed/ reorganized from CSA 2007. June 2020

Based on figures from the 2007 Population and Housing Census results of Central Statistical Agency, this city has an estimated total population of 222,035 of whom 108,872 were males and were 111,340 females. In 1994 National Census report, this City had a total population of 127,842 of whom 61,965 were males and 65,877 were females. This shows the population of the city has grown by 74 percent.Now Currently in 2020 Adama City total population projection shows 472,703 Residing in Adama city in different ways that was out of total permanently residing in Adama city 426,626 population of whom 211,153 were males 215,473 were females others around 28,593 are rural and floating and around 17,484 estimated residents of Adama University.

Figure 18: Adama City Kebeles/Genadas orientation



Source: Own data, June 2020

Population Size: Population is the central part of planning as the purpose of planning is to satisfy peoples need. It is, therefore, crucial to have reliable data on the current as well as future population size of the Adama City since the number of housing units and social services required to address the current as well as the future demand of the local population depends on the population size that the Local or Action Area can accommodate.

According to the survey, the total number of households in the project site has been counted to be close to 94,415. Taking in to account the average household size (5) of the Adama City which is obtained based on sample of households, the current (during study time) population size of the Action Area has been estimated to be about 472,073.

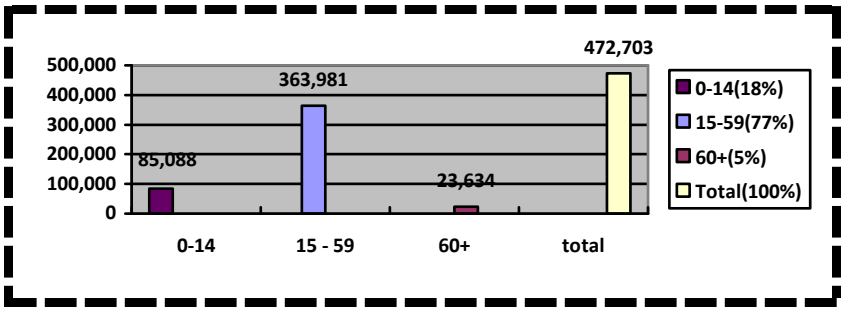
Sex composition: Sex is one of the demographic variables, which is essential in demographic analysis. As it is explained above, the total current population size of the project site is about 472,073. Out of 472,073 residents in the project site, the proportion of male and female has been estimated to be close to 49.54%(234,192) and 50.46 percent(238,511), respectively, the proportion of females being larger than that of male .

Age Composition: Age is another important demographic variable. Most of the demographic information in use is expressed in terms of the age at which something happens; for example when an individual leaves school, enters employment or dies. Age data provides an indispensable basis for estimating:

- Manpower potential;
- Economic dependency ratio; and,
- Potential school age population.

Most demographic analysis on age structure is conducted by classifying population size by five year age group. Accordingly, an attempt has been made to present distribution of the population of the project site by broad age group as stated in table below. As can be seen from this Table, the classification of the population by broad age group showed close to 22.26 percent of the total current population of the site to be aged below 15 years. The population in the age group 15-59 and 60 years and above has constituted 78.43 and 5.82 percent, respectively.

Figure 19 Age Composition of the Residents



Source: Own Survey. June 2020

4.5. Economic Aspects:

The positive impact of the water supply development project on socioeconomic improvement is significant. Even though it is not measured easily, the benefit of the project will raise the living standard of beneficiaries and create productive force.

However, thepossible adverse effects of implementation of project are as follows, but not limited to:

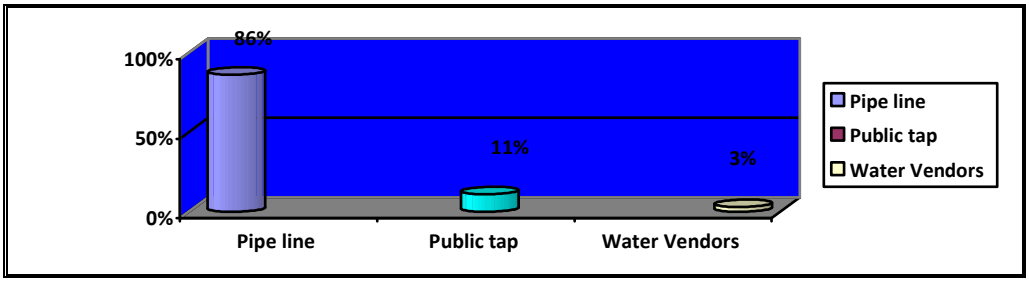
- ❖ Loss of cultivation land around water source area, reservoir and pipe line.
- ❖ Rearrangements of public utilities such as road and like, as the pipe line crosses and pass through.

Characteristics of survey respondents --1

As depicted in Table above, out of 166 interviewed sample households, 61% were female and the rest are male. The age range distribution of the respondents showed that 16% of them were in 20 to 30 age groups, 31% were in 31 to 40 age groups and the remaining were above 41. Concerning the educational level of the respondents, 2% were illiterate, 73% had formal education and 25% had informal education.

Figure 20 Chart shows Sample households' characteristics (Primary water source),&

Table 10 .Water supply connection,



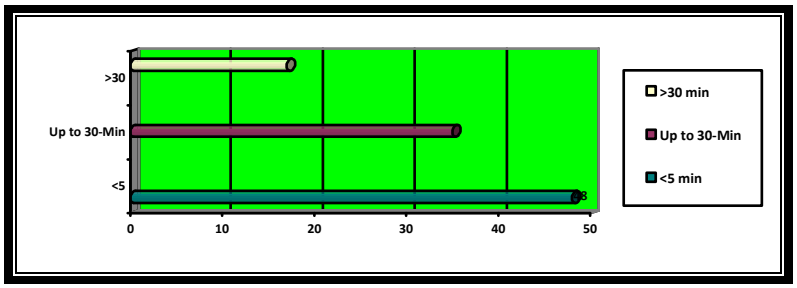
Description	Variables	Frequency	Percent
Primary water source for the household	Pipe line connection	142	86%
	Public tap	19	11%
	Water Vendors	5	3%
Distance from the water source to residence(m)	Up to 10	82	52%
	Up to -50	37	23%
	50-100	26	16%
	100-200	3713	8%
	>200	7	5%
Average time spent to collect water Minutes	<5	80	48%
	Up to 30-Min	58	35%
	>30	28	17%
How much water do you use on average per person per day in liter	Use <20 L/p/day	6	4%
	20-30 liter/p/day	36	22%
	30-50 liter/p/day	92	55%
	>50 liter/p/day	32	19%

Source: Sample survey June 2020

Out of the total interviewed sample households in Adama City, 86% obtained water from Pipe line connection regardless of its frequency, 23% used water from public tap and the remaining got water from water vendors. The survey result revealed that majority of the respondents (52%) travelled less than 10 m to collect water from Pipe line connection. Some of them (23%) reported distances up to 50 m, 16% from 50 to 100 m, and 8% from 100 to 200 m while the remaining (5%) reported

distances from more than 200 m from their residence. Similarly, some of the respondents (17%) spent more than 30 min to collect drinking water, 48% of them < 5 min, the rest 35% spent from 5 to 30 min (above Tables). An estimate reveals that about 52% of Ethiopian population travelled half an hour or more to collect water every day (CSA, 2006).

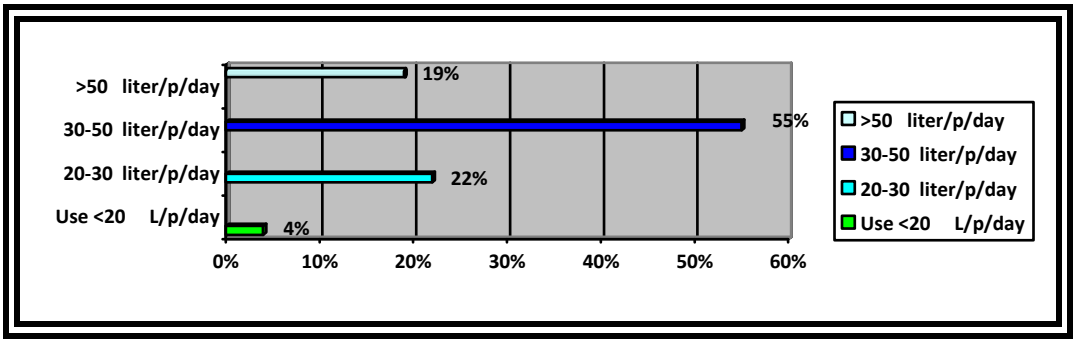
Figure 21 Chart shows Sample households' characteristics (Average time spent),



Source: S. survey.June 2020

Characteristics of survey respondents –2

Figure 22 Water supply **Status *accessibility* to *sources***,



Source: Sample survey (2020).

Regarding the per capita water requirement, majority (55%) of the respondents reported that they use less than 30-50 L of water per capita per day & the remaining (26%) of the respondents reported that they use less than 30L of water per capita per day which is less than the recommended standard. African Water Development Report (2006) estimated that to ensure the basic water needs of humans, 80-100 L of water free from harmful contaminants are needed every day. According to Ministry of Water, Irrigation and Energy (MoWIE) (2011), basic access of water for urban dweller is 80-100 L per capita per day within 0.5 km service radius in universal access plan. On the other hand, as per WHO (2008), the basic access of water is 20 L per capita per day within 100 m to 1 km and the average time spent to collect water is 5 to 30 min. More than 1 km of travelling distant in search of water is said to be no access.

Table 11. Drinking Water supply satisfaction & fairness,

Description	Variables	Frequency	Percent
Are you satisfied in the current potable water supply of the city?	Yes	7	4%
	No	159	96%
How often do you get Water for your consumption?	Always	22	13%
	Once in day	28	17%
	Once in 1-2 days	32	19%
	Once in 3-4 days	26	16%
	Once in 4-5 days	24	14%
	Once in a week	22	13%
	More than 1 week	12	7%
Is their fair water distribution	No	87	52%
	Yes	79	48%

Source: Sample survey June 2020

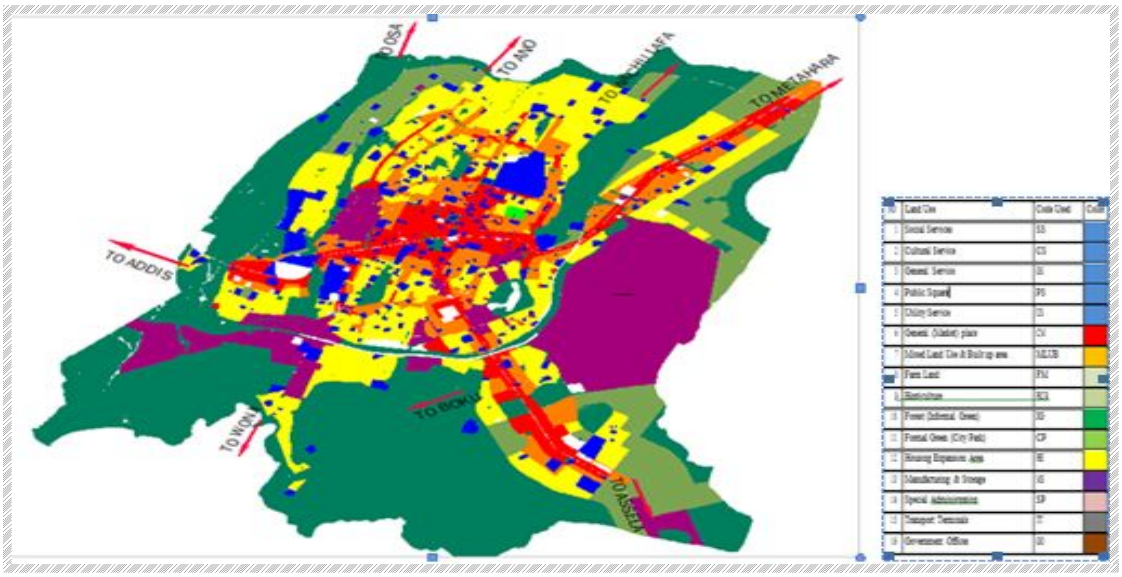
Characteristics of survey respondents –3

Regarding the satisfaction & fairness thus, majority of households did not satisfies to basic access of water for their domestic needs. It implies that water accessibility standards are not well exercised in the city. Bartram and Howard (2003) underlined that adequate and reliable water supply is critical for coping with every day urban life. Poor access to potable water has negative day urban life. Poor access to potable water has negative impact on development. Challa (2011) also indicated that, poor access to water supply and sanitation limits opportunities to escape poverty and exacerbates the problems of vulnerable and marginalized groups. As depicted in Figure above, the city residences use 'Garis' carts and yellow plastic jars 'Jerikans' to fetch water from long distances and some organizations and hotels also use lorries to meet their water demand from public taps.

4.6. Development Plan and prospects

A master plan or equivalent proposed plan of the project area is very important for demand forecasting as well as in laying out different water supply components like the distribution line, service reservoirs, and pumping stations. Adama City has a recently revised master plan which is fundamental for its present and future socio-economic development prospects.

Figure 23 development plan of Adama city



Source:-Computed/ reorganized from Adama City Administration. June 2020

4.7. Concept Development

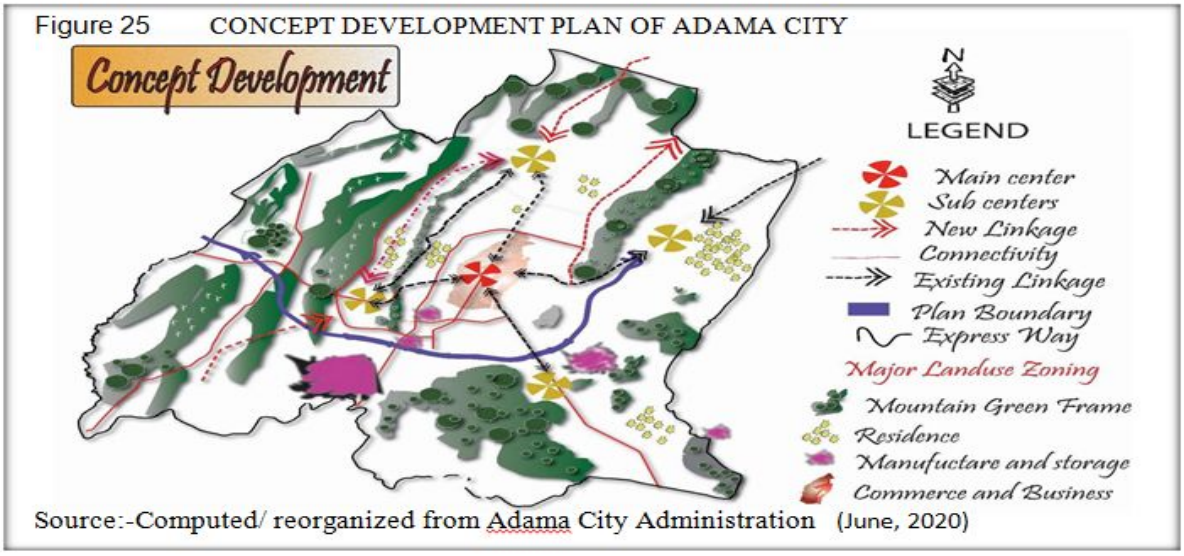
Some of the Principles followed for concept plan preparation identification of the spatial development trend of the City; Indication of the existing built-up area showing main elements (Manufacturing and storage, Services, administration, Commercial activities, Residential area), indication of the future development/ expansion areas incorporating main elements (to all out let), indicate major roads integrating future expansion areas and existing built up area, indicating main center and sub-centers clearly.

Accordingly, Derartu square /Aba Gada is the main center that was identified and four sub centers were seen based on the conceptual analysis of existing development of the city, distance from the main center as well as the potential expansion direction. The four sub centers found at Assela outlet, at the center of Bole Sub City, at Adds Ababa outlet to Aba Gada conference hall and Sub center at the Harar outlet. Based on the above Conceptual development plan or guide line Adama City it is better to propose future Utilities design with integrated manner by adjoining with master plan or

equivalent proposed structural plan of the city is very important for future expansion, development planning, investment attraction as well as in laying out different water supply components like the distribution line, service reservoirs, and pumping stations. Adama City has a recently revised master plan which is fundamental for its present and future socio-economic development prospects.Accordingly, based on the above detailed bold concepts, the concept map on which the proposal abased on is indicated as follows.

Figure 24 CONCEPT DEVELOPMENT PLAN OF ADAMA CITY

Figure 25 CONCEPT DEVELOPMENT PLAN OF ADAMA CITY



Source:-Computed/ reorganized from Adama City Administration (June, 2020)

4.8. Water supply satisfaction

Most countries give first priority to satisfaction of basic human needs for water. The service deficiencies primarily affect the poorest segments of the population in developing countries. This survey result showed that out of the total respondents, about 96% are dissatisfied with the current service due to frequent interruption and unfair distribution of water whereas the rest reported that they are satisfied with the services. Of the total interviewed respondents, 13% obtained tap water once a week. In some cases, the water may not be available due power supply interruption. While expanding improved water source schemes is generally essential, it is equally important to ensure that the schemes have increased users' satisfaction with water quality and availability for everyday use (UNICEF, 2010). The majority of the sample households replied that the water distribution is unfair and variable. As reported by respondents, some area may be served water frequently while other areas stay without water service at all. Consequently, the city water supply service enterprise should devise a mechanism so as to minimize the inequitable distribution of water among the residents of the city.

4.9. Level of Water Supply Services

The level of water supply service greatly affects the water demand of the users. If the level of the service is excellent as house connection, the demand for water is also very high due to consumption for multipurpose such as toilet flushing, laundry machines and bathing rooms. The water demand of the users is decreasing as the level of the water supply decreases. Commonly there are four categories mode of services namely: - yard connections, public tap connections and house connections. But, according to MWR 2006, p, 14 the mode of services is divided in to four categories. In general, the level of service to be provided to consumers depends on the social and economic development of the community. Consequently, the following common three types of service levels have been adopted for urban canters of Ethiopia.

i. House Connections (HC);

ii. Yard Connections (YCP & YCS); And

iii. Public Fountains and Neighborhood Taps (PF)

Table 12 Modes of Services by Percentage for year 2018/19

Mode of service	Percent of Population Served In Adama City
HC	21%
YCO	39%
YCS	30%
PT	10%
Total	100%

Source:- Computed/ reorganized from Adama City WSSSE June 2020

4.10. Water Demand Analysis

4.10.1. Per-capita Water Demand

The amount of water used per person per day for daily life and activity is known as per capita water demand which uses as a base for estimating the domestic water demand of communities. It is a function of daily basic needs but should be adjusted by socioeconomic development and climatologic factors. The estimated per capita demand to be used for this project has been adopted from the detail design guide line of The Federal Democratic Republic of Ethiopia (FDRE) Ministry of Water, Irrigation & E for water supply projects with Adama adjustments for some of the figures that could reflect the actual physical and socio-economic features of the area. For the present population the average per capita water demand considered is 80 to 100 lit/ capita / day taking the per capita water consumption growth rate of 0.5% per annum, the water demand per head.The per-capita domestic water demand for various mode of service varies depending on the various climatic, social and economic factors explained in previous section. According to (MW, 2006, p. 14) Design criteria the initial and final stage of demand for mode of service is summarized as shown below.

Table 13 Per-capita demand by mode of service

Categories of consumer	Stage 1	Stage 2
- House connection (HC).	50 l/c/day	70 l/c/day
- Yard connection, own (YCO).	25 l/c/day	30 l/c/day
- Yard connection, shared (YCS).	30 l/c/day	40 l/c/day
- Public tap supplies (PT).	20 l/c/day	25 l/c/day

Source: MWR, 2006, Urban water supply design criteria June 2020

Table 14 Town Population size and average per-capita demand

Town Category	Population size	Per-capita demand
1	>1000000	100
2	100000 – 1000000	80
3	50000 -100000	60
4	20000 – 50000	50
5	<20000	40

Source: GTPII water Sector document June 2020

Since, GTPII standard doesn't show per-capita demand breakdown by mode of service based on the table above the following steps were followed to modify per-capita demand for this design. Base and end design year population of the city are determined and projected. Using the base and

end year population projection the average per-capita demand is determined. The Adama city base (current) is 472,703. From the table above the average per-capita demand for Adama city is then 80 l/c/d.Table above and average per-capita demand of GTPII is used to adjust the mode of service for the design period and summarized in the table below:-

Table 15 : Per-capita demand for Adama city MWR Design Criteria modified with GTPII

Mode of service	Design Period		
	2018	2019	2020
HC	80	80	80
YCO	50	65	67
YCS	65	65	67
PT	50	45	40

Source: MWR, 2006, Urban water supply design criteria June 2020

4.10.2. Domestic water demand

Adama city domestic water demand includes use of water required for various domestic needs such as drinking, cooking, bathing, washing, and etc. Moreover, peri-urban dwellers around the four corners of the City have been merged to Adama City since it has been already restructured and established by the Regional Government to higher level of special zonal administration.

Analysis of the distribution network has been conducted for two scenarios, i.e. the peak and minimum demands of 160% and Minimum hour demand respectively, as described in the forgoing sections.

Domestic water demand for a given year can be calculated

Domestic water demand = (total no of population) x (individual water consumption rate)

Accordingly, domestic water demand Adama city is calculated and presented by assuming all of the total populations at every year are beneficiary from the system.

