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Utility Service Provision from Planning Perspective (The case of Debre Birhan Town, ANRS, Ethiopia

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Acronyms/Abbreviations

AA Addis Ababa
AMP-DB asset management Plan of Debre Birhan Town
ANRS Amhara National Regional State
ASDR Age Specific Death Rate
CSA Central Statistical Authority/Agency
DB Debre Birhan
DBU Debre Birhan University
EBCS Ethiopian Building Code Standards
EEPCO Ethiopia Electric Power Corporation
EEP Ethiopian Electric Power
ECSU Ethiopian Civil Service University
EIA Environmental Impact Assessment
EMA Ethiopian Metrological Agency
EPE Environmental Policy of Ethiopia
GER Gross Enrolment Ratio
GFR General Fertility Rate
GMFR General Marital Fertility Rate
GRR Gross Reproductive Rate
Ha Hectare
HH Household
HIV Human Immunodeficiency Virus
HU Housing Unit
IMR Infant Mortality Rate
Kebele The lowest administration unit in the municipality structure
m.a.s.l meter above sea level
MoUDC Ministry of Urban Development and Construction
MoUDHC Ministry of Housing, Urban