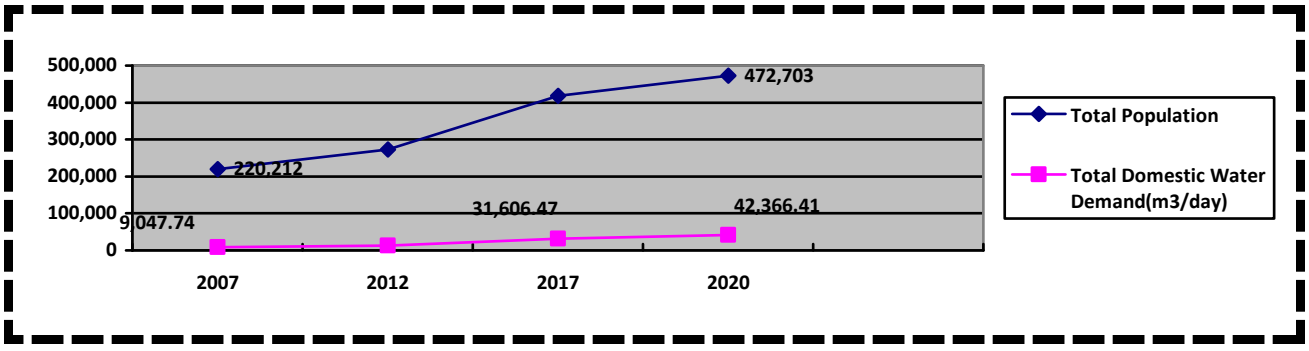
4.10.3. Summary of Domestic Demand

Table 16 **Domestic Water Demand**

ADAMA CITY -DOMESTIC WATER DEMAND ANALYSIS					
Population	Unit	Year			
		2007	2012	2017	2020
Male	No	108,872	135,026	185,565	211,153
Female	No	111,340	138,087	189,361	215,473
SUM Residing in Adama	No	220,212	273,114	374,926	426,626
Rural and Floating				25,697	28,593
Adama University				16,959	17,484
SUM		**220,212**	**273,114**	**417,582**	**472,703**
Percentage of Population Served by:-					
HC	%	13	15	21	22
YC	%	37	40	54	68
PF	%	50	45	25	10
Population by Service Level					
HC	No	28,627.56	40,967.05	87,692.22	103,994.60
YC	No	81,478.44	109,245.48	225,494.28	321,437.86
PF	No	110,106.0	122,901.16	104,395.50	47,270.27
Per Capita Demand					
HC	lpcd	55	60	80	80
YC	lpcd	35	35	60	67
PF	lpcd	20	22	25	25
Demand by Service Standard					
HC	m3/d	1,574.52	2,458.02	7,015.38	8,319.57
YC	m3/d	2,851.75	3,823.59	13,529.66	21,536.34
PF	m3/d	2,202.12	2,703.83	2,609.89	1,181.76
Sub Total	m3/d	6,628.38	8,985.44	23,154.92	31,037.66
Climatic Factor (Say 1.3 for 20-25^{0}C)	Combined Factor (1.3*1.05)=	1.365	1.365	1.365	1.365
Socio-economic Factor (Say 1.05)					
Total Domestic Water Demand	m3/d	9,047.74	12,265.13	31,606.47	**42,366.41**

Source: MWR, 2006, Urban water supply design criteria June 2020

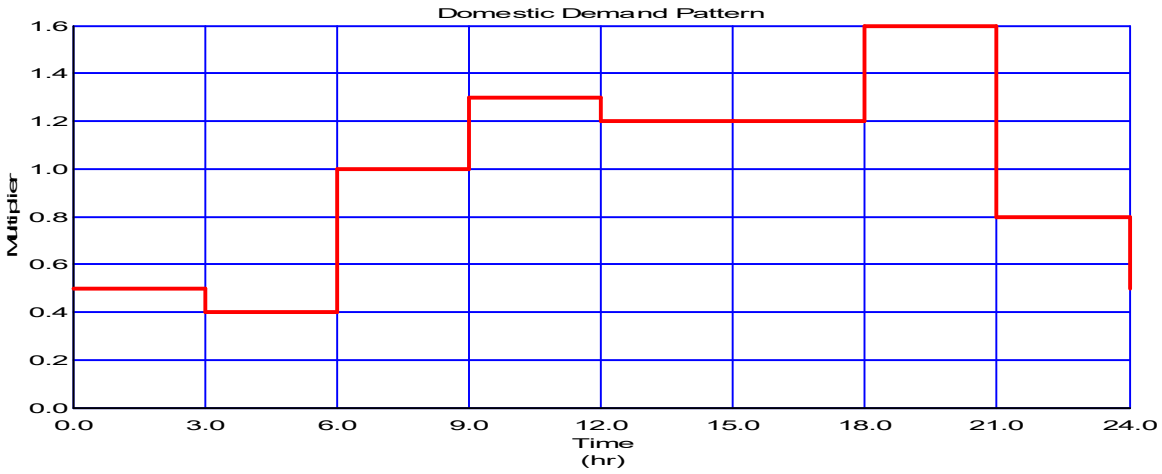
Figure 25: Summary of Domestic Demand



Source: MWR, 2006, Urban water supply design criteria June 2020

The total domestic demand was obtained by multiplying the per-capita per day demand with population and applying the socio-economic and climatic adjustment factors as shown in the following table

Figure 26: Peak and Minimum hour consumption pattern



Source: Own data June 2020

The peak hour demand is analyzed to verify that the sizes of network pipes are sufficient to provide the minimum required pressure at all demand points. The minimum hour demand is analyzed for evaluation of pipe material and strength of the network. Consequently, the peak hour demand of each distribution zone will be from 6-7 O'clock in the morning when most people gets up for daily business, whereas the minimum consumption will be from 23 to 2 hours in the night (see Figure below Recommended Domestic Water Demand usage pattern).

Table 17 PROJECTION OF MODE OF SERVICES

URBAN PER-CAPITA PER DAY WATER DEMAND IN LITERS (As per Urban Water Supply Design Criteria of The Federal Democratic Republic of Ethiopia(FDRE) Ministry of Water, Irrigation & E., January ,31, 2006)

Activity	*2016*			*2017*			*2018*			*2019*			*2020*		
	HC	*YC*	*PF*	*HC*	*YC*	*PF*	*HC*	*YC*	*PF*	*HC*	*YC*	*PF*	*HC*	*YC*	*PF*
Drinking	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Cooking	5.5	4	4	5.5	4	4	5.5	4	4	5.5	4	4	5.5	4	4
Ablutions	11	7	7.5	11	7	7.5	11	7	7.5	11	7	7.5	11	7	7.5
Washing Dishes	6	5	2.5	6	5	2.5	6	5	2.5	6	5	2.5	6	5	2.5
Cloth Washing /Laundry	12	8	7	12	8	7	14	8	7	14	8	7	14	8	7
House Cleaning	5	3.5	2.5	5	3.5	2.5	6	3.5	2.5	6	3.5	2.5	6	3.5	2.5
Bath & Shower	14	7		14	7		15	7		15	7		15	7	
Toilets	7	4		7	4		7	4		7	4		7	4	
Others(Garage, laboratories…	3			3			3			3			4		
Total Domestic Demand	**65**	**40**	**25**	**65**	**40**	**25**	**69**	**40**	**25**	**69**	**40**	**25**	**70**	**40**	**25**

DOMESTIC WATER DEMAND = Population * 100 l/c/d /24/3600 = in l/s,

PUBLIC WATER DEMAND= 25-40 l/c/d

Source: Computed MWR, 2006, Urban water supply design criteria June 2020

4.10.4. Non- Domestic Water Demand

The non- domestic water demand includes use of water for public services, commercial, animals water demand and unaccounted - for water.. Beside this industrial water demand are not considered.

The non- domestic Water Demands normally include the following categories

a. Industrial Water Demand,
b. Commercial and Public Water Demands
c. Livestock Water Demand,
d. Unaccounted For Water (UFW) and Water Demand for Fire Fighting

We have considered Livestock water demand, commercial & public water demand and unaccounted for water for this particular project. All water leakages in the system and unauthorized connections are categorized under UFW. For urban and complex system, it is usually taken as 15 to 25 % of the total water demands depending on the condition and management of the system. In our case UFW was assumed to be 15% of the total water demand for Detail Design of Adama City Water Supply Project.

The water required for School, hospital, hotels, public facilities, Parks, Offices, Commercial establishments, military Camps, small-scale industries and etc. are included in Commercial & Public demand category. Commercial & Public demand is usually expressed as a percentage of the average day domestic demand. As a guide 10% to 20% of domestic water demand is recommended for public demand. For this specific project considering the future growth of Adama City 20% of domestic demand was considered for commercial & public demand.

As per Urban Water Supply Design Criteria of MW, 2006 the review will assess the extent and development of the institutional and commercial base in each City and vary the likely daily demand, if necessary, based on the following consumptions:

Table 18 The daily demands of different consumptions is as follows

Restaurants	10 l/seat	Abattoir	150 l/cow
Boarding school	60 l/pupil	Hospitals	50 - 75 l/bed
Day schools	5 l/pupil	Hotels	25 -50 l/bed
Public offices	5 l/employee	Public Bath	30 l/visitor
Workshop/shops	5 l/employee	Railway & Bus station	5 l/user
Mosques & Church	5 l/worshipper	Military Camps	60 l/person
Cinema house	4 l/seat	Public latrines (with water facility connection)	20 litres/seat

Source: Computed MWR, 2006, Urban water supply design criteria June 2020

4.10.5. Institutional Water and Commercial Demand

Institutional water demand includes demands for schools, university, hospitals, health center, government offices and services, religious institutions and other public facilities. Similarly, water demand required for restaurants, shopping centers, local drinks, and other commercial purposes, is classified as commercial water demand. Both water demands are termed as public water demand. Accurate calculation of public demand hardily possible due to various factors and there are various approaches to estimate public demand. Based on the design Criteria set by Ministry of Water, 2006 the calculation of public demand is shown below.

Table 19 Public Water Demand for Adama City

Public Employee Water Demand

Business Type	QTY	No of employees	PCD l/d	Total Demand L/d
Banks	114	1880	5	9,400
Insurance	22	140	5	700
Credit & Saving	13	122	5	610
Telecom offices	1	324	5	1,620
Utility office	3	445	5	2,225
Power utility	1	280	5	1,400
Other public offices	1	5400	5	27,000
Military Camp	1	370	60	22,200
Total				**65,155**

Hotel & Restaurants Water Demand

Type of Institution	Number	No of bed/No. employee	PCD l/d	Total Demand L/d
Hotel	244	7600	40	304,000.00
Restaurants	587	98000	10	980,000.00
Cafe	622	65000	10	650,000.00
Pension	280	6220	30	186,600.00
Night club	55	8500	5	42,500.00
Photo shops	32	120	5	600.00
Workshops/shops	65	1500	5	7,500.00
Total				**2,171,200.00**

Source:- (Raw data (Number) computed/ reorganized from Adama city Administration previous report).

Considering the public demand calculation based on the actual socio economic data of Adama City, the public demand (institutional and commercial demands) is calculated is about 15% of the Domestic demand, for safety a higher percentage of public demand is taken which is 20% of domestic demand.

A. Public Water Demand

Public water demand is the total volume of water used for schools and other public services. Practically, the total volume required for public demand is about 10% of the domestic demand.

University, colleges, TVET and other educational institutes have been flourished There are around 283 Educational Institutions. The first and secondary level schools have over 127, 883 students while colleges have more than 18,774 regular and evening students. The number of health service institutions has been increasing over the past years. A total 119 Public and Private Health Institutions have been established so far.

There are more than 98 religious institutions of which 52 mosques 46 Orthodox churches and 28 evangelical churches are found in Adama. There are also about 11 categories of sporting entities organized under 122 different clubs are in the city. Four stadiums are found in Adama city to entertain various sporting events.

Table 20 Basic social Infrastructure Water Demand

Basic social Infrastructure Water Demand / schools

Type of Institutions	Number of school available in the City & students			
	No of schools	No. of students	PCD l/d	Total Demand L/d
KG	116	18492	5	92460
1 to 8	108	65692	5	328460
9 to 10	24	15335	5	76675
11 to 12	9	6737	5	33685
10+3 (TVET)	8	2711	5	13555
University	1	16959	60	1,017,540.00
Private University	7	1515	5	7575
Boarding School	1	442	60	26520
Total				
		Grand Total		**1,596,470.00**

Bus Stations Water Demand

Type of Institution	Number	No. of Visitors	PCD l/d	Total Demand L/d
Bus Stations	2	35000	5	175000
Total				**175,000.00**

Abattoir Water Demand

Type of Institutions	Number	No. Cow	PCD l/d	Total Demand L/d
Abattoir	1	500	150	**75,000**

Health Institutions Water Demand

Type of Institutions	Number	No of bed	PCD l/d	Total Demand L/d
Hospitals	6	481	60	28860
Private clinics	101	5300	30	159000
Health centers	12	1560	25	39000
Total				**226,860.00**

Religious Organizations Water Demand

Type of Institutions	Number	No of visitor	PCD l/d	Total Demand L/d
Mosques	52	7,000	5	35,000.00
Church	46	8,000	5	40,000.00
Total				**75,000.00**

Basic social infrastructures Water Demand

Type of Institutions	Number	No of Seat/Visitor	PCD l/d	Total Demand L/d
Communal shower	10	150	25	3750
Communal toilets	16	96	10	960
Total				4710

Summary of Public Water Demand

	Total Demand L/d	Total Demand m3/d
Total	**4,389,395.00**	**4,389.40**

Source:- computed from Adama city Administration previous report June 2020

B. Commercial Water Demand

Commercial water demand is the total volume of water used for Hotels, Restaurants, Tearooms and other public services. Practically, the total volume required for Commercial demand is about 5- 10% of the domestic demand. Trade plays a significant role in the economy of Adama City. There are around Public around 156 which have around 8,961 employees & around 26,160 legal traders though the existences of considerable illegal traders are inevitable. Industrial activities have been increased. Around above 242 industrial establishments are found in the City. Around 885 ha of land or 15% of the Master Plan have been reserved for industries. The recently built infrastructures, High way ,Gelma Aba Geda hall , Memorial Monument, Industrial park and all the aforementioned triggers have resulted in tremendous increase in Water Demand Requirements of Adama City.

Table 21 Commercial and Public Water Demand

Commercial and Public Water Demand				
i. Public Employee Water Demand				
Business Type	**QTY**	**No of employees**	**PCD l/d**	**Total Demand L/d**
Banks	114	1880	5	9,400.00
Insurance	22	140	5	700.00
Credit & Saving	13	122	5	610.00
Telecom offices	1	324	5	1,620.00
Utility office	3	445	5	2,225.00
Power utility	1	280	5	1,400.00
Other public offices	1	5400	5	27,000.00
Military Camp	1	370	60	22,200.00
Total		**8,961.00**		**65,155.00**
II. Hotel & Restaurants Water Demand				
Type of Institution	**Number**	**bed/No. employee**	**PCD l/d**	**Total Demand L/d**
Hotel	244	7,600.00	40	304,000.00
Restaurants	587	98,000.00	10	980,000.00
Cafe	622	65,000.00	10	650,000.00
Pension	280	6,220.00	30	186,600.00
Night club	55	8,500.00	5	42,500.00
Photo shops	32	120.00	5	600.00
Workshops/shops	65	1,500.00	5	7,500.00
Total				**2,171,200.00**

Source:- computed from Adama city Administration previous report June 2020

*C. **Livestock Water Demand***

Urban farms have started to be expanded in a large scale. Cattle fattening is a major practice in Adama City. Around 141,679 cattle are kept daily for fattening and milk production purposes.

When animal watering is to be allowed for, the following specific demands will be adopted :(As per Urban Water Supply Design Criteria of The Federal Democratic Republic of Ethiopia(FDRE) Ministry of Water, Irrigation & E., January ,31, 2006)

Table 22 Adama City Livestock Water Demand

ADAMA Livestock Water Demand			
Types Animals	Water Consumption Rate (l/d)	No Of Animals	Water Required (m3/d)
		2020	
Cattle	50	101154	5057.7
CamelCamel (150 l/head/month)	5	4092	20.46
Goat	10	17012	170.12
Horses Gari/ Donkey	50	12432	621.6
Sheep	10	6989	69.89
TOTAL LIVESTOCK WATER DEMAND			**5939.77**
Supply 50%		**141679**	**2969.885**

Source:- computed from Adama city Administration previous report June 2020

D. Unaccounted (or non-revenue) - For Water

Unaccounted-for water (UFW) is expressed as a percentage of the total water produced for the system. Unaccounted - for water includes all water losses in the water supply system, over flow & other losses. Here, about 10-20 % of the total domestic demand is considered.

UFW cannot be assessed easily without adequate and reliable metering. Others have estimated that in Addis Ababa some 25% to 30% of the water produced might be unaccounted for. The situation in the other City may be even worse given the generally lower levels of maintenance. A figure of 50% would not be without precedent. As per Urban Water Supply Design Criteria of The Federal Democratic Republic of Ethiopia (FDRE) Ministry of Water, Irrigation & E., January, 31, 2006 a figure of 15% is generally regarded as good, and uneconomical to try and reduce.

Table 23 Adama City Unaccounted (or non-revenue) - For Water

Losses as % of Production				
Start year	5 years	10 years	15 years	20years
40%	35%	30%	27.5%	25%

Source: Computed MWR, 2006, Urban water supply design criteria June 2020

E. Water Demand for Fire Fighting

As per Urban Water Supply Design Criteria of The Federal Democratic Republic of Ethiopia (FDRE) Ministry of Water, Irrigation & E., January, 31, 2006 fire hydrants shall be installed at public and municipality interest such as schools, shops, hospitals, fuel stations and at salient points of distribution network. This demand is taken off by increasing the volume of the storage tanks by 10 %. Here, about **10 %** of the total domestic demand is considered for Fire Fighting.

Table 24 **Summary of Non Domestic Water Demand**

SUMMARY OF ADAMA CITY - NON-DOMESTIC DEMAND CALCULATION		
	Total Demand L/d	Total Demand m3/d
Total	4,389,395.00	4,389.40

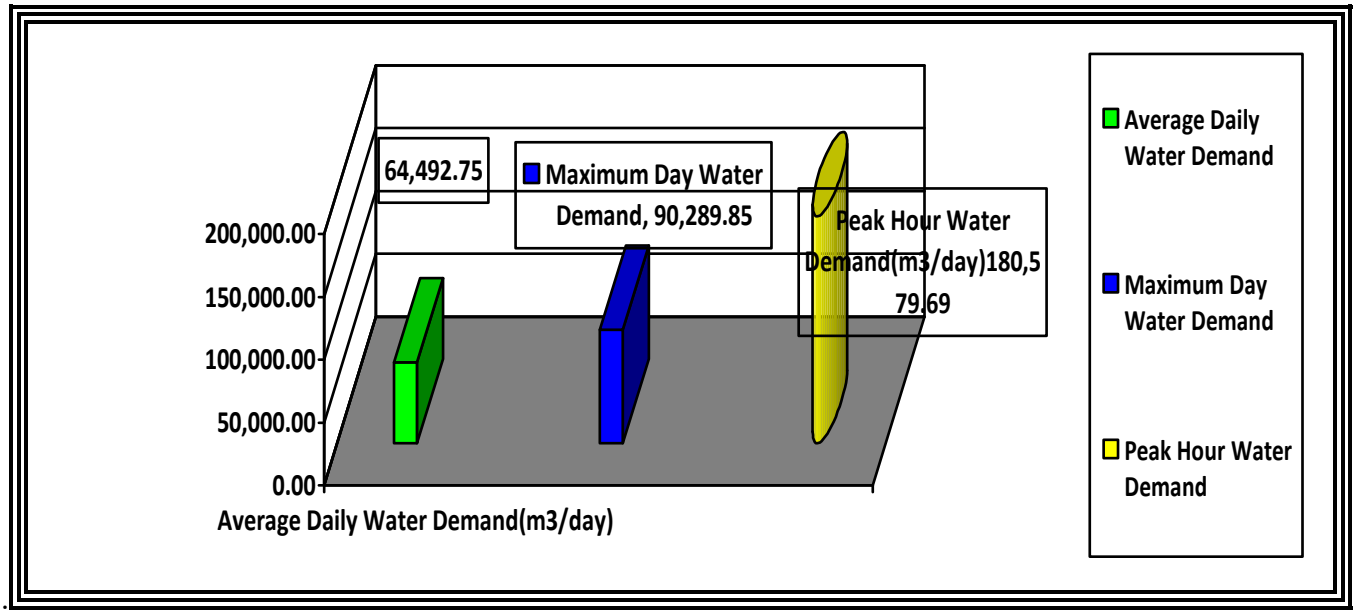
Source: Computed MWR, 2006, Urban water supply design criteria June 2020

4.10.6. Water demand and Design factors

The water demand factors are applied to average day, maximum day and peak hour demands. These demand types are defined in the design guide line of Urban Water Supply Design Criteria of The Federal Democratic Republic of Ethiopia(FDRE) as follows:

- ***Average day demand***: this is obtained by simply summing up the domestic and non-domestic demands as well as unaccounted for water (*UFW*).
- ***Total average daily water demand*** The total average daily water demand is taken as the summation of domestic, public and water losses.
- ***Maximum day demand***: is the highest demand of any one 24-hour period over any specified year. It represents the changes in demand with season and some special events happening in any specified year. The maximum day demand is obtained by multiplying the average day demand with the maximum day factor.

Figure 27 **Water demand and Design factors Adama City**



Source: Own Data June 2020

- The maximum day water demand is considered to meet water consumption changes with season and weeks day. It is determined by multiplying the total average daily demand by a factor of 1.2 to 1.6 depending on local situation. For this particular site a factor of 1.4 is adopted.
- ***Peak hour demand***: is the highest demand of any one-hour over the maximum day. It represents the daily variations in water demand resulting from the behavioral patterns of the local population. The peak hour demand is obtained by multiplying the average day demand with the peak hour factor.
- The peak hour water demand is equivalent to 1.4 to 2.0 times (depending on local situation) the average daily water demand or 1.5 times the maximum daily water demand. A factor of 1.6 (to be multiplied by average daily water demand) is adopted for this particular site.

4.11. Design flows and water supply system capacity

The design guideline of FDRE Ministry of Water Resource , Urban Water Supply Design Criteria January 31, 2006 for water supply projects describes that all water supply system physical components or facilities i.e. sources, pumping stations, treatment plants, transmission and distribution mains, and storage reservoirs must have sufficient capacities to meet reliably the water demand requirements of its customers.

These water demand requirements also termed as design flows are worked out and estimated and summarized in table below.

Table 25:- **Summary of Design Flows**

Design Flows	**Unit**	**Year**			
		2007	**2012**	**2017**	**2020**
Average Day Demand (ADD)	**m^3/day**	16,702.77	22,456.98	50,667.04	**64,492.75**
	l/s	193.32	259.92	586.42	746.44
Maximum Day Factor		1.40	1.40	1.40	1.40
Peak Hour Factor		2.00	2.00	2.00	2.00
Maximum Day Demand (MDD)	**m3/day**	23,383.88	31,439.77	70,933.85	**90,289.85**
	l/s	270.65	363.89	820.99	1,045.02
Peak Hour Demand (PHD)	**m3/day**	46,767.75	62,879.53	141,867.71	**180,579.69**
	l/s	541.29	727.77	1,641.99	2,090.04

Source: Own Data June 2020

Note: $Q_{avg\ day}$ (Average Daily Water Demand) = **64,492.75** m^3/ day = **746.44** lit/sec

$Q_{max\ day}$ (Maximum Daily Water Demand) =**90,289.85**m^3/ day = **1,045.02**lit/sec

$Q_{peak\ day}$ (Peak Hour Daily Water Demand) = **180,579.69**m3/ day = **2,090.04** lit/sec.

The demand is large; hence storage facility with raising main & distribution system is required as shown above.

4.11.1. Summary of Water Demands

Table 26 **Summary of Water Demand**

Summary of Total Water Demands for Adama City					
Population/service Level	Unit	Year			
		2007	2012	2017	2020
Population	No	220,212	273,114	417,582	472,703
Percentage of Population Served by:-					
HC	%	13	15	21	22
YC	%	37	40	54	68
PF	%	50	45	25	10
Population by Service Level					
HC	No	28,627.56	40,967.05	87,692.22	103,994.60
YC	No	81,478.44	109,245.48	225,494.28	321,437.86
PF	No	110,106.0	122,901.16	104,395.50	47,270.27
Per Capita Demand					
HC	lpcd	55	60	80	80
YC	lpcd	35	35	60	67
PF	lpcd	20	22	25	25
Demand by Service Standard					
HC	m3/d	1574.52	2458.02	7015.38	8319.57
YC	m3/d	2851.75	3823.59	13529.66	21536.34
PF	m3/d	2202.12	2703.83	2609.89	1181.76
Sub Total	m3/d	6628.38	8985.44	23154.92	31037.66
Climatic Factor (Say 1.3 for 20-25^{0}C)	Combined Factor (1.3*1.05)=	1.365	1.365	1.365	1.365
Socio-economic Factor (Say 1.05)					
Total Domestic Water Demand	m3/d	9,047.74	12,265.13	31,606.47	**42,366.41**
Industrial Demand 5 to 10%(say 5%)	m3/d	452.39	613.26	1,580.32	2,118.32
Commercial and Public Demand (20 to 40%)	m3/d	1,809.55	2,453.03	4,740.97	4,389.40
Livestock Water Demand	m3/d	2,969.89	2,969.89	2,969.89	2,969.89
Water Demand for Fire Fighting 10 to 15%(say 10%)	m3/d	904.77	1,226.51	3,160.65	4,236.64
TOTAL WATER DEMAND	m3/d	15,184.33	19,527.81	44,058.29	56,080.65
Unaccounted For Water (UFW) 15 to 25%(say 15%)	%	10.00	15.00	15.00	15.00
Unaccounted For Water (UFW)	m3/d	1,518.43	2,929.17	6,608.74	8,412.10
Average Daily Water Demand	m3/d	16,702.77	22,456.98	50,667.04	**64,492.75**
Average Daily Water Demand	l/s	193.32	259.92	586.42	746.44
Maximum Day Factor		1.40	1.40	1.40	1.40
Peak Hour Factor		2.00	2.00	2.00	2.00
Maximum Day Water Demand	m3/d	23,383.88	31,439.77	70,933.85	**90,289.85**
Maximum Day Water Demand	l/s	270.65	363.89	820.99	1,045.02
Peak Hour Water Demand	m3/d	46,767.75	62,879.53	141,867.71	**180,579.69**
Peak Hour Water Demand	l/s	541.29	727.77	1,641.99	2,090.04

The total water demand was obtained by adding all domestic and non-domestic demands, and unaccounted for water and applying all demand factors mentioned in the previous section.

Source: Own Data June 2020

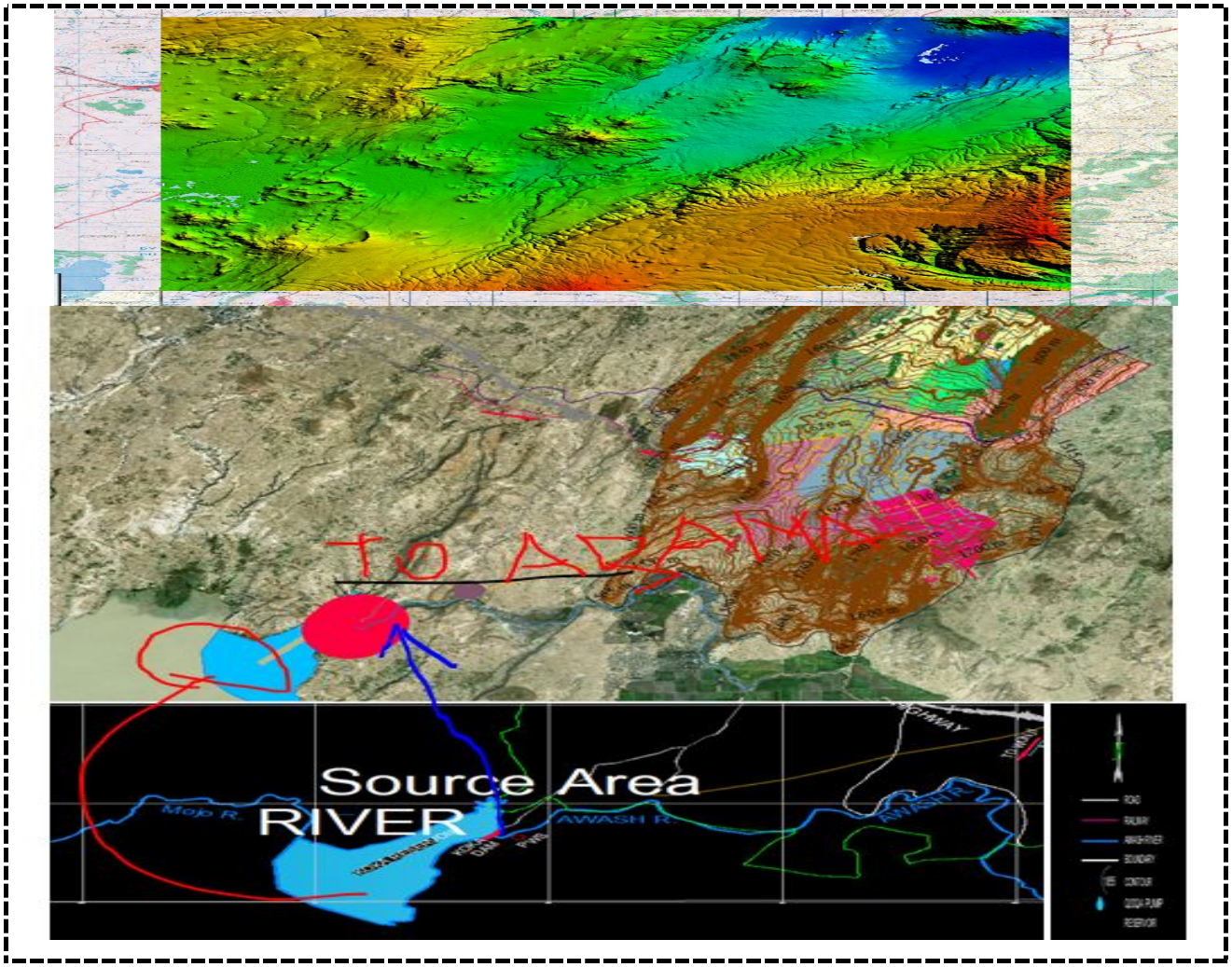
4.12. WATER SOURCES

4.12.1. Surface Water Source

ACWSSE raw data & site visit shows the water supply of the City is now supplied from Awash river but previously the boreholes drilled at various locations around the City in the radius of 11 km were rich in their fluoride content and children have suffered dental discolorations on top of the water scarcity due to rapid increase in water demand as the number of users frequently rises.

Due to the local recharge condition, slope of the area, nature of the geologic formation, and other local and regional factors, no local springs are shown in the area.

Figure 28 Adama City Water Source location



Source: Computed from Global Mapper & other software June 2020

4.12.2. Groundwater Resource

ACWSSE raw data & site visit shows it is seen from the local geological setting of the area, the water bearing capacity of the rock units is poor due to the surface permeability of the rocks exposed on the surface and underlying the thin alluvial sediments of clay nature at the uplands of the area; down flow interrupting nature of the intercalated marl and shale units at different depths; steep slope nature of the units exposed at the bank of the river valleys in both sides; the highly fractured and weathered properties of the rock units of the river banks that easily transmit the local recharges of the area which permit to outflow to the surface; and the other factors. Only the rock units underlying the river beds and the central equivalent formations of the same level are expected to be the potential water bearing units of the area that receive the regional and local flows of the area. The depth to these units is expected to be in the range of 450m to 700m which is uneconomical to drill and develop for the water supply source due to the challenges of operational management, the boreholes drilled at various locations around the City in the radius of 11 km were rich in their fluoride content and children have suffered dental discolorations water quality problem and other.

4.12.3. The Selected Water Source

After comparing the site conditions of the two options depending on the set criteria, general analysis was done for the thesis feasibility of the sources from the technical, financial and social point of view not only for the development period but also for the operation period. Based on the analysis result, there are two options according to the following order of priorities:

1. Up grading /developing the existing Source of Awash river.
2. Developing the Groundwater Resource by drilling boreholes. Accordingly, this existing Source of Awash River has been selected as a source for Adama City potable Water source. Currently the flow of the Awash River was estimated to be *410.94 lit/sec*, which is much less than the required Maximum Day Demand which is 1,045.02 lit*/sec.*

4.12.4. Conclusion of Water Resource

Up grading /developing the existing Source of Awash River was commented to be used as a source for Adama City potable Water source by ACWSSSE. Currently Awash River is used for irrigation farming by the inhabitants of downstream residents. This implies that shearing of Awash River for Adama City potable Water source creates more pressure on the river flow and this may lead to conflict of interest with the community using Awash river water for irrigation farming.

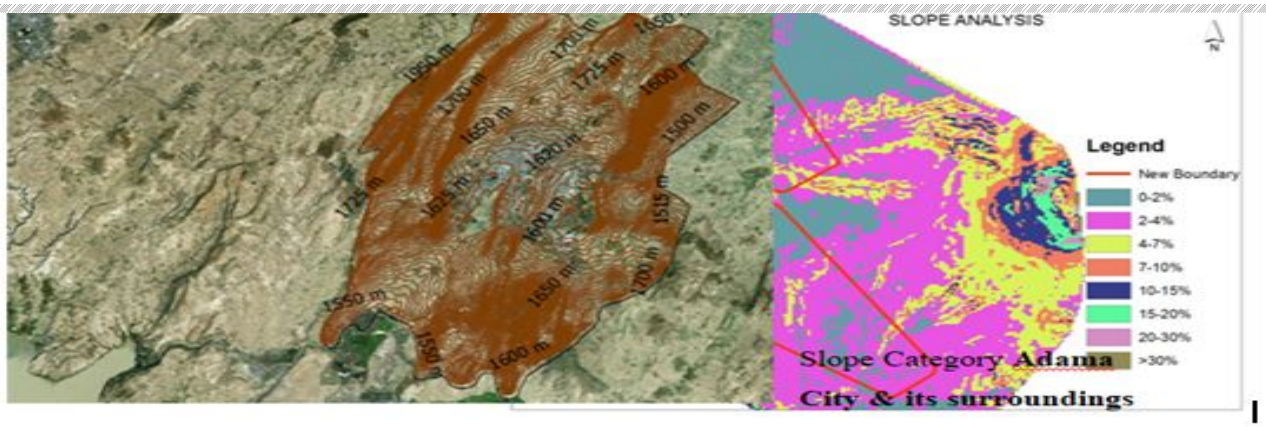
4.13. Suitability of the proposed water supply system

4.13.1. Slope and Aspects Analysis

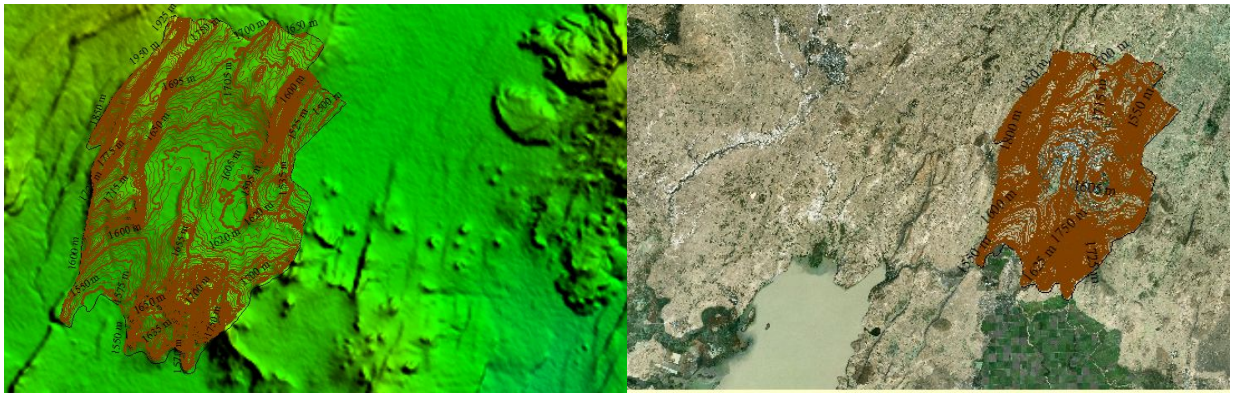
Slope is determinant factor for any use of a certain land. The slope of the site is a little bit inclined downward from West & North-West to South & South-East . More than 85% of the site is below 10% slope which is very ideal for any development .The East facing aspect of the site makes it convenient not only for natural sunlight exposure as the sun is tilting towards the south but also for natural ventilation as the wind is blowing from south east-east to north west-west (or easterlies). The detail slope analysis shows by classifying the site in to different classes (see table -below)

Figure 29 Slope Category Adama City & its surroundings &

Table 27: Slope Category Adama City & its surroundings



Slope Category (%)	Area (hec)	Percent %	Remark
0 to 4	7,899.61	59.10%	Good for development, consider floods
4 to 7	3,114.40	23.30%	
7 to 10	1,844.58	13.80%	
Above 10 (Water Bodies, Under Construction and Gorge)	507.93	3.80%	less good for development and consider slope treatments and land escapes.
	13,366.52	**100%**	

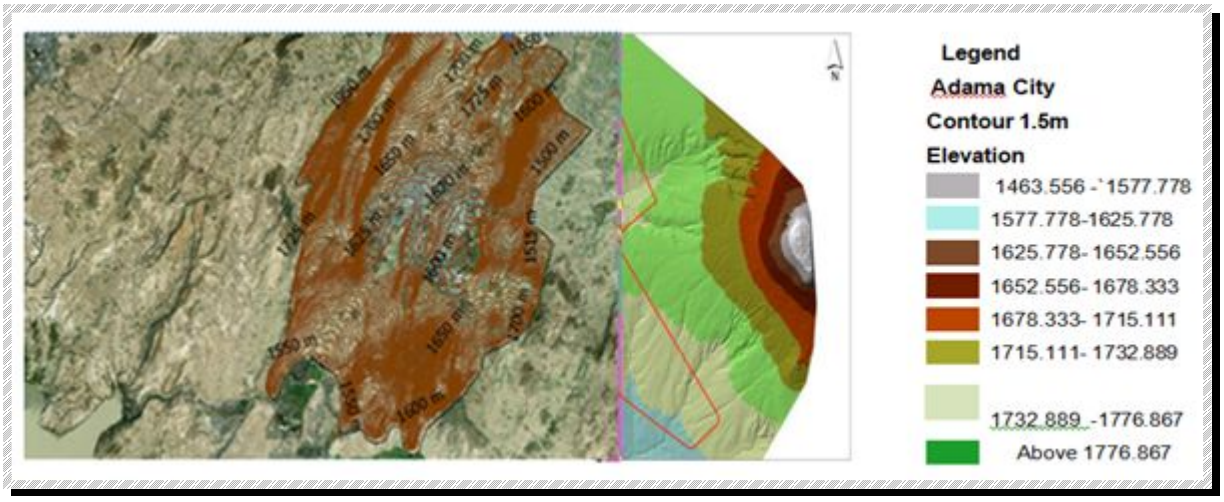


Source: Computed from Global Mapper & other software June 2020

4.13.2. Water shade

The project site is drained by seasonal dry streams flowing from north west to south east direction. Some of the streams are small, intermittent and shallow while there is one relatively big river bordering the site to the western direction with deep gorge. The drainage pattern of the site is depicted on the map

Figure 30 Water shade of Adama City



Source: Computed from Global Mapper & other software June 2020

4.14. Reservoirs

4.14.1. General

Operational reservoir(s) should be provided to command a distribution system, located at elevation(s) providing the required pressure for water flow within the system. They should have sufficient storage to cover the difference between hourly peak demand and actual supply from the source, fire fighting demands if to be allowed for, and for a limited emergency volume in case of power breakdown, repairs or O&M activities.

4.14.2. Types of Reservoirs

The two main types of reservoir are the ground level type (GLR) and elevated water tank type (EWT). Whenever the local topographical conditions permit, ground level reservoirs are preferable. Ground level reservoirs will be usually be of solid block masonry or reinforced concrete, cylindrical or rectangular but under special circumstances may be of glass reinforced plastic (GRP). Elevated water tanks will be cylindrical or conical in reinforced concrete.

Reservoirs are also categorized into transfer and service reservoirs. Transfer reservoirs are designed as follows: Transfer reservoirs were designed to accommodate only for a detention period of 30 minute flow. The storage volume required for service reservoirs have to be large enough to

accommodate the cumulative differences between water supply and demands plus 15% reserve for fire fighting and additional provision for emergency cases such as power interruptions and repair works. Accordingly, the capacities of service reservoirs are determined either by mass curve analysis for urban centers or by calculating one third of Average day demand plus the required provisions for fire and emergency cases.

4.14.3. Reservoir Location

A reservoir location should maintain the desired pressure range in the supply network. Possible future extension of the storage capacity should be taken into consideration when selecting a site. Existing and provision of additional Reservoirs

As the water supply system Design of Adama City project is quite tough and challenging, provision of booster pumping stations and additional Transfer Reservoirs is a must and is unavoidable at any cost. The location and capacity of transfer, existing & new reservoirs provided at booster stations are shown below

Table 28: Existing Storage Facilities in the Project area

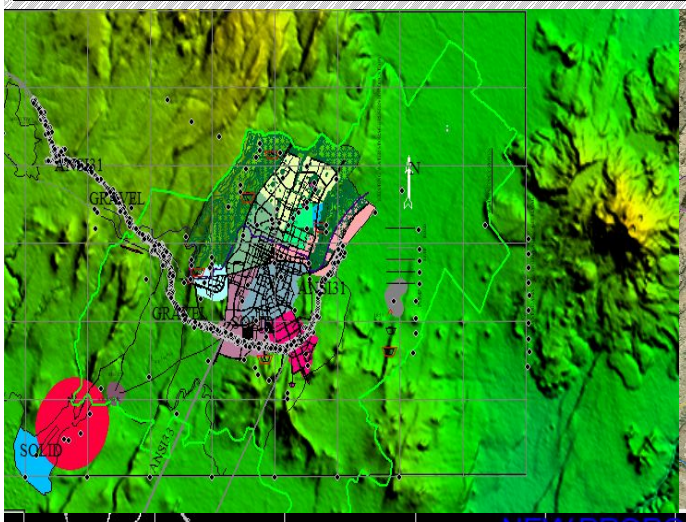
Location and Capacity of Existing Storage Reservoirs(Projection: Adindan UTM)						
Reservoir Description	**Reservoir Specific location**	**X (m)**	**Y (m)**	**Elev. (m)**	**Total Capacity Required (m^3)**	**Existing Reservoir (m^3)**
GAR3-1750(two)	GELMA ABBA GEDA(4000+200)	525885	943790	1750	4,255	4,200
DAR6-1740	DHAKA ADI	532333	947952	1740	790	1000
AUR7-1720	AROUND ASTU PIONEER	531885	946978	1720	2,538	1,500
LUR9-1685(two)	LUGO(4000+2000)	529025	940544	1685	17,291	6,000
EBR10-1719	BOKU	531079	937711	1719	11,112	500
Total					**35,986**	**13,200**

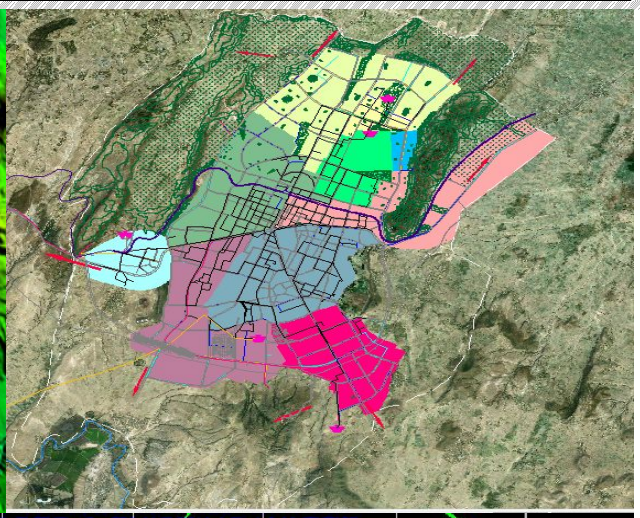
Source:- Computed/ reorganized from Adama City WSSSE .June 2020

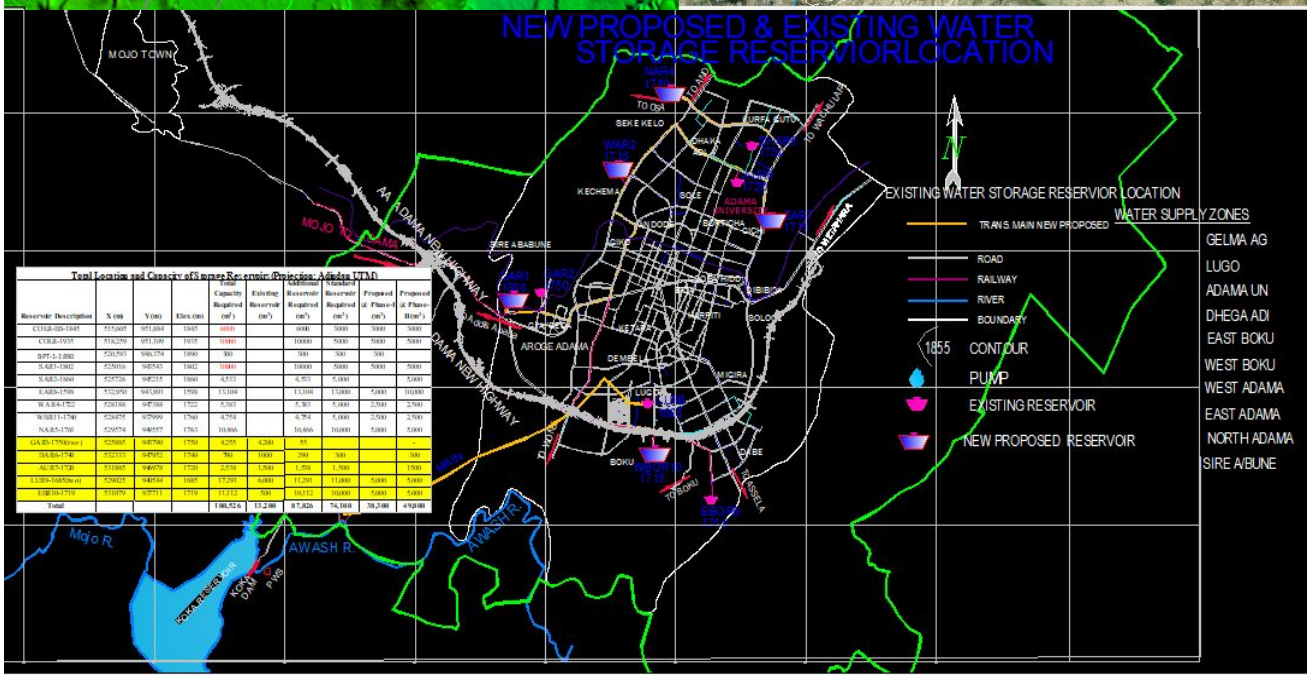
Figure 31 Adama City proposed Storage Reservoir Location

Total Location and Capacity of Storage Reservoirs(Projection: Adindan UTM)

Reservoir Description	X (m)	Y (m)	Elev. (m)	Total Capacity Required (m^3)	Existing Reservoir (m^3)	Additional Reservoir Required (m^3)	Standard Reservoir Required (m^3)	Proposed @ Phase-I (m^3)	Proposed @ Phase-II (m^3)
COLR-BS-1845	515,605	951,884	1845	6000		6000	3000	3000	3000
COLR-1935	518,259	951,109	1935	10000		10000	5000	5000	5000
BPT-1-1890	520,593	946,374	1890	300		300	300	300	
SAR1-1802	525016	943543	1802	10000		10000	5000	5000	5000
SAR2-1860	525726	945215	1860	4,533		4,533	5,000		5,000
EAR8-1598	532,950	943,891	1598	13,104		13,104	13,000	5,000	10,000
WAR4-1722	528188	947388	1722	5,383		5,383	5,000	2,500	2,500
WBR11-1760	528475	937999	1760	4,754		4,754	5,000	2,500	2,500
NAR5-1763	529574	949557	1763	10,466		10,466	10,000	5,000	5,000
GAR3-1750(two)	525885	943790	1750	4,255	4,200	55			-
DAR6-1740	532333	947952	1740	790	1000	290	300		300
AUR7-1720	531885	946978	1720	2,538	1,500	1,538	1,500		1500
LUR9-1685(two)	529025	940544	1685	17,291	6,000	11,291	11,000	5,000	5,000
EBR10-1719	531079	937711	1719	11,112	500	10,112	10,000	5,000	5,000
Total				**100,526**	**13,200**	**87,826**	**74,100**	**38,300**	**49,800**







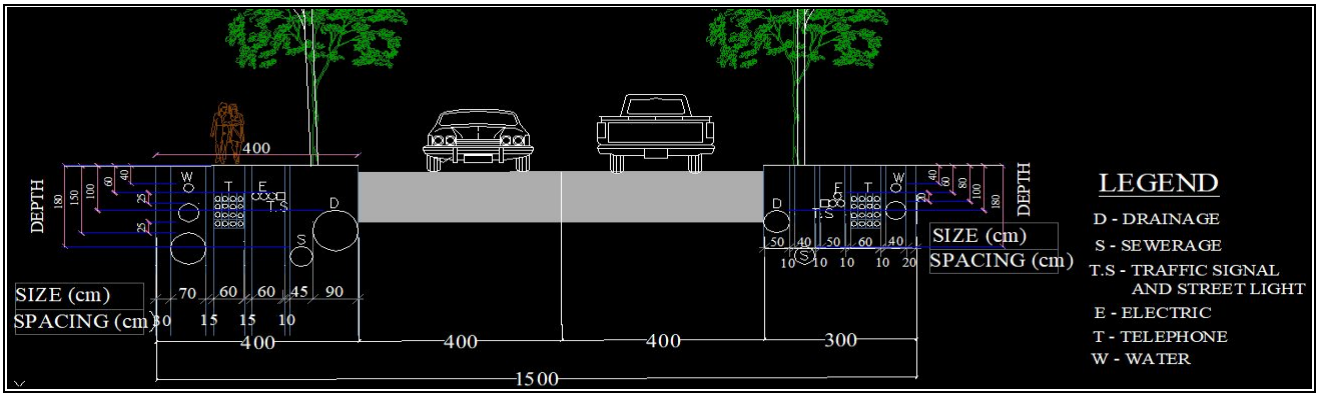
Source: Computed from Global Mapper & other software June 2020

4.15. Design of Pipe Line

4.15.1. Rising and gravity transmission mains design

Rising and gravity transmission mains from source to distribution should be designed for the maximum day demand, based on the design hours of water source operation. Storage facilities at the termination of the transmission main(s) should cater for the peak hourly flow in the distribution system. The number and diameters of transmission pipes should be determined primarily on the basis of economic considerations, comprising either a single large diameter pipe of sufficient capacity for the final planning horizon or several parallel pipes of smaller diameter, installed at various intermediate horizons. The economic analysis should take into account the cost of pipe and energy to determine its optional diameter (which should normally be selected from the standard range diameters).

Figure 32 Standard Utilities location

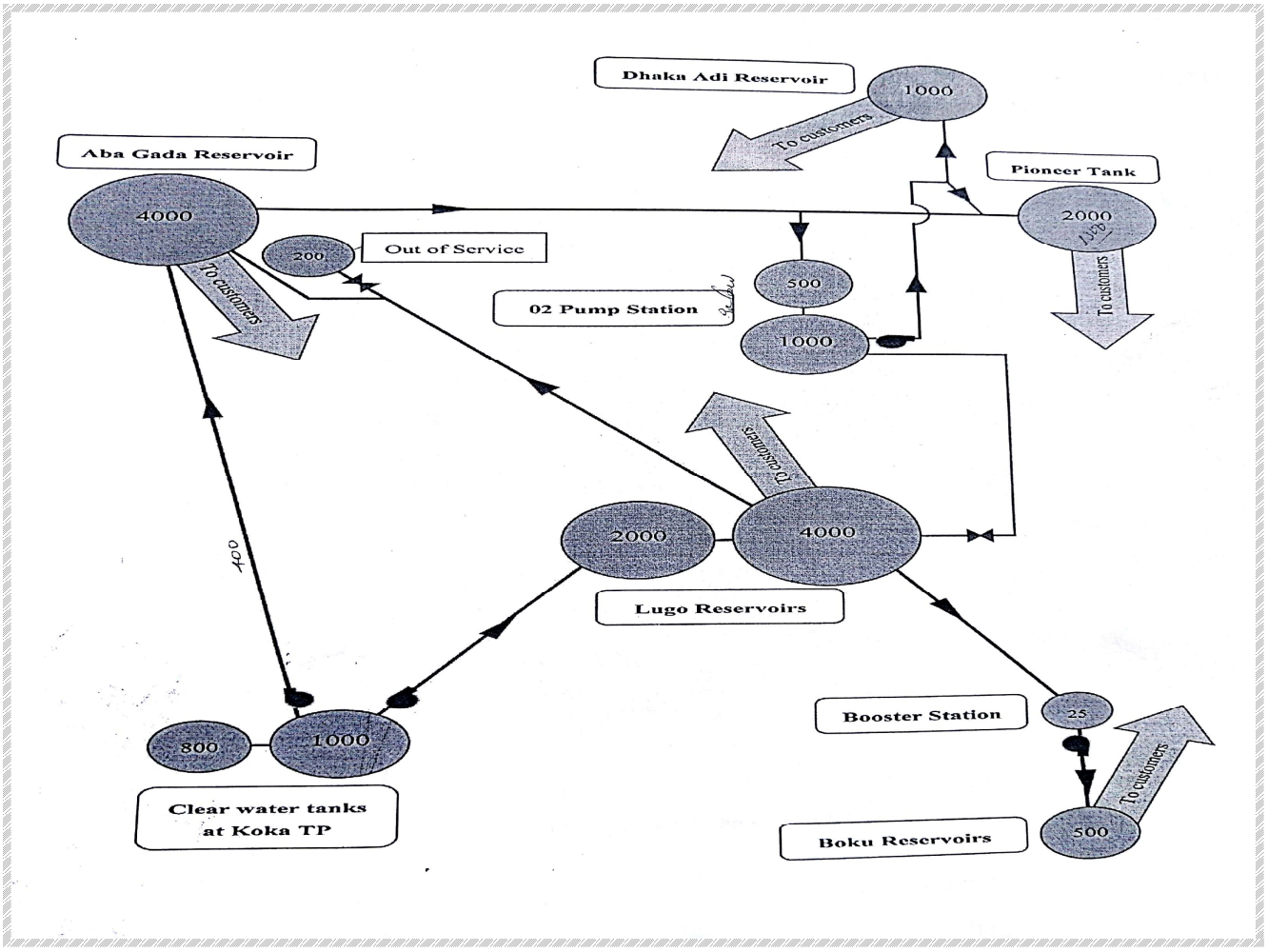


Source:- Computed from Street design standard for Urban Ethiopia.March, 2016.

No house connections should be made to transmission mains.

The hydraulic analysis of the system has been carried out so as to identify the kind of materials and pressure classes of pipes to be used for the transmissions mains. It is known that pressures to be developed in the system is due to the pressure of pumps and the pressure of pipes are normally getting decline as we go far away from pumps along the route of the main because of increasing ground elevations and decreasing energy of pumps. The selection of materials and classes of pipes are hence based on this principle of hydraulics. Consequently, the pressure pipes Adama city are DCI of PN 10-25 bars, this is because of the rocky nature of the transmission main route.

Figure 33 Detail Linkage between Storage Reservoirs with gravity & Rising main in Adama



Source:- Computed/ reorganized from Adama City WSSSE & Own data with software .June 2020

4.15.2. Gravity Main Design

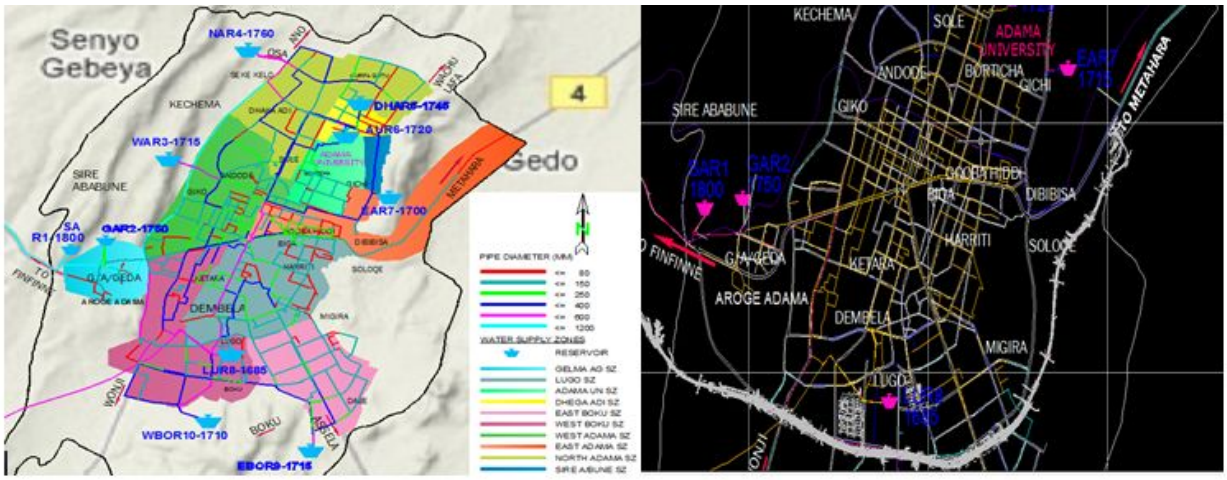
The gravity main pipes of different size are mainly designed to convey the water for the maximum day demand. The main from the storage reservoir to be laid along the steep and gentle slope of the terrain to convey the design discharge will again be of the high quality high density polyethylene (HDPE) for its reasonable cost but DCI pipe is used for Rocky terrain and many other reasons previously enthroned should be DCI Pipe .

The Gravity main pipe laid along the very difficult sharp side slope of gorge with flat and little slope of the selected rout of the terrain nature with no alternative for selection will be laid carefully in such a way that there will not be dismantling during the internal hydraulic pressure and metallic pipe origins may be looked at.It is designed on the basis of the peak hourly water demand, Qpd, at the end of design period. To determine economic diameter of gravity main, 'Lea' formula is used.

D=0.97 to 1.22√Q (Lea formula) By adopting, D=1.22√Q and Q= Qpd (in m3/s)

In the project study, type of pipe, nominal size, minimum and maximum pressure head limits and minimum and maximum velocity are stipulated to be used as guideline design criteria. The type of pipe to be used is determined based on the pressure head and type of soil. For the project, a little DCI & more than 90% HDPE type of pipe that is High-density polyethylene (HDPE) has a density that ranges from 0.94 to 0.97 g/cm3. Its molecules have an extremely long carbon backbone with no side groups. As a result, these molecules align into more compact arrangements, accounting for the higher density of HDPE. HDPE is stiffer, stronger, and less translucent than low-density polyethylene.

Figure 34**:** Map of Rising Mains, Gravity Mains and Distribution Main



Source:- Computed/ reorganized from Adama City WSSSE & Own data with software .June 2020

4.15.3. Detail Rising & Gravity Main Pipe and Riser Pipe Design

Raising main is designed for the maximum daily water demand at the end of the design period

Design Discharge Qdmax = 90,289.85 m3/d = 90,289.85 /(24*60*60)= 1.045 m3/s

To determine economic diameter of raising main D,' Lea' formula is used.

D= 0.97 to 1.22√Q (Lea formula) By adopting, D=1.22√Q and Q = Qdmax (in m3/s)

D=1.22√ (1.045) = 1.22 x1.02m=1.244m take 1244 mm=>1300mm

Therefore, use DCI Pipe Ø 400mm" for raising main. (There are two Existing Rising Mains in addition separate 400mm & 500mm rising main required)

Gravity Main Design

Gravity Main Pipe is designed on the basis of the peak hourly water demand, Qpd, at the end of design period.

Design Discharge (Qpd = 180,579.69 m3/d = 180,579.69 *1000/(24*60*60) = 2,090.042 x10-3 m3/s)

To determine economic diameter of gravity main, 'Lea' formula is used.

Diameter D = 0.97 to 1.22 √Q (Lea formula)

By adopting, D=1.22√Q and Q= Qpd (in m3/s) D=1.22√ (2.090) = 1.22 x 1.446 m = 1.764m=1800mm

Therefore, use all above 600mm DCI or HDPE/ uPVC pipe up to the junction and 300mm (12") HDPE/ uPVC. Pipe, 250mm (8”) " HDPE/ uPVC. pipe, 90mm(4") u PVC pipe , 200mm HDPE/ uPVC pipe for the rest gravity main and all above 63mm(2½") HDPE/ uPVC / or G.I.P pipe for distribution main to the water points.

4.15.4. Standard distribution network Systems

The distribution network will be designed for the peak hourly demand. The minimum pipe size to be considered for primary and secondary networks should be DN 2”. Tertiary pipes may be below DN 2”, but not below DN 1”. Large scale networks may conceivably have a larger minimum diameter for primary and secondary pipes. Distribution systems should be planned with either one large diameter pipe suitable for the final planning horizon, or multiple smaller diameter pipes installed at various intermediate-planning horizons. An economic analysis should be carried out to determine the cheapest solution.

4.15.5. Network Configuration

It is a branched type network & looped systems consist of one supply source and some dead ends. The intermediate nodes in the system are connected by one supply link upstream and one more distribution links downstream. Fixed flow direction is generated by the distribution from the source to the ends of the system. Wherever possible, the layouts of pipelines are being along road sides. Each distribution zone is commanded by respective reservoirs.

4.16. Public Taps/ Public fountains

As the resident in the project area are of low-income group, some of the communities in the project area are expected to be served by public taps. Public taps are quantified based on the coverage area and the number of people served. Hence, taking the number of people to be served by each public taps in the range of 500m and some public fountains are proposed for Adama City around Dhaka Adi, Sole, Boku, Elka Adama ,Dabe Soloke & Kella & considering the rural villages at the border of the city are proposed for the community at the source area to ensure the sustainability of the system. Public taps should be installed to provide a maximum walking distance of 500m in any direction as per the standard.

CHAPTER FIVE

5. MAJOR FINDINGS

5.1. Social Aspects Findings: for Water Supply System design

A fundamental consideration for sizing of any potable water supply system or its component parts is an estimate of the amount of water expected to be used by the customers on from the system. The total water requirement of a project was normally estimated by its uses for domestic purposes such as drinking, cooking, ablution, washing clothes and utensils and cleaning houses, and for non-domestic purposes such as public, commercial, industrial and fire fighting institutions, and livestock watering. In addition unaccounted for water was considered while calculating the total water requirement of the system.

There are various factors affecting the population growth of community and various factors associated with population size, distribution and growth rate are births, deaths and migration. These factors are influenced by social and economic factors. Factors for unexpected population growth of Adama City summarized as: Social development level, medical facility development and advancement, natural disasters, educational level, industrialization and commercialization etc.

5.2. Economic Aspects Findings:

The positive impact of the water supply development project on socioeconomic improvement is significant. Even though it is not measured easily, the benefit of the project will raise the living standard of beneficiaries and create productive force.From economic point of view, the major findings have been stated as follows large unemployment rate seen in Adama City. At national level unemployment rate in the urban part of the country in 2012 was estimated about 17 percent, very large gender disparity in the proportion of unemployment among male (relatively less %age) and female (relatively more %age).More than 16 percent of those who are involved in the economic activity have been operating in the informal sector. The figure is assumed to be larger than 16 percent since there are lots of persons who reported as if they are operating in the formal sector, the monthly income for the majority of the respondents has been reported to be low.

5.3. Spatial/Physical Aspects Findings :

Sample size 166 residence & households representatives were taken as sample respondents. Since the city is classified into six sub cities, sample households were randomly selected from the three sub-cites purposively based on their population number. Data analysis and presentation Qualitative data was analysed and presented through description narration and interpretation of the situations contextually.

5.3.1. Findings , Results and discussion

As depicted in Table above, out of 166 interviewed sample households, 61% were female and the rest are male. The age range distribution of the respondents showed that 16% of them were in 20 to 30 age groups, 31% were in 31 to 40 age groups and the remaining were above 41. Concerning the educational level of the respondents, 2% were illiterate, 73% had formal education and 25% had informal education.

Findings on Status of drinking water supply /Water sources and accessibility

The water supply of Adama City is now supplied from Awash river but previously the boreholes drilled at various locations around the City in the radius of 11 km were rich in their fluoride content and children have suffered dental discolorations on top of the water scarcity due to rapid increase in water demand as the number of users frequently rises. Out of the total interviewed sample households in Adama City, 86% obtained water from Pipe line connection regardless of its frequency, 23% used water from public tap and the remaining got water from water vendors. The survey result revealed that majority of the respondents (52%) travelled less than 10 m to collect water from Pipe line connection. Some of them (23%) reported distances up to 50 m, 16% from 50 to 100 m, and 8% from 100 to 200 m while the remaining (5%) reported distances from more than 200 m from their residence. Similarly, some of the respondents (17%) spent more than 30 min to collect drinking water, 48% of them < 5, the rest 35% spent from 5 to 30 min. Regarding the per capita water requirement, majority (55%) of the respondents stated that they use less than 30-50 L of water per capita per day, 19% of the respondents stated that they use more than 50 L of water per capita per day & the remaining (26%) of the respondents reported that they use less than 30L of water per capita per day which is less than the recommended standard. African Water Development Report (2006) estimated that to ensure the basic water needs of humans, 80-100 L of water free from harmful contaminants are needed every day. According to Ministry of Water, Irrigation and Energy (MoWIE) (2011), basic access of water for urban dweller is 80-100 L per capita per day within 0.5 km service radius in universal access plan. On the other hand, poor access to potable water has

negative day urban life. Poor access to potable water has negative impact on development also indicated that, poor access to water supply and sanitation limits opportunities to escape poverty and exacerbates the problems of vulnerable and marginalized groups.

5.4. The major findings related to the spatial aspects of Water pipe lines & utilities

Regarding Urban planning & design Urban canter decay; Public transport inadequacy & less consideration of pedestrian and bicycle transportation; Urban Spaces with un-appropriate setbacks leads Water pipe lines & other utilities exposed for damage by road users, in the central city & major City area there is limitation in installation and protection of water pipe lines signs & marker post. But also there is limitation in maintenance and marking of water pipe line; symbols, marker post and the installed signs are not placed in appropriate place and not visible at a clear distance according to the standard. Poor drainage system and poor waste management leads to poor aesthetic value; Urban Spaces with un-appropriate waste disposal/leads to poor aesthetic value Poor environmental conditions e.g. narrow streets, poor drainage, congestion and pollution. Poor pedestrian linkage system:- Such as insufficient pavements, intrusive vehicular traffic & poor pedestrian network liking poor development of commercial canters and residence units; less consideration for Public space developments(play grounds, city parks, street side public spaces, court yards etc);Street parking and public parking problems; Poor road networks, roundabout and street escape design problems and dead end roads; Low density and horizontal development; Social services shortages

5.5. Potable water coverage

The WHO/UNICEF JMP report of 2015 indicated that the improved water coverage in Ethiopia was found to be 93 and 49% in urban and rural areas, respectively. The country coverage of improved water source usage reached 57%. On the other hand, 30% of the total Ethiopian citizens rely on unimproved drinking water sources. In 2019, the potable water coverage of Adama City was reported to be 77.31% (ACWSSSE, 2019 report). Water supply systems in urban areas are often unable to meet existing demands and are not available to everyone, rather some consumers take disproportionate amounts of water and the poor is the first victim of the problem. As depicted in small as compared to the population growth as reported by ACWSSSE, financial constraint and poor management of the existing water supply are the main challenges for the low coverage of the water supply. Some of the respondents also reported that due to water shortage they incur additional costs and face health problems like diarrhoea as they are forced to use alternative sources of water of poor quality the piped water coverage increment is very more has to be invested in developing sector capacity through strengthening institutional structures especially at city at all, sub city/Kebeles and community levels.

5.6. Level of Water Supply Services

The water demand of the users is decreasing as the level of the water supply decreases. Commonly there are four categories mode of services namely: - yard connections, public tap connections and house connections.

Table 29 Modes of Services by Percentage for year 2018/19

Mode of service	Percent of Population Served In Adama City
HC	21%
YCO	39%
YCS	30%
PT	10%
Total	100%

Source:- Computed/ reorganized from Adama City WSSSE

Water Demand Analysis

5.6.1. Per-capita Water Demand

The Federal Democratic Republic of Ethiopia (FDRE) Ministry of Water, Irrigation & E for water supply projects with Adama adjustments for some of the figures that could reflect the actual physical and socio-economic features of the area. For the present population the average per capita water demand considered is 80 to 100 lit/ capita / day taking the per capita water consumption growth rate of 0.5% per annum, the water demand per head.

Table 30 City/Town Population size and average per-capita demand

Town Category	**Population size**	**Per-capita demand**
1	>1000000	100
2	100000 – 1000000	80
3	50000 -100000	60
4	20000 – 50000	50
5	<20000	40

Source: GTPII water Sector document

Since, GTPII standard doesn't show per-capita demand breakdown by mode of service based on the table above the following steps were followed to modify per-capita demand for this design. Base and end design year population of the city are determined and projected. Using the base and end year population projection the average per-capita demand is determined. The Adama city base (current) is 472,703. From the table above the average per-capita demand for Adama city is then 80 l/c/d.

Summary of Water Demands

Table 31 **Summary of Water Demand**

Summary of Total Water Demands for Adama City					
Population/service Level	Unit	Year			
		2007	2012	2017	2020
Population	No	220,212	273,114	417,582	472,703
Percentage of Population Served by:-					
HC	%	13	15	21	22
YC	%	37	40	54	68
PF	%	50	45	25	10
Population by Service Level					
HC	No	28,627.56	40,967.05	87,692.22	103,994.60
YC	No	81,478.44	109,245.48	225,494.28	321,437.86
PF	No	110,106.0	122,901.16	104,395.50	47,270.27
Per Capita Demand					
HC	lpcd	55	60	80	80
YC	lpcd	35	35	60	67
PF	lpcd	20	22	25	25
Demand by Service Standard					
HC	m3/d	1574.52	2458.02	7015.38	8319.57
YC	m3/d	2851.75	3823.59	13529.66	21536.34
PF	m3/d	2202.12	2703.83	2609.89	1181.76
Sub Total	m3/d	6628.38	8985.44	23154.92	31037.66
Climatic Factor (Say 1.3 for 20-25^{0}C) Socio-economic Factor (Say 1.05)	Combined Factor (1.3*1.05)=	1.365	1.365	1.365	1.365
Total Domestic Water Demand	m3/d	9,047.74	12,265.13	31,606.47	**42,366.41**
Industrial Demand 5 to 10%(say 5%)	m3/d	452.39	613.26	1,580.32	2,118.32
Commercial and Public Demand (20 to 40%)	m3/d	1,809.55	2,453.03	4,740.97	4,389.40
Livestock Water Demand	m3/d	2,969.89	2,969.89	2,969.89	2,969.89
Water Demand for Fire Fighting 10 to 15%(say 10%)	m3/d	904.77	1,226.51	3,160.65	4,236.64
TOTAL WATER DEMAND	m3/d	15,184.33	19,527.81	44,058.29	56,080.65
Unaccounted For Water (UFW) 15 to 25%(say 15%)	%	10.00	15.00	15.00	15.00
Unaccounted For Water (UFW)	m3/d	1,518.43	2,929.17	6,608.74	8,412.10
Average Daily Water Demand	m3/d	16,702.77	22,456.98	50,667.04	**64,492.75**
Average Daily Water Demand	l/s	193.32	259.92	586.42	746.44
Maximum Day Factor		1.40	1.40	1.40	1.40
Peak Hour Factor		2.00	2.00	2.00	2.00
Maximum Day Water Demand	m3/d	23,383.88	31,439.77	70,933.85	**90,289.85**
Maximum Day Water Demand	l/s	270.65	363.89	820.99	1,045.02
Peak Hour Water Demand	m3/d	46,767.75	62,879.53	141,867.71	**180,579.69**
Peak Hour Water Demand	l/s	541.29	727.77	1,641.99	2,090.04

Source:- Computed/ reorganized from Own data with software .June 2020

The total water demand was obtained by adding all domestic and non-domestic demands, and unaccounted for water and applying all demand factors mentioned in the previous section.

5.7. WATER SOURCES

5.7.1. The Selected Water Source

After comparing the site conditions of the two options depending on the set criteria, general analysis was done for the thesis feasibility of the sources from the technical, financial and social point of view not only for the development period but also for the operation period. Based on the analysis result, there are two options according to the following order of priorities up grading the existing Source of Awash river, developing the Groundwater Resource of the at various locations around Modjo City area by drilling boreholes. Accordingly, this existing Source of Awash River has been selected as a source for Adama City potable Water source. Currently the flow of the Awash River was estimated to be *410.94 lit/sec*, which is much less than the required Maximum Day Demand which is 1,045.02 lit*/sec.*

5.7.2. Conclusion of Water Resource

The quantity of raw water being used from Awash River is around 410.94 l/s (35,505. 22 m3/d) whereas the required would be 1,045.02 l/s (90,289.85 m3/d). This amount covers only 40% of the water demand required. Besides, there is no alternative water source for emergency case, to upgrade the need for Urban development & investment required for Adama City; if supply fails from Awash River, water supply situation is becoming worst in the City due to lack emergency water supply source. This situation was happened in the system due to power interruptions. The other major problem sawn in the area Awash River source may had been getting different water quality problems.

Up grading /developing the existing Source of Awash river was commented to be used as a source for Adama City potable Water source by ACWSSSE. Currently Awash River is used for irrigation farming by the inhabitants of downstream residents. This implies that shearing of Awash River for Adama City potable Water source creates more pressure on the river flow and this may lead to conflict of interest with the community using Awash river water for irrigation farming. So that developing the Ground water source of at various locations around Modjo area by drilling boreholes was more sustainable for future development of the City.

5.8. Reservoirs

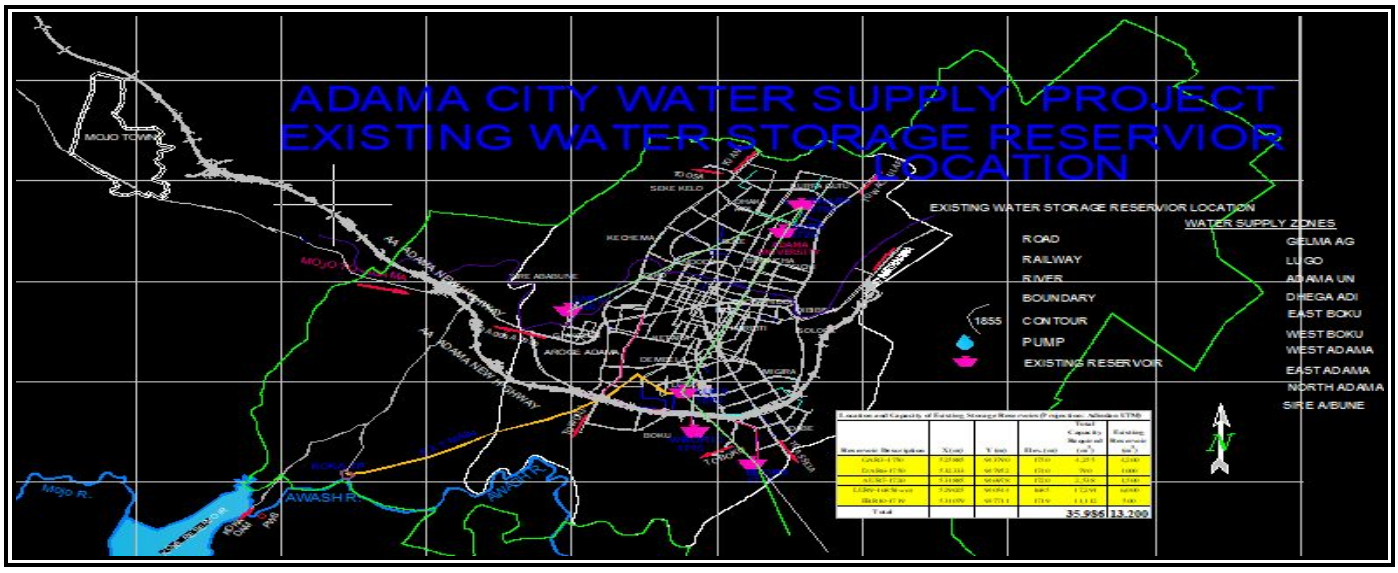
5.8.1. General

Operational reservoir(s) should be provided to command a distribution system, located at elevation(s) providing the required pressure for water flow within the system. They should have sufficient storage to cover the difference between hourly peak demand and actual supply from the source, firefighting demands if to be allowed for, and for a limited emergency volume in case of power breakdown, repairs or O&M activities

5.8.2. Reservoir Location

A reservoir location should maintain the desired pressure range in the supply network. Possible future extension of the storage capacity should be taken into consideration when selecting a site.

Figure 35 Adama City Reservoir Location



Source:- Computed/ reorganized from Adama City WSSSE & Own data with software .June 2020

5.8.3. Existing and provision of additional Reservoirs

As the water supply system Design of Adama City project is quite tough and challenging, provision of booster pumping stations and additional Transfer Reservoirs is a must and is unavoidable at any cost. The location and capacity of transfer, existing & new reservoirs provided at booster stations are shown below

Table 32: Existing Storage Facilities in the Project area

Location and Capacity of Existing Storage Reservoirs(Projection: Adindan UTM)						
Reservoir Description	**Reservoir Specific location**	**X (m)**	**Y (m)**	**Elev. (m)**	**Total Capacity Required (m^3)**	**Existing Reservoir (m^3)**
GAR3-1750(two)	GELMA ABBA GEDA(4000+200)	525885	943790	1750	4,255	4,200
DAR6-1740	DHAKA ADI	532333	947952	1740	790	1000
AUR7-1720	AROUND ASTU PIONEER	531885	946978	1720	2,538	1,500
LUR9-1685(two)	LUGO(4000+2000)	529025	940544	1685	17,291	6,000
EBR10-1719	BOKU	531079	937711	1719	11,112	500
Total					**35,986**	**13,200**

Source:- Computed/ reorganized from Adama City WSSSE & Own data with software .June 2020

Table 33:-:- Location & Capacity of existing & new Reservoirs to be provided.

Location X(m), Y(m)	Storage Capacity (m^3)	Ground Level* m (asl)	Location (Projection: Addendum UTM)	Service	Remark
LUGO SZ-1	4000	1685	X= 529025 Y=940544	Receives water from koka treatment center serves as wet well/sump for pump station source 1 raw water & 2 treated for pumping to Lugo & Abba Geda .,Serves as a storage/sum for pumping through old line distribution network to most of Adama directly with gravity	Old pipes leakage & frequently breakage may lead to contamination @Junction pt
LUGO SZ-1	2000	1685	X= 529025 Y=940544	Receives water from koka treatment center through old line distribution network to most of Adama directly with gravity	Old pipes leakage & frequently breakage may lead to contamination @Junction pt
ADAMA UNI. NZ(Pioneer tank)	1000	1720	X=531885 Y=946978	Receives water from GELMA ABBA GEDA distribution network to Adama University surrounding	Old pipes leakage, Small diameter pipes not fully serve the required demand
DHAKA ADI NE	1000	1740	X=532333 Y=947952	Receives water from wet well/sump From Kebele 02 serve community above Adama University	Old pipes leakage, Small diameter pipes not fully serve the required demand
GELMA ABBA GEDA west	200	1757	X=525895 Y=943754	Receives water from GELMA ABBA GEDA distribution network to Melka Adama & Abba Geda Hall	Small size reservoir not fully serve the required demand
GELMA ABBA GEDA west	4000	1757	X=525885 Y=943790	Receives water from koka treatment center through new line .Balances out peak flows via a rise and fall main connected to all above Reservoirs' kebele 02 booster station & distribution network to most of Adama directly with gravity	Old pipes leakage, Small diameter pipes not fully serve the required demand
EAST BOKU SZ	500	1719	X=531079 Y=937711	Receives treated water from Boku booster pump station(25m3 Underground collection chamber) serves as wet well/sump for pump station source for pumping to EAST BOKU 500m3 .,Serves as a storage/sump for pumping and distribution point for surrounding locality higher than Lugo Reserv	Small size reservoir Old pipes leakage, Small diameter pipes not fully serve the required demand
Kebele 02 PUMP STATIO	1000+ 500	1650		Receives water from GELMA ABBA GEDA & emergency case from Lugo sump for pumping to only to Lugo Reservoir	

Source:- Computed/ reorganized from Adama City WSSSE & Own data with software .June 2020

Figure 36 Adama City proposed Storage Reservoir Location

Total Location and Capacity of Storage Reservoirs(Projection: Adindan UTM)									
Reservoir Description	X (m)	Y (m)	Elev. (m)	Total Capacity Required (m^3)	Existing Reservoir (m^3)	Additional Reservoir Required (m^3)	Standard Reservoir Required (m^3)	Proposed @ Phase-I (m^3)	Proposed @ Phase-II (m^3)
COLR-BS-1845	515,605	951,884	1845	6000		6000	3000	3000	3000
COLR-1935	518,259	951,109	1935	10000		10000	5000	5000	5000
BPT-1-1890	520,593	946,374	1890	300		300	300	300	
SAR1-1802	525016	943543	1802	10000		10000	5000	5000	5000
SAR2-1860	525726	945215	1860	4,533		4,533	5,000		5,000
EAR8-1598	532,950	943,891	1598	13,104		13,104	13,000	5,000	10,000
WAR4-1722	528188	947388	1722	5,383		5,383	5,000	2,500	2,500
WBR11-1760	528475	937999	1760	4,754		4,754	5,000	2,500	2,500
NAR5-1763	529574	949557	1763	10,466		10,466	10,000	5,000	5,000
GAR3-1750(two)	525885	943790	1750	4,255	4,200	55			-
DAR6-1740	532333	947952	1740	790	1000	290	300		300
AUR7-1720	531885	946978	1720	2,538	1,500	1,538	1,500		1500
LUR9-1685(two)	529025	940544	1685	17,291	6,000	11,291	11,000	5,000	5,000
EBR10-1719	531079	937711	1719	11,112	500	10,112	10,000	5,000	5,000
Total				**100,526**	**13,200**	**87,826**	**74,100**	**38,300**	**49,800**

Source:- Computed/ reorganized from Adama City WSSSE & Own data with software .June 2020

5.8.4. Design of Reservoir

Service reservoir is a storage facility that is designed to: equalize the hourly fluctuation of flow, make uniform pumping rate possible, provide uniform water pressure, reduce operating cost by operating pumps at the rate for the maximum efficiency and for emergency reason, and etc.From engineering point of view, reservoir capacity is *one-third* of maximum daily water demand. Thus the maximum daily demand becomes.Hence, volume of service reservoir is = 1/3 * $Q_{d\ max}$ = (1/3) x 90,289.85 (m^3/d) m^3 = 30,096.62 m^3

Accordingly, 10,000m3 + 5,000m3 service reservoir is recommended for phase I and the remaining in phase II as per based on the availability of Budget.

5.9. Description and Design of the proposed water supply system

From the above table he Average day water required for the design period (Year 2020) was estimated to be 746.44 l/s. The peak hour demands are also estimated to be 2,090.04 L/s. These design flows were used for determining the capacities of water supply components, transmission mains from sources to service reservoirs are designed to meet the maximum day demands. Service reservoirs, transmission mains from service reservoirs to distribution network, and distribution mains are sized to meet peak hour demands in line with minimum pressure requirements.

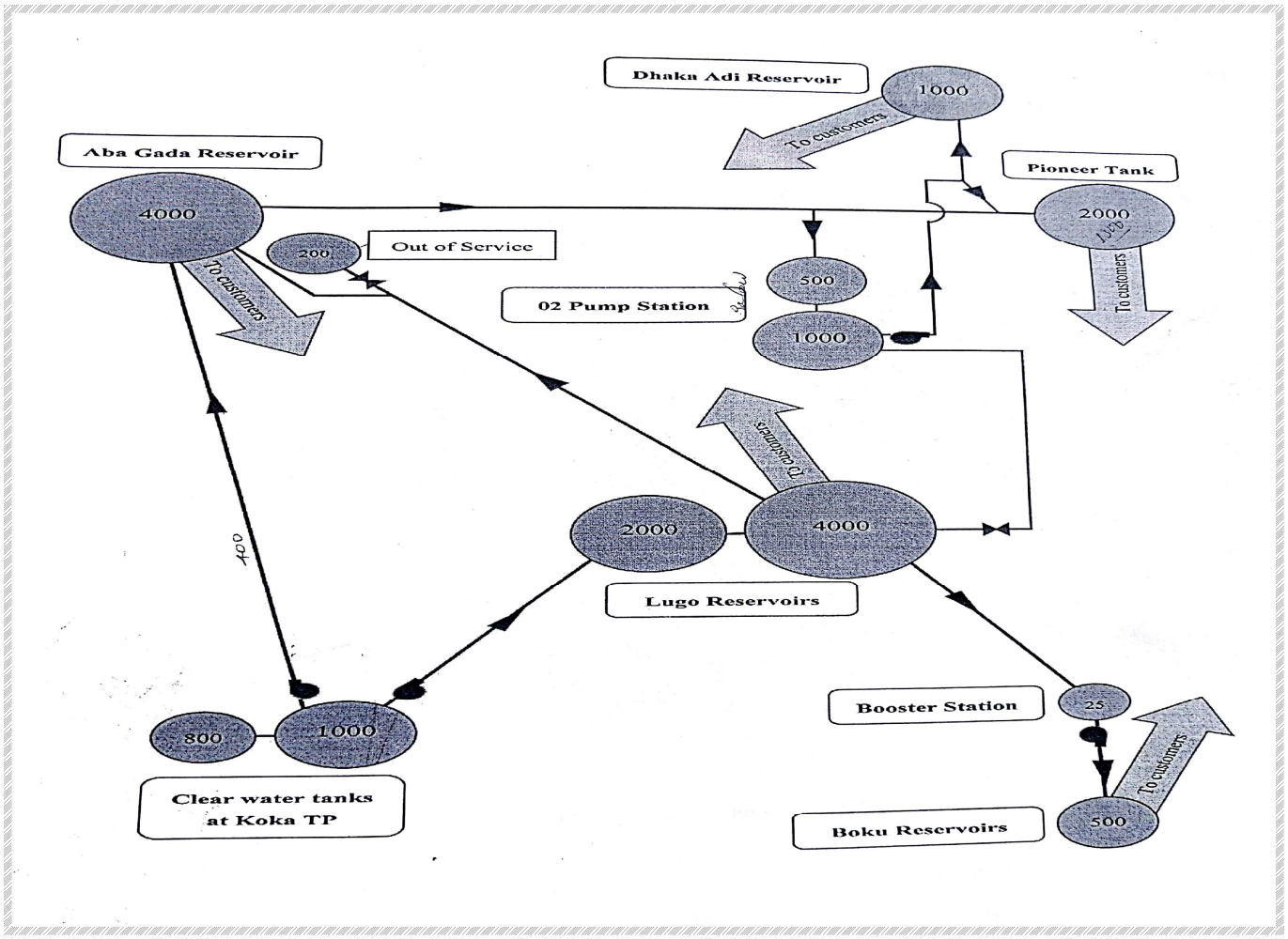
5.9.1. Existing Distribution Main in the Project Area

I am try to examined the area of the distribution system and the distribution system covers about 65% of Adama City Master plan. The distribution system partially does not include Dhaka Adi, Sole, Boku, Elka Adama ,Dabe Soloke & Kella kebeles The distribution pipe is composed of different type of pipes DCI, PVC, GS and HDPE.

Table 34:-:- ZONES of Rising Mains, Gravity Mains and Distribution Main.(only sample)

S/NO	ZONE	Diameter(mm)	Material	Year of Installation	Remar
1	GELMA ABBA GEDA	From Koka to WR TWO DIFFERENT LINE 600mm & 400mm distribute with Different size	DCI, GS and HDPE	BEFORE 2009	NEEDS REHABITATION & UPGRADING
2	LUGO SZ	From Koka to WR 600mm then distribute with <=600 Different size	Same	BEFORE 1994	
3	ADAMA UNI. SZ	<=300 Different size	Same	BEFORE 1995	
4	DHEGA ADI SZ	<=300 Different size	Same	BEFORE 2006	

Figure 37 Detail Linkage between Storage Reservoirs with gravity & Rising main in Adama



Source:- Computed/ reorganized from Adama City WSSSE & Own data with software .June 2020

According to the previous ACWSSSE reports shows, the existing distribution system was commissioned and inaugurated in November 2002. The construction was delayed for about 5 years due to design change and lack of pipe and fittings. Assuming the start of the project was in 1997, it is around 22 years old. The existing distribution system consists of materials such as DCI, uPVC, HDPE and GI pipes. This means the uPVC pipes, which are dominating in quantities, are old enough and cannot serve more than 25 years in accordance with the urban design criteria of MoWR.

The analysis result indicates that some parts of the distribution pipe network couldn't meet the Master Plan the layouts of pipe networks around Migira and left of Lugo Reservoir are noncompliance with the Master Plan(LDP) and need to be corrected. Some parts of the distribution pipe network couldn't meet the required pressure of water during the peak hour demand most parts of the central network being suffered by lower flow this is to the extent of occurring zero (no) flow conditions in some of the pipes.These are found around Bole sub city Kebele 04 around Medhanialem, Hangatu Kebele Gendegara, Migira ,Boku, Giko and are parts of at the back of Adama University areas, Lugo and Boku Supply Zone. The main reasons for such lower pressures are the installed pipes were small in sizes, relatively found on higher ground levels, increased population and water demand regarding to evaluation of the capacities of reservoirs proved that the total storage capacities of existing reservoirs cover only 40%(Total Capacity Required =1/3 of (100,526 m^3)) of the requirement which is 13,200m3.

5.9.2. Existing Pump Stations with in Adama City

The summary of pumping stations visited initially includes four pump stations with in Adama City area as shown in next table.

Table 35: List of pump stations visited with in Adama City

S/N	NAME OF THE PUMP STSTION	SPECIFIC LOCATION	DESIGN DISCHARGE	DESIGN HEAD(m)	STAND BY POWER	REMARK
1	Koka Dam/ wet well/sump	Awash River	7 pumps each (m3/hr)	180	110(KW)	The main problem at the pumping stations power interruption electrical, control panel, telemetry system, operations test of pump system, operations test of generator, operations & maintenance
2	Near Kebel 02 Booster	Gelawdeyos	2 pumps each		250(KW)	
3	Boku Booster station	Robe Gebeya				

Source:- Computed/ reorganized from Adama City WSSSE & Own data with software .June 2020

CHAPTER SIX

6.0. CONCLUSION AND RECOMMENDATION

6.1. Conclusion

This thesis has attempted to examine "Access and adequacy of potable water in Adama City" using the potable water supply, access and demand scenario. The water demand of the City is increasing due to urbanization and population growth. Access to and use of safe drinking water can contribute enormously to health, productivity and social development. Regarding Urban planning & design proper Planning & designing requires for any Urban utilities rehabilitation, expansion, operation, maintenance, leakage controlling and management. Urban canter utilities deficit; water supply inadequacy & less consideration of improvement; poor access to potable water has negative day urban life. Poor access to potable water has negative impact on development, poor access to water supply and sanitation limits opportunities to escape poverty and aggravates the problems of vulnerable and marginalized groups. Urban Spaces with un-appropriate planning & design leads Water pipe lines & other utilities exposed for damage by road users, in the central city & major City area there is limitation in installation and protection of water pipe lines signs & marker post. But also there is limitation in maintenance and marking of water pipe line have seen in Adama City.

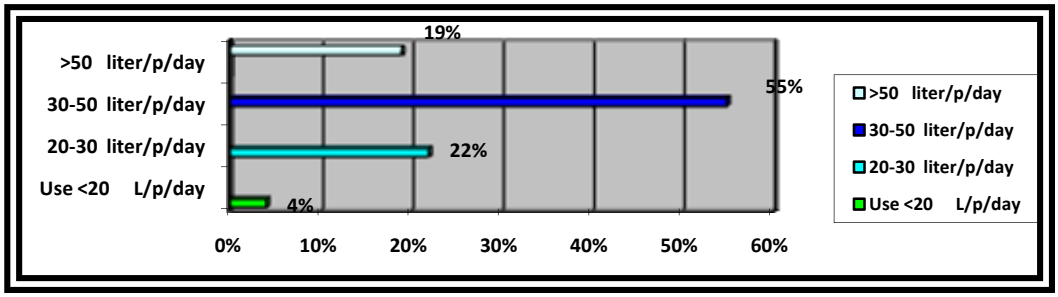
This study was conducted to assess the existing water supply and demand scenario of Adama City, central part of Ethiopia. To achieve the objective of the study, a total of 166 residence & households representatives were randomly selected and interviewed by using semi structured questionnaire. To collect the required data, interview schedule, observation, and key informant interviews were used. In addition, different documents were reviewed. The existing water supply and demand scenario of Adama City study process follows the following procedures that is from the development plan supplemented with field survey work the spatial distribution of the existing infrastructures were identified; using a digitized map the total area of the city is divided into distribution zones, further, these zones' land use is identified based on the category of users and these areas are delineated, measured and tabulated; the area ratio of the specific category of users inside each block was computed; sub-areal demands for specific users were computed by multiplying the area ratio specific category users with the average day demand; the total demand for each kebeles & zones is found by adding the demand of specific category users inside the zones & kebeles.The collected data were analyzed using descriptive statistics. The survey revealed that the City water supply cannot fulfill

consumer demand for water supply system ,long age of the system especially pipe lines, electric power supply problem, low Storage Reservoirs capacity, low minimum/under diameter of pipe lines, regular interruption of water supply and unfair water distribution & a huge gap between the water supply and demand of the city leads to the average per capita consumption was found to be which is less than the recommended standard finally lack of finance and under function of pumps are the basic limitations & the basic factors for this imbalance.

The average per capita consumption was found to be less than 50-80 L/person/day which is less than the recommended standard. In line with this, according to the survey results, the most frequent complaints by water customers are regular interruption of water supply and unfair water distribution. The findings of the data lead to the conclusion that there is a huge gap between the water supply and demand of the city.

With regard to water accessibility, distance &time travelled to fetch water are considered. Out of the total interviewed sample households in Adama City, 86% obtained water from Pipe line connection regardless of its frequency, 23% used water from public tap and the remaining got water from water vendors. The survey result revealed that majority of the respondents (52%) travelled less than 10 m to collect water from Pipe line connection. Some of them (23%) reported distances up to 50 m, 16% from 50 to 100 m, and 8% from 100 to 200 m while the remaining (5%) reported distances from more than 200 m from their residence. Similarly, some of the respondents (17%) spent more than 30 min to collect drinking water, 48% of them < 5 min, the rest 35% spent from 5 to 30 min (as mentioned in chapter 4).

Figure 38 Water supply **Status *accessibility* to *sources***,



Source: Sample survey (2020).

Regarding the per capita water requirement, majority (55%) of the respondents reported that they use less than 30-50 L of water per capita per day, 19% of the respondanet use >50L of water per capita per day & the remaining (26%) of the respondents reported that they use less than 30L of water per capita per day which is less than the recommended standard. According to Ministry of Water, Irrigation and Energy (MoWIE) (2011), basic access of water for urban dweller is 80-100 L per capita

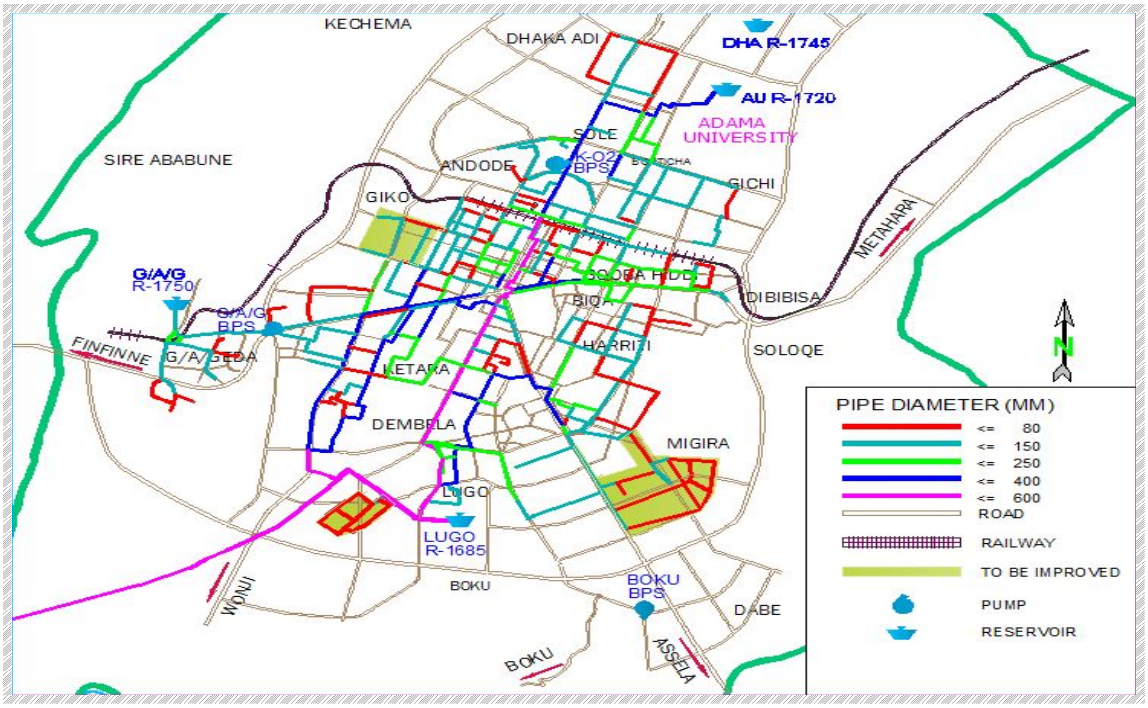
per day within 0.5 km service radius in universal access plan. On the other hand, as per WHO (2008), the basic access of water is 20 L per capita per day within 100 m to 1 km and the average time spent to collect water is 5 to 30 min. More than 1 km of travelling distant in search of water is said to be no access. Thus, majority of households did not have basic access of water for their domestic needs. It implies that water accessibility standards are not well exercised in the city. Most studies underlined that adequate and reliable water supply is critical for coping with every day urban life.

The potable water coverage of Adama City was reported to be 77.31% (ACWSSSE, up dated report). Water supply systems in Adama City was often unable to meet existing demands and are not available to everyone, rather some consumers take disproportionate /unequal amounts of water and the poor is the first victim of the problem. As reported by the key informant, there is chronic water shortage in the jail and as a result they complement their water need from Bote trucks & Gari. As depicted in small as compared to the population growth as reported by ACWSSSE, financial constraint and poor management of the existing water supply are the main challenges for the low accesses & coverage of the water supply. Some of the respondents also reported that due to water shortage they incur additional costs and face health problems like diarrhoea as they are forced to use alternative sources of water of poor quality.

The quantity of raw water being used from Awash River is around 410.94 l/s (35,505. 22 m^3/d) whereas the required would be 1,045.02 l/s (90,289.85 m^3/d). This amount covers only 40% of the water demand required. Besides, there is no alternative water source for emergency case, to upgrade the need for Urban development & investment required for Adama City; if supply fails from Awash River, water supply situation is becoming worst in the City due to lack emergency water supply source. This situation was happened in the system due to power interruptions. The other major problem sawn in the area Awash River source may had been getting different water quality problems. Such as Water source pollution of Awash River may be mainly caused by leaching or erosion of chemicals from surrounding agricultural lands and municipal storm runoff, and the discharges of wastes from industries like Kolba Tannery, Gelan Tannery, Shawa Tannery, Mesako Global and Mojo Tannery S.C to the river and Qoqa Reservoir. The deterioration of water source has been caused the enterprise for higher costs for treating the water needs at the moment high concept of urban planning & design for city development to attract investors more. The others factors related to Water treatment plant needs requirements maintenance of chemical dosing electro mechanical components are being started due to short period of design life phase out, since these components are expected to serve a maximum of ten years. Replacement of these components is a must to the soonest possible. Production of poor quality water. There is a shortcoming in the stability of pump, and lack of spare part in stock is also a major problem for operation and maintenance.

According to the previous ACWSSSE reports shows, the existing distribution system was commissioned and inaugurated in November 2002. The construction was delayed for about 5 years due to design change and lack of pipe and fittings. Assuming the start of the project was in 1997, it is around 22 years old. The existing distribution system consists of materials such as DCI, uPVC, HDPE and GI pipes. This means the uPVC pipes, which are dominating in quantities, are old enough and cannot serve more than 25 years in accordance with the urban design criteria of MoWR. Based on this information and its existing condition, uPVC pipes in some parts are becoming due to leaks and bursts in the distribution system out service because design period over. All existing DCI pipes those were laid in accordance with the master plan roads are in good condition estimated they could serve for about 40 years design periods. Supply system problems, long age of the system especially pipe lines, deterioration of the supply system and Production of poor quality water, Crack, hence water leakage and losses due to cracks, Electric power interruption /supply problem, low Storage Reservoirs capacity, low minimum/under diameter of pipe lines, as per analysis shows the existing distribution system covers around 65% ha of the Master Plan area of the City. It has also limited to the central lowlands of Adama city, it should be expanded to the highland areas to solve the current water shortage of the residents, frequent pipe bursts and excessive leakages in the network due to the existence of oldest pipe lines have also decreasing the coverage capacity of the service Unaccounted for water has been increasing great impact on water production.

Figure 39: Existing distribution system covers around 65% of the Master Plan & Some parts of the network requiring improvement



Source:- Computed/ reorganized from Adama City WSSSE & Own data with software .June 2020

The analysis result indicates that some parts of the distribution pipe network couldn't meet the Master Plan the layouts of pipe networks around Migira and left of Lugo Reservoir are noncompliance with the Master Plan(LDP) and need to be corrected. Some parts of the distribution pipe network couldn't meet the required pressure of water during the peak hour demand most parts of the central network being suffered by lower flow this is to the extent of occurring zero (no) flow conditions in some of the pipes.These are found around Bole sub city Kebele 04 around Medhanialem, Hangatu Kebele Gendegara, Migira ,Boku, Giko and are parts of at the back of Adama University areas, Lugo and Boku Supply Zone. The main reasons for such lower pressures are the installed pipes were small in sizes, relatively found on higher ground levels, increased population and water demand regarding to evaluation of the capacities of reservoirs proved that the total storage capacities of existing reservoirs cover only 40%(Total Capacity Required =1/3 of (100,526 m^3)) of the requirement which is 13,200m3.

Up dated professional Urban planning institutional development, Institutional studies of water supply service reveal that a considerable number of water supply facilities constructed with scarce resources of the country have been turned wasteful, inefficient during the operation stage, and fallen short of achieving their intended objectives. Adequate and wholesome water has not been provided to the users; schemes fail to operate at the required level of satisfaction and efficiency. Apart from the technical constraints manifested in many water supply services, management systems fail to receive much attention from the concerned bodies. Among the major managerial and technical problems are: lack of appropriate organizational set-up; lack of trained manpower; limited involvement of stakeholders and investors ; low focus on preventive maintenance; poor recordings of assets, failure to ensure efficient use of assets and to optimize life of assets through timely maintenance, and disposition and replacement; limited funding, failure to understand the cost structure of the water supply system including private participation, and inability to undertake business and financial planning.

6.2. Recommendation

This thesis has attempted to examine "Access and adequacy of potable water in Adama City" using the potable water supply and demand scenario. The water demand of the City is increasing due to urbanization and population growth.

According to the survey results, consequently, in order to narrow the supply and demand gap of the city the following measures should be taken. The major driving forces for existing and potential development of the City, administrative to the required higher level, improved lifestyle of its Urban dwellers, availability of improved City infrastructures(especially potable water), Strategic location of the city on the highways connecting eastern and southern parts of the country. Expansion activities that match with the

City development must be carried out to meet the water requirements of the city. The concerned stakeholders should discharge their respective responsibility properly. The improvement of the water supply service for the city is fundamental so that the Adama City Administration with Water Supply Service and Sewerage Enterprise (AWSSSE) be aware of the problem, and committed to enhance the social welfare of the population through provision of adequate and equitable accesses/ distribution of water among the residents and the concerned stakeholders should discharge their respective responsibilities properly. The provision of this valuable service could also boost in turn socio-economic development of the city. Consequently,

Professional strategic planning & design of water supply to enhance development clearly demonstrates how to tackle the water supply problems of Adama city for the coming planning and designing periods. It comprises different components of planning elements like demand requirements of the development and investment of the city, the physical development plan indicates system components to be installed to meet the water supply service plan , bbudgeting and financing plan outlines the total cost and financing plan required to implement the planning & design.Major programs and plans are necessary to support the Enterprise's effort to provide safe drinking water supply service to city populations taking into account of future growth of population and urban development. ACWSSSE should devise a mechanism so as to assure the equitable distribution of water among the residents and the concerned stakeholders should discharge their respective responsibilities properly. Additional study should be conducted to find out other possible causes for water shortage so as to act accordingly as mentioned below.

Phase 1 Immediate Improvement and Rehabilitation Project

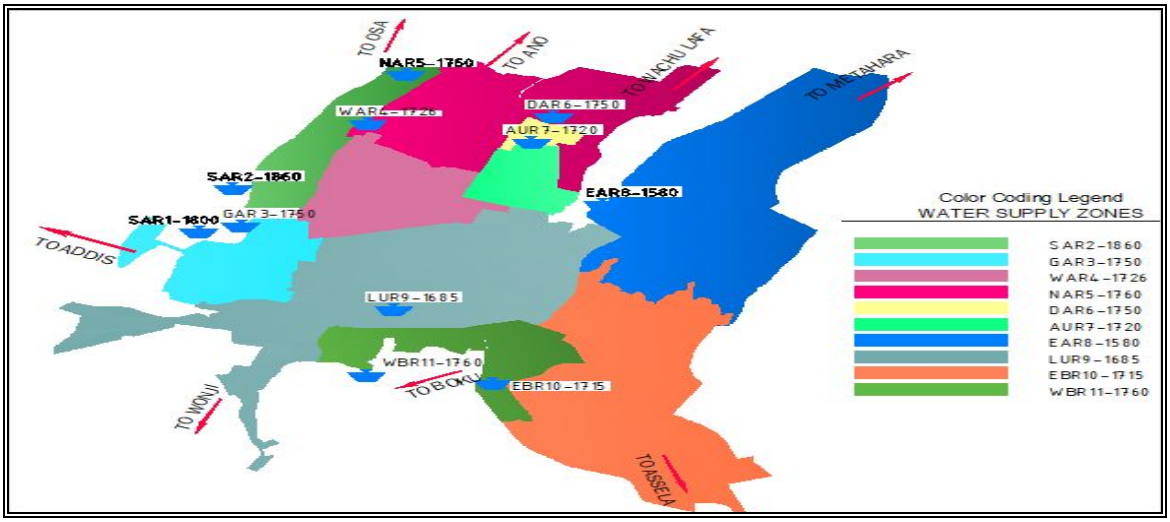
The design life of some existing system has been reached to phased out and needs to be rehabilitated before water shortage crises ad disaster will take place. The existing distribution system covers around 75% physical of the Master Plan area of the city some part abounded water supply . It has also limited to the central lowlands of Adama city, it should be expanded to the highland areas to solve the current water shortage of the residents. The improvement requirements of the potable water supply for Adama City will thus include the following short and long term will provide recommendations; as mentioned above, majority of urban residents did not have basic access of water for their domestic needs; it implies adequate and reliable water supply is critical for coping with every day urban life. So that rehabilitation of pipe lines, Electro Mechanical equipment, civil work component, water loss reduction program due to frequent pipe bursts and excessive leakages in the network due to the existence of oldest pipe lines have also decreasing the coverage capacity of the service. Preparation and updating of water supply system maps; planning Proposal and implementation of improved practices for the location and repair of damaged pipes; continuous leakage detection surveys of all pipelines; Institutional development

planning to operate at the required level of satisfaction and efficiency, to solve the major managerial and technical problems including lack of appropriate organizational set-up; to capacitate weak management systems, lack of trained manpower; water resource protection by encouraging limited involvement of pertinent stakeholders are some required immediate actions.

Phase 2 Planning & design of adequate and reliable potable water supply Major Project

Currently Awash River is used for irrigation farming by the inhabitants of downstream residents. This implies that shearing of Awash River for Adama City potable Water source creates more pressure on the river flow and this may lead to conflict of interest with the community using Awash River water for irrigation farming at downstream. The Ground water source by drilling boreholes was more sustainable for future development of the City. So that developing principal alternative sources for meeting the demand requirements of the city have been required.

Figure 40**:** Map of the potable water d loop distribution zones of Adama City



Source:- Computed/ reorganized from Adama City WSSSE & Own data with software .June 2020

In this case the distribution network is divided into reliable zones to avoid risking leaks and bursts in the distribution system, to integrate and use the existing reservoirs, to minimize customers complaining for unbalanced and unfair water distribution service due to undulating topography of the City, each distribution zone is commanded by respective reservoirs, as presented in Figure above.

Regarding to Service Reservoirs the storage volume required for service reservoirs have to be large enough to accommodate the cumulative differences between water supply and demands plus 10% provision for emergency cases such as power interruptions and repair works. Service reservoirs are located at higher ground elevations where water will be distributed to target communities with flow of gravity. By doing so, the need of booster pump stations will be avoided. The storage volume required for service reservoirs have to be large enough to

accommodate the cumulative differences between water supply and demands plus provision for emergency cases such as firefighting, power interruptions and repair works. Capacities are thus determined by calculating one third of maximum day demand plus 10% reserve.

The next planning & design service reservoirs are designed to distribute about 2,090 l/s(180,579.69 m3 /day)of the total Peak Hour Demand of Phase II to Adama Town , through respective distribution proposed zones as shown on the above figure networks by flow of gravity. Multipurpose Reservoirs; those reservoirs ; which have dual purposes that is transfer and service functions shall be sized by adding the requirements of both transfer and service capacities. Standardization principle has been established in sizing of reservoirs without affecting the storage requirements. This principle is significant for the following major purposes. Regarding to evaluation of the capacities of reservoirs proved that the total storage capacities of existing reservoirs cover only 40 %(Total Capacity Required =1/3 of (100,526 m^3)) of the requirement which is 13,200m3. As mentioned in the above sections, majority of urban residents did not have basic access of water for their domestic needs; it implies adequate and reliable water supply is critical for surviving with every day urban life. Up grading the existing Source of Awash River was comment to be used as a source for Adama City potable Water source by ACWSSSE.

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Research questionnaire

CHECK LIST FOR STUDY AND DESIGN

"Access and adequacy of potable water in Adama City"

I. Executive summary

- Short summary of the Adama city WSSS ENTERPRISE -- Adama City & Surrounding Community Serve from Enterprise
- The total beneficiaries of the project -- Estimated to 320048 out of 432,300 Estimated population

Description	2012	2016	2017	2018	2019
Total Population			399,268	399,268	430,851
Population served with potable water				331892	333,048
potable water coverage(%)				83%	77.31

- Adama City 5 Years potable Water Coverage from Adama city WSSS ENTERPRISE
- In 2011 & 2012 , the potable water coverage of Adama City was reported to be ---77.3%--- % & --- 77.3% out of 432,300 population ---

II. Scope and methodology

1. Physical description of the project area

1.1. Water Quality

- Existing water supply quality standard (Both as WHO and National standard---------- Satisfy the WHO standard
- Existing sources of pollutants (if any) Awash River Industry Treatment
- Water types of the area (hydrochemistry), if possible ----------

1.2. Water resources potential

1.2.1. Surface water

- Rivers, stream, ponds, and etc---------- Awash River

* Kebeles with Light suffering with potable water. Boku Medkanalem (of Kebele, Boku Sharar & Lugo Area
* High demand Areas central part of City & Industrial Zone

- its discharge---43,270--- (m3/day) but reliable
- Its reliable flows during wet and dry period---decrease in quantity
- Types of streams/river (perennial or intermittent) ---Awash River
- If possible stream flow discharge data ----------

1.2.2. Groundwater

-Borehole data ---proposed from modjo deep well--- its discharge---different size

1.2.3. Water supply sources

- Existing ---Surface water (Awash River)
- Proposed ---Ground Water (RH)---its discharge---------- (m3/day)

1.2.4. Conclusion and Recommendation

Conclusion

- Verification of water resources potential by giving attention on the proposed sources ---Modjo Area deep well fields Very important to solve the suffering--- Procedures followed to reach upon my proposal etc ----------

Recommendation

- Forward my recommendation that think important in the design part-------
---Modjo Area well fields (deep well proposed)---
- Recommend things that may be beyond your capacity to reach upon good decision ---Budget (Very Investment Required)---

2. Socio- economic survey

2.1. Population and Growth

Present Population ---420,851--- Estimated population size ---333,048 Served---

Note 77.2

2.2. Social services

2.2.1. Health

- Hospital, health center, clinic, health post etc ----------

---

2.2.2. Education

- Kindergarten, Elementary school, high school, Preparatory and etc----------

---

5.0.Water demand

3. **Water demand**/Present & future water demand Analysis

- *individual water consumption rate(per capital demand)*---------- 80 l/p/day m3/day
- Domestic water demand---------- 11,211 ----------m3/day
- The present daily average water demand ---------- 47,804.2 m/day
- The present period max. daily water demand ---------- 57,365.04
- Peak daily water demand ---------- 91,784.1 ----------
- Non- domestic Water Demands normally include the following categories

a. Industrial Water Demand, ----------

b. Commercial and Public Water Demands----------

c. Livestock Water Demand, ----------

d. Unaccounted For Water (UFW) ----------

e. Water Demand for Fire Fighting----------

4. ZONES of Existing Rising Mains, Gravity Mains and Distribution Main.(only sample)

S/NO	ZONE	Diameter(mm)	Material	Length (km)	Year of Installation	Remark
1	GELMA ABBA GEDA	rom Koka to WR 600mm & 400m istribute Different size	DCI, GS and u PVC & HDPE		BEFORE 2008 ------ YEARS	
2	LUGO SZ	From Koka to WR 600mm then distribute with <=600 Different size			BEFORE 1994 ------YEARS	
3	ADAMA UNI.	<= ---------- Different size 300 mm			BEFORE 1998 ------YEAR	
4	DHEGA ADI	<= ---------- Different size 200 MM			BEFORE 2006 -----YEAR	

5. **Electromechanical**

Pump Capacity

- Quality of water (temperature, corrosively, abrasiveness)----------

---

- Power supply capacities
- *Pump Capacity No of pump* Design Head, Design discharge and type -- 8 different type

---

Power Source & capacity---------- 110 KW - 250 KW required

S/NO	NAME OF THE PUMP STSTION	SPECIFIC LOCATION	DESIGN DISCHARGE (m3/hr)	DESIGN HEAD(m)	STAND BY POWER (KW)	REMARK
1	Koka Dam/ wet well/sump	Awash River	2 pumps each -----	444	Yes------ KVA 320 kw	No Scada
2	02	Gelaw deyas.	------ pumps each -----	144	yes 250kv	
3	Boku Shoma	Kobé Gebaya	------ pumps each -----	144		

6. **Existing Water Treatment Facilities**----------

7. **Existing Storage Facilities in the Project area**

Location	Storage Capacity(m^3)	Ground Level*m (asl)	Service
GELMA ABBA GEDA	4000 &200	1754	Receives water from Koka Dam/ wet well/sump/ Acts as a storage
LUGO SZ	4000 K 2000	1685	distribute to Customer Boku reservoir
ADAMA UNI. SZ		1720	Adama University
DHEGA ADI SZ		1746	distribute to customer
EAST BOKU SZ Pump Station		1622	Received from Lugo distribute to Customer
WEST BOKU SZ Reservoir		1722?	
EAST ADAMA SZ			
NORTH ADAMA SZ			
SIRE A/BUNE SZ			

Research questionnaire

Research questionnaire for thesis proposal --"Access and adequacy of potable water in Adama City"

PART ONE:

I. Socio-economic and demographic characteristics:

1. Region---------- Oromia
2. District----------Adama City
3. Adama Sub City----------
4. Kebele----------
5. Name of the respondent----------
6. Sex of the respondent----------

7. Age of the respondent----------
8. Educational status of the respondent:
    a. Illiterate, b. Read & write, c. 1-8th grade, d. 9-10 grade,
    e. Preparatory, f. Diploma, g. Degree, h. Other, specify……..
9. Marital Status of the respondent:
    a. Single, b. Married c. Divorced, d. Widowed.
10. Religion of the respondent:
    a. Christian, b. Muslim, c. Other, specify……
11. Number of household members contributed work to the household;
    a. Single, b. Two, c. Three, d. Four, e. Five, f. Greater than five.
12. What is your relation with the head of the household?
    a. Wife, b. Maid, c. Daughter, d. Head of the house, e. Other-(specify) ---
13. Type of your living houses (with the intervention);
    a. Thatched roof Hut,
    b. Corrugated iron,
    c. Other (specify) ---
    d. Occupation:Agriculture b. Daily labourer c. Petty trade, Other (specify)----------

PART TWO:

II. Questions about economic income & services

1. Major sources of income for the family/household:

Trade-------- Petty trade-------Employee's--------Private work, --------Daily labourer, --------Other (specify) --------

2. Land holding size of the household----------m2.
    a. Do you have a monetary income, were you able to save money and if yes, how much (per month)? Yes, b. No.

If yes, how much per month?

a. Less than 100 Birr, b.101-200 Birr,
b. 201-300 Birr,
c. 301-400 Birr,
d. 401-500 Birr,
e. 501-1000 Birr,
f. Greater than 1000 Birr,
g. Don't know.

3. Distance you live away from main road----------m;
4. Distance you live away from drinking water sources----------m;
5. Does the household get adequate drinking water every day? a. Yes, b. No.

5.1. Domestic water demand

- House connection (HC).70-1000 l/c/day ----------
- Yard connection 30-40 l/c/day,----------
- own (YCO) Yard connection, ----------
- shared (YCS) 40-50 l/c/day ----------
- Public tap supplies (PT)30-40 l/c/day ----------

5.2. If yes, how many & how many times do you/and your family take drinking water per day?

a. Once, b. Twice c. Three times d. Four times& above

6. How many minutes do you spend in your fetching drinking water activities per day? ----------
7. Are you satisfied with the quality of drinking water provided to you?

a. Yes b. No

8. Is your annual income enough for you and your family?

a. Yes, b. No

8.1. If yes, why? ---------

8.2. If no, why? ------

9. What is your future plan to improve your income your family take drinking water as required? ----------

Name of Enumerator: ----------

Signature: ----------

Date: ----------

I. Research questionnaire

Hangatu peak area

Research questionnaire for thesis proposal --"Access and adequacy of potable water in Adama City"

PART ONE:

I. Socio-economic and demographic characteristics:

1. Region---------- Oromia
2. District----------Adama City
3. Adama Sub City---------- Dabe
4. Kebele---------- Hangatu
5. Name of the respondent---------- Yitbarek Tesfaye
6. Sex of the respondent---------- Female
7. Age of the respondent---------- 32
8. Educational status of the respondent:
   a. Illiterate, b. Read & write, c. 1-8th grade, d. 9-10 grade,
   e. Preparatory, (f.) Diploma, g. Degree, h. Other, specify.....
9. Marital Status of the respondent:
   a. Single, (b.) Married c. Divorced, d. Widowed.
10. Religion of the respondent:
    (a.) Christian, b. Muslim, c. Other, specify.....
11. Number of household members contributed work to the household;
    a. Single, (b.) Two, c. Three, d. Four, e. Five, f. Greater than five.
12. What is your relation with the head of the household?
    (a.) Wife, b. Maid, c. Daughter, d. Head of the house, e. Other-(specify) ---
13. Type of your living houses (with the intervention);
    a. Thatched roof Hut,
    (b.) Corrugated iron,
    c. Other (specify) ---
    d. Occupation:Agriculture b. Daily labourer c. Petty trade, Other (specify)- Private
    ---

Hangatu peak area

PART TWO:

II. Questions about economic income & services

1. Major sources of income for the family/household:
   Trade-------- Petty trade-------Employee's--------Private work, ---✓---Daily labourer, -----
   ---Other (specify) --------
2. Land holding size of the household------160------m2.
   a. Do you have a monetary income, were you able to save money and if yes, how much (per month)? Yes, (b.) No.

   If yes, how much per month?

   a. Less than 100 Birr, b.101-200 Birr,
   b. 201-300 Birr,
   c. 301-400 Birr,
   d. 401-500 Birr,
   e. 501-1000 Birr,
   f. Greater than 1000 Birr,
   (g.) Don't know.
3. Distance you live away from main road---------<5---------m;
4. Distance you live away from drinking water sources---------5---------m;
5. Does the household get adequate drinking water every day? a. Yes, (b.) No.
   5.1. Domestic water demand
   - House connection (HC).70-1000 l/c/day ---✓---
   - Yard connection 30-40 l/c/day,----------
   - own (YCO) Yard connection, ----------
   - shared (YCS) 40-50 l/c/day ----------

Hangatu peak area

- Public tap supplies (PT)30-40 l/c/day ----------

5.2. If yes, how many & how many times do you/and your family take drinking water per day?

(a.) Once, b. Twice c. Three times d. Four times& above

6. How many minutes do you spend in your fetching drinking water activities per day? ---------2 hr (Slow motion (velocity of flow)
7. Are you satisfied with the quality of drinking water provided to you?

   (a.) Yes b. No

8. Is your annual income enough for you and your family?

   a. Yes, (b.) No

   8.1. If yes, why? ---------
   8.2. If no, why? --- Not Satisfied
9. What is your future plan to improve your income your family take drinking water as required? --- To Change Their Work

Name of Enumerator: Yitbarek Tesfaye
Signature: ---
Date: 27 April 2012

Dudhacha Arara Near Medhanialem

I. Research questionnaire

Research questionnaire for thesis proposal --"Access and adequacy of potable water in Adama City"

PART ONE:

I. Socio-economic and demographic characteristics:

1. Region---------- Oromia
2. District----------Adama City
3. Adama Sub City---------- Bole
4. Kebele---------- Dadhacha Arara Near Medhanialem
5. Name of the respondent---------- 418 Hatebe Motuma
6. Sex of the respondent---------- Female
7. Age of the respondent---------- 48
8. Educational status of the respondent:
   a. Illiterate, (b.) Read & write, c. 1-8th grade, d. 9-10 grade,
   e. Preparatory, f. Diploma, g. Degree, h. Other, specify.....
9. Marital Status of the respondent:
   a. Single, (b.) Married c. Divorced, d. Widowed.
10. Religion of the respondent:
    (a.) Christian, b. Muslim, c. Other, specify.....
11. Number of household members contributed work to the household;
    a. Single, b. Two, c. Three, d. Four, e. Five, (f.) Greater than five.
12. What is your relation with the head of the household?
    a. Wife, b. Maid, c. Daughter, (d.) Head of the house, e. Other-(specify) ---
13. Type of your living houses (with the intervention);
    a. Thatched roof Hut,
    (b.) Corrugated iron,
    c. Other (specify) ---
    d. Occupation:Agriculture b. Daily labourer c. Petty trade, Other (specify)- Private
    ---

Dudhacha Arara Near Medhanialem

PART TWO:

II. Questions about economic income & services

1. Major sources of income for the family/household:
   Trade-------- Petty trade-------Employee's--------Private work, ---✓---Daily labourer, -----
   ---Other (specify) --------
2. Land holding size of the household------140------m2.
   a. Do you have a monetary income, were you able to save money and if yes, how much (per month)? Yes, (b.) No.

   If yes, how much per month?

   a. Less than 100 Birr, b.101-200 Birr,
   b. 201-300 Birr,
   c. 301-400 Birr,
   d. 401-500 Birr,
   e. 501-1000 Birr,
   f. Greater than 1000 Birr,
   (g.) Don't know.
3. Distance you live away from main road---------up to 150---------m;
4. Distance you live away from drinking water sources---------2 100---------m; (Not get yet)
5. Does the household get adequate drinking water every day? a. Yes, (b.) No.
   5.1. Domestic water demand
   - House connection (HC).70-1000 l/c/day ---✓---
   - Yard connection 30-40 l/c/day,----------
   - own (YCO) Yard connection, ----------
   - shared (YCS) 40-50 l/c/day ----------

Dudhacha Arara Near Medhanialem

- Public tap supplies (PT)30-40 l/c/day ----------

5.2. If yes, how many & how many times do you/and your family take drinking water per day?

(a.) Once, b. Twice c. Three times d. Four times& above

6. How many minutes do you spend in your fetching drinking water activities per day? ---------30
7. Are you satisfied with the quality of drinking water provided to you?

   (a.) Yes b. No

8. Is your annual income enough for you and your family?

   a. Yes, (b.) No

   8.1. If yes, why? ---------
   8.2. If no, why? ---------not enough
9. What is your future plan to improve your income your family take drinking water as required? --- To over come water try to borrow

Name of Enumerator: Hazel Motuma
Signature: ---
Date: April 2020

I. Research questionnaire

Research questionnaire for thesis proposal --"Access and adequacy of potable water in Adama City"

PART ONE:

I. Socio-economic and demographic characteristics:

1. Region---------- Oromia
2. District----------Adama City
3. Adama Sub City----------
4. Kebele----------
5. Name of the respondent----------
6. Sex of the respondent----------
7. Age of the respondent----------
8. Educational status of the respondent:
   a. Illiterate, b. Read & write, c. 1-8th grade, d. 9-10 grade,
   e. Preparatory, f. Diploma, g. Degree, h. Other, specify----------
9. Marital Status of the respondent:
   a. Single, b. Married c. Divorced, d. Widowed.
10. Religion of the respondent:
    a. Christian, b. Muslim, c. Other, specify----------
11. Number of household members contributed work to the household;
    a. Single, b. Two, c. Three, d. Four, e. Five, f. Greater than five.
12. What is your relation with the head of the household?
    a. Wife, b. Maid, c. Daughter, d. Head of the house, e. Other-(specify) ---
13. Type of your living houses (with the intervention):
    a. Thatched roof Hut,
    b. Corrugated iron,
    c. Other (specify) ---
    d. Occupation:Agriculture b. Daily labourer c. Petty trade, Other (specify)----------

Hargato Grenda Gara Peak

Date
A-Hargato (Female 19)
HH Genet Hurrisa
Female
42
bA degree & Diploma
Govern

PART TWO:

II. Questions about economic income & services

1. Major sources of income for the family/household:
   Trade--------- Petty trade-------Employee's--------Private work, --------Daily labourer, -----
   ---Other (specify) ---Government
2. Land holding size of the household----------160----------m2.
   a. Do you have a monetary income, were you able to save money and if yes, how much (per month)? (Yes), b. No.

   If yes, how much per month?

   a. Less than 100 Birr, b.101-200 Birr,
   b. 201-300 Birr,
   c. 301-400 Birr,
   d. 401-500 Birr,
   e. 501-1000 Birr,
   f. Greater than 1000 Birr,
   g. Don't know.
3. Distance you live away from main road----------<100 (but deficult)<100----------m;
4. Distance you live away from drinking water sources----------m;
5. Does the household get adequate drinking water every day? a. Yes, b. No.
   5.1. Domestic water demand
   - House connection (HC).70-1000 l/c/day ----------
   - Yard connection 30-40 l/c/day,----------
   - own (YCO) Yard connection, ----------
   - shared (YCS) 40-50 l/c/day ----------

Hargato Grenda Gara peak

- Public tap supplies (PT)30-40 l/c/day ----------

5.2. If yes, how many & how many times do you/and your family take drinking water per day?

a. Once, b. Twice c. Three times d. Four times& above (not Exact)

6. How many minutes do you spend in your fetching drinking water activities per day? ----1 day
7. Are you satisfied with the quality of drinking water provided to you?

   a. Yes b. No

8. Is your annual income enough for you and your family?

   a. Yes, b. No

   8.1. If yes, why? ---------
   8.2. If no, why? ------
9. What is your future plan to improve your income your family take drinking water as required? ----Up grade her Education level

Name of Enumerator: ----Genet Hurrisa
Signature: ----
Date: ----April 2020

Gara Lugo Upper area

I. Research questionnaire

Research questionnaire for thesis proposal --"Access and adequacy of potable water in Adama City"

PART ONE:

I. Socio-economic and demographic characteristics:

1. Region---------- Oromia
2. District----------Adama City
3. Adama Sub City----------Lugo.
4. Kebele----------Gaara Lugo
5. Name of the respondent----------Awjecho Leni
6. Sex of the respondent----------Male
7. Age of the respondent----------44
8. Educational status of the respondent:
   a. Illiterate, b. Read & write, c. 1-8th grade, d. 9-10 grade,
   e. Preparatory, f. Diploma, g. Degree, h. Other, specify----12 completed
9. Marital Status of the respondent:
   a. Single, b. Married c. Divorced, d. Widowed.
10. Religion of the respondent:
    a. Christian, b. Muslim, c. Other, specify----------
11. Number of household members contributed work to the household;
    a. Single, b. Two, c. Three, d. Four, e. Five, f. Greater than five.
12. What is your relation with the head of the household?
    a. Wife, b. Maid, c. Daughter, d. Head of the house, e. Other-(specify) ---
13. Type of your living houses (with the intervention):
    a. Thatched roof Hut,
    b. Corrugated iron,
    c. Other (specify) ---
    d. Occupation:Agriculture b. Daily labourer c. Petty trade, Other (specify)--Private
    ----

Gara Lugo Upper Area

PART TWO:

II. Questions about economic income & services

1. Major sources of income for the family/household:
   Trade--------- Petty trade-------Employee's--------Private work, ----Daily labourer, -----
   ---Other (specify) --------
2. Land holding size of the household----140----m2.
   a. Do you have a monetary income, were you able to save money and if yes, how much (per month)? Yes, b. No.

   If yes, how much per month?

   a. Less than 100 Birr, b.101-200 Birr,
   b. 201-300 Birr,
   c. 301-400 Birr,
   d. 401-500 Birr,
   e. 501-1000 Birr,
   f. Greater than 1000 Birr,
   g. Don't know.
3. Distance you live away from main road----<250----m;
4. Distance you live away from drinking water sources----<125----m;
5. Does the household get adequate drinking water every day? a. Yes, b. No.
   5.1. Domestic water demand
   - House connection (HC).70-1000 l/c/day ----
   - Yard connection 30-40 l/c/day,----------
   - own (YCO) Yard connection, ----------
   - shared (YCS) 40-50 l/c/day ----------

Gaara Lugo Upper Area

- Public tap supplies (PT)30-40 l/c/day ----------

5.2. If yes, how many & how many times do you/and your family take drinking water per day?

a. Once, b. Twice c. Three times d. Four times& above

6. How many minutes do you spend in your fetching drinking water activities per day? ----7.1 days
7. Are you satisfied with the quality of drinking water provided to you?

   a. Yes b. No

8. Is your annual income enough for you and your family?

   a. Yes, b. No

   8.1. If yes, why? ---------
   8.2. If no, why? ----Not known
9. What is your future plan to improve your income your family take drinking water as required? ----Change The Service

Name of Enumerator: ----Awjecho Leni
Signature: ----
Date: ----April 2020

I. Research questionnaire

Chafee Around Kella

Research questiunnaire for thesis proposal --"Access and adequacy of potable water in Adama City"

PART ONE:

I. Socio-economic and demographic characteristics:

1. Region---------- Oromia
2. District---------- Adama City
3. Adama Sub City---------- Dabe
4. Kebele---------- Chafee Meturoa Dadi
5. Name of the respondent---------- [illegible]
6. Sex of the respondent---------- Male
7. Age of the respondent---------- 58
8. Educational status of the respondent:
   a. Illiterate, (b) Read & write, c. 1-8th grade, d. 9-10 grade,
   e. Preparatory, f. Diploma, g. Degree, h. Other, specify.....
9. Marital Status of the respondent:
   a. Single, (b) Married c. Divorced, d. Widowed.
10. Religion of the respondent:
    (a) Christian, b. Muslim, c. Other, specify.....
11. Number of household members contributed work to the household:
    a. Single, b. Two, c. Three, (d) Four, e. Five, f. Greater than five.
12. What is your relation with the head of the household?
    a. Wife, b. Maid, c. Daughter, (d) Head of the house, e. Other-(specify) ---
13. Type of your living houses (with the intervention);
    a. Thatched roof Hut,
    (b) Corrugated iron,
    c. Other (specify) ---
    d. Occupation:Agriculture b. Daily labourer c. Petty trade, Other (specify) Non Gove

Chafee Around Kella

PART TWO:

II. Questions about economic income & services

1. Major sources of income for the family/household:
   Trade-------- Petty trade-------Employee's--------Private work, ---(6)---Daily labourer, -----
   ---Other (specify) --------
2. Land holding size of the household---- 140 ----m2.
   a. Do you have a monetary income, were you able to save money and if yes, how much (per month)? Yes, (b) No.
   If yes, how much per month?
   a. Less than 100 Birr, b.101-200 Birr,
   b. 201-300 Birr,
   c. 301-400 Birr,
   d. 401-500 Birr,
   e. 501-1000 Birr,
   f. Greater than 1000 Birr,
   (g) Don't know.
3. Distance you live away from main road---------- < 50 ----------m;
4. Distance you live away from drinking water sources---------- < 500 ----------m;
5. Does the household get adequate drinking water every day? a. Yes, b. No.
   5.1. Domestic water demand
   - House connection (HC).70-1000 l/c/day ---(c)---
   - Yard connection 30-40 l/c/day,----------
   - own (YCO) Yard connection, ----------
   - shared (YCS) 40-50 l/c/day ----------

Kella

- Public tap supplies (PT)30-40 l/c/day ----------

5.2. If yes, how many & how many times do you/and your family take drinking water per day?

(a) Once, b. Twice c. Three times d. Four times& above

6. How many minutes do you spend in your fetching drinking water activities per day? ---- 7-80 hr.
7. Are you satisfied with the quality of drinking water provided to you?
   (a) Yes (b) No
8. Is your annual income enough for you and your family?
   a. Yes, (b) No
   8.1. If yes, why? ----
   8.2. If no, why? ---- To charge their Wife
9. What is your future plan to improve your income your family take drinking water as required? ---- Work Style Change. Plan

Name of Enumerator: Meturoa Dadi
Signature: [signature]
Date: April 2020

I. Research questionnaire

Dabe Soloka

Research questionnaire for thesis proposal --"Access and adequacy of potable water in Adama City"

PART ONE:

I. Socio-economic and demographic characteristics:

1. Region---------- Oromia
2. District---------- Adama City
3. Adama Sub City---------- Dabe
4. Kebele---------- Dabe Soloka Ayantu Soloka
5. Name of the respondent----------
6. Sex of the respondent---------- Female
7. Age of the respondent---------- 42
8. Educational status of the respondent:
   a. Illiterate, b. Read & write, c. 1-8th grade, d. 9-10 grade,
   e. Preparatory, (f) Diploma, g. Degree, h. Other, specify.....
9. Marital Status of the respondent:
   a. Single, (b) Married c. Divorced, d. Widowed.
10. Religion of the respondent:
    (a) Christian, b. Muslim, c. Other, specify.....
11. Number of household members contributed work to the household:
    a. Single, b. Two, c. Three, d. Four, (e) Five, f. Greater than five.
12. What is your relation with the head of the household?
    (a) Wife, b. Maid, c. Daughter, d. Head of the house, e. Other-(specify) ---
13. Type of your living houses (with the intervention);
    a. Thatched roof Hut,
    (b) Corrugated iron,
    c. Other (specify) ---
    d. Occupation:Agriculture b. Daily labourer c. Petty trade, Other (specify) Non-Government.

Dabe Soloka

PART TWO:

II. Questions about economic income & services

1. Major sources of income for the family/household:
   Trade-------- Petty trade-------Employee's--------Private work, ---------Daily labourer, -----
   ---Other (specify) ---Non goverment
2. Land holding size of the household----------m2.
   a. Do you have a monetary income, were you able to save money and if yes, how much (per month)? (Yes) b. No.
   If yes, how much per month?
   a. Less than 100 Birr, b.101-200 Birr,
   b. 201-300 Birr,
   c. 301-400 Birr,
   d. 401-500 Birr,
   e. 501-1000 Birr,
   (f) Greater than 1000 Birr,
   g. Don't know.
3. Distance you live away from main road---------- 1-50 ----------m.
4. Distance you live away from drinking water sources---------- 150 ----------m.
5. Does the household get adequate drinking water every day? a. Yes, (b) No.
   5.1. Domestic water demand
   - House connection (HC).70-1000 l/c/day ---(c)---
   - Yard connection 30-40 l/c/day,----------
   - own (YCO) Yard connection, ----------
   - shared (YCS) 40-50 l/c/day ----------

Dabe Soloka

- Public tap supplies (PT)30-40 l/c/day ----------

5.2. If yes, how many & how many times do you/and your family take drinking water per day?

(a) Once, b. Twice c. Three times d. Four times& above

6. How many minutes do you spend in your fetching drinking water activities per day? ---- 2-30 Min
7. Are you satisfied with the quality of drinking water provided to you?
   (a) Yes b. No
8. Is your annual income enough for you and your family?
   a. Yes, (b) No
   8.1. If yes, why? ----
   8.2. If no, why? ----(c)---
9. What is your future plan to improve your income your family take drinking water as required? ---- Not planned

Name of Enumerator: Ayantu Soboka
Signature: [signature]
Date: April 2020

I. Research questionnaire

Dhaka Adi Border part

Research questionnaire for thesis proposal --"Access and adequacy of potable water in Adama City"

PART ONE:

I. Socio-economic and demographic characteristics:

1. Region---------- Oromia
2. District---------- Adama City
3. Adama Sub City---------- Bole
4. Kebele---------- Dhaka Adi #2 Chaltu Hasi
5. Name of the respondent----------
6. Sex of the respondent---------- Female
7. Age of the respondent---------- 42
8. Educational status of the respondent:
   a. Illiterate, (b.) Read & write, c. 1-8th grade, d. 9-10 grade,
   e. Preparatory, f. Diploma, g. Degree, h. Other, specify.....
9. Marital Status of the respondent:
   a. Single, (b.) Married c. Divorced, d. Widowed.
10. Religion of the respondent:
    a. Christian, b. Muslim, c. Other, specify..... Kolefecha
11. Number of household members contributed work to the household;
    a. Single, b. Two, c. Three, d. Four, (e.) Five, f. Greater than five.
12. What is your relation with the head of the household?
    (a.) Wife, b. Maid, c. Daughter, d. Head of the house, e. Other-(specify) ---
13. Type of your living houses (with the intervention);
    a. Thatched roof Hut,
    (b.) Corrugated iron,
    c. Other (specify) ---
    d. Occupation:Agriculture b. Daily labourer c. Petty trade, Other (specify)- Private

Dhaka Adi Border part

PART TWO:

II. Questions about economic income & services

1. Major sources of income for the family/household:
   Trade-------- Petty trade-------Employee's--------Private work, ✓ -----Daily labourer, -----
   ---Other (specify) --------
2. Land holding size of the household---150---m2.
   a. Do you have a monetary income, were you able to save money and if yes, how much (per month)? (Yes,) b. No.

   If yes, how much per month?

   a. Less than 100 Birr, b.101-200 Birr,
   b. 201-300 Birr,
   c. 301-400 Birr,
   d. 401-500 Birr,
   e. 501-1000 Birr,
   f. Greater than 1000 Birr,
   (g.) Don't know.
3. Distance you live away from main road---------250---------m;
4. Distance you live away from drinking water sources---------120---------m;
5. Does the household get adequate drinking water every day? a. Yes, (b.) No.
   5.1. Domestic water demand
   - House connection (HC).70-1000 l/c/day ----------
   - Yard connection 30-40 l/c/day,----------
   - own (YCO) Yard connection, ----------
   - shared (YCS) 40-50 l/c/day ----------✓

Dhaka Adi Border part

- Public tap supplies (PT)30-40 l/c/day ----------

5.2. If yes, how many & how many times do you/and your family take drinking water per day?

a. Once, (b.) Twice c. Three times d. Four times& above

6. How many minutes do you spend in your fetching drinking water activities per day? ---up to 30min---
7. Are you satisfied with the quality of drinking water provided to you?

   a. Yes (b.) No

8. Is your annual income enough for you and your family?

   a. Yes, (b.) No

   8.1. If yes, why? ---------
   8.2. If no, why? ------
9. What is your future plan to improve your income your family take drinking water as required? ---to up grade their work---

Name of Enumerator: Chaltu Hasi
Signature: Chaltu Hasi
Date: April 2020

I. Research questionnaire

Goroo - Upper

Research questionnaire for thesis proposal --"Access and adequacy of potable water in Adama City"

PART ONE:

I. Socio-economic and demographic characteristics:

1. Region---------- Oromia
2. District---------- Adama City
3. Adama Sub City---------- Bole
4. Kebele---------- Goroo
5. Name of the respondent---------- Abu Sadesa
6. Sex of the respondent---------- Female
7. Age of the respondent---------- 34
8. Educational status of the respondent:
   a. Illiterate, b. Read & write, c. 1-8th grade, d. 9-10 grade,
   e. Preparatory, (f.) Diploma, g. Degree, h. Other, specify.....
9. Marital Status of the respondent:
   a. Single, b. Married c. Divorced, d. Widowed.
10. Religion of the respondent:
    (a.) Christian, b. Muslim, c. Other, specify.....
11. Number of household members contributed work to the household;
    a. Single, b. Two, c. Three, (d.) Four, e. Five, f. Greater than five.
12. What is your relation with the head of the household?
    (a.) Wife, b. Maid, c. Daughter, d. Head of the house, e. Other-(specify) ---
13. Type of your living houses (with the intervention);
    a. Thatched roof Hut,
    (b.) Corrugated iron,
    c. Other (specify) ---
    d. Occupation:Agriculture b. Daily labourer c. Petty trade, Other (specify) private

Goro - Upper

PART TWO:

II. Questions about economic income & services

1. Major sources of income for the family/household:
   Trade-------- Petty trade-------Employee's--------Private work, ✓ -----Daily labourer, -----
   ---Other (specify) --------
2. Land holding size of the household---140---m2.
   a. Do you have a monetary income, were you able to save money and if yes, how much (per month)? Yes, (b.) No

   If yes, how much per month?

   a. Less than 100 Birr, b.101-200 Birr,
   b. 201-300 Birr,
   c. 301-400 Birr,
   d. 401-500 Birr,
   e. 501-1000 Birr,
   f. Greater than 1000 Birr,
   (g.) Don't know.
3. Distance you live away from main road---------410---------m;
4. Distance you live away from drinking water sources---------8---------m;
5. Does the household get adequate drinking water every day? a. Yes, (b.) No.
   5.1. Domestic water demand
   - House connection (HC).70-1000 l/c/day ----------✓
   - Yard connection 30-40 l/c/day,----------
   - own (YCO) Yard connection, ----------
   - shared (YCS) 40-50 l/c/day ----------

Goro - Upper part

- Public tap supplies (PT)30-40 l/c/day ----------

5.2. If yes, how many & how many times do you/and your family take drinking water per day?

(a.) Once, b. Twice c. Three times d. Four times& above

6. How many minutes do you spend in your fetching drinking water activities per day? 2hr. (Very slow velocity)
7. Are you satisfied with the quality of drinking water provided to you?

   (a.) Yes b. No

8. Is your annual income enough for you and your family?

   (a.) Yes, b. No

   8.1. If yes, why? ---✓
   8.2. If no, why? ------
9. What is your future plan to improve your income your family take drinking water as required? ---Improve their life---

Name of Enumerator: Cebise Abu
Signature:
Date: April 2020

I. Research questionnaire

Boku Robe Geleya

Research questionnaire for thesis proposal --"Access and adequacy of potable water in Adama City"

PART ONE:

I. Socio-economic and demographic characteristics:

1. Region---------- Oromia
2. District---------- Adama City
3. Adama Sub City---------- Boku
4. Kebele---------- Boku
5. Name of the respondent---------- Mulugeta Serbeb
6. Sex of the respondent---------- Female
7. Age of the respondent---------- 68
8. Educational status of the respondent:
   a. Illiterate, b. Read & write, c. 1-8th grade, d. 9-10 grade,
   e. Preparatory, f. Diploma, g. Degree, h. Other, specify.....
9. Marital Status of the respondent:
   a. Single, b. Married c. Divorced, d. Widowed.
10. Religion of the respondent:
    a. Christian, b. Muslim, c. Other, specify.....
11. Number of household members contributed work to the household:
    a. Single, b. Two, c. Three, d. Four, e. Five, f. Greater than five.
12. What is your relation with the head of the household?
    a. Wife, b. Maid, c. Daughter, d. Head of the house, e. Other-(specify) ---
13. Type of your living houses (with the intervention):
    a. Thatched roof Hut,
    b. Corrugated iron,
    c. Other (specify) ---
    d. Occupation:Agriculture b. Daily labourer c. Petty trade, Other (specify) House Maker

Boku Robe Geleya

PART TWO:

II. Questions about economic income & services

1. Major sources of income for the family/household:
   Trade------ Petty trade------Employee's------Private work, ------Daily labourer, -----
   ---Other (specify) ---------
2. Land holding size of the household---------160---------m2.
   a. Do you have a monetary income, were you able to save money and if yes, how much (per month)? Yes, b. No.

   If yes, how much per month?

   a. Less than 100 Birr, b.101-200 Birr,
   b. 201-300 Birr,
   c. 301-400 Birr,
   d. 401-500 Birr,
   e. 501-1000 Birr,
   f. Greater than 1000 Birr,
   g. Don't know.
3. Distance you live away from main road---------> 200m---------m;
4. Distance you live away from drinking water sources---------> 200---------m;
5. Does the household get adequate drinking water every day? a. Yes, b. No.
   5.1. Domestic water demand
   - House connection (HC).70-1000 l/c/day ----------
   - Yard connection 30-40 l/c/day,----------
   - own (YCO) Yard connection, ----------
   - shared (YCS) 40-50 l/c/day ----------

Boku Robe Geleya

- Public tap supplies (PT)30-40 l/c/day ----------

5.2. If yes, how many & how many times do you/and your family take drinking water per day?

a. Once, b. Twice c. Three times d. Four times& above

6. How many minutes do you spend in your fetching drinking water activities per day? ----45
7. Are you satisfied with the quality of drinking water provided to you?

   a. Yes b. No

8. Is your annual income enough for you and your family?

   a. Yes, b. No

   8.1. If yes, why? ----------

   8.2. If no, why? ----There is don't hard

9. What is your future plan to improve your income your family take drinking water as required? ----Be rich old----------

Name of Enumerator: ---Mulugeta Serbeb

Signature: ----------

Date: ---April 2020

Road to Asella

I. Research questionnaire

Research questionnaire for thesis proposal --"Access and adequacy of potable water in Adama City"

PART ONE:

I. Socio-economic and demographic characteristics:

1. Region---------- Oromia
2. District---------- Adama City
3. Adama Sub City---------- Boku
4. Kebele---------- Megira
5. Name of the respondent---------- Testaye Hailu
6. Sex of the respondent---------- Male
7. Age of the respondent---------- 52
8. Educational status of the respondent:
   a. Illiterate, b. Read & write, c. 1-8th grade, d. 9-10 grade,
   e. Preparatory, f. Diploma, g. Degree, h. Other, specify.....
9. Marital Status of the respondent:
   a. Single, b. Married c. Divorced, d. Widowed.
10. Religion of the respondent:
    a. Christian, b. Muslim, c. Other, specify.....
11. Number of household members contributed work to the household:
    a. Single, b. Two, c. Three, d. Four, e. Five, f. Greater than five.
12. What is your relation with the head of the household?
    a. Wife, b. Maid, c. Daughter, d. Head of the house, e. Other-(specify) ---
13. Type of your living houses (with the intervention):
    a. Thatched roof Hut,
    b. Corrugated iron,
    c. Other (specify) ---
    d. Occupation:Agriculture b. Daily labourer c. Petty trade, Other (specify) Private

Road to Asella

Megra - kebele

PART TWO:

II. Questions about economic income & services

1. Major sources of income for the family/household:
   Trade--------- Petty trade-------Employee's-------Private work, ------Daily labourer, -----
   ---Other (specify) ---------
2. Land holding size of the household---------158---------m2.
   a. Do you have a monetary income, were you able to save money and if yes, how much (per month)? Yes, b. No.

   If yes, how much per month?

   a. Less than 100 Birr, b.101-200 Birr,
   b. 201-300 Birr,
   c. 301-400 Birr,
   d. 401-500 Birr,
   e. 501-1000 Birr,
   f. Greater than 1000 Birr,
   g. Don't know.
3. Distance you live away from main road---------250---------m;
4. Distance you live away from drinking water sources---------250---------m;
5. Does the household get adequate drinking water every day? a. Yes, b. No.
   5.1. Domestic water demand
   - House connection (HC).70-1000 l/c/day ----------
   - Yard connection 30-40 l/c/day,----------
   - own (YCO) Yard connection, ----------
   - shared (YCS) 40-50 l/c/day ----------

Megra kebele Road to Asella

- Public tap supplies (PT)30-40 l/c/day ----------

5.2. If yes, how many & how many times do you/and your family take drinking water per day?

a. Once, b. Twice c. Three times d. Four times& above

6. How many minutes do you spend in your fetching drinking water activities per day? ----45
7. Are you satisfied with the quality of drinking water provided to you?

   a. Yes b. No

8. Is your annual income enough for you and your family?

   a. Yes, b. No

   8.1. If yes, why? ----------

   8.2. If no, why? ----No work some times

9. What is your future plan to improve your income your family take drinking water as required? ----------

Name of Enumerator: ---Testaye Hailu

Signature: ---TESTAYE HAILU.

Date: ---April 2020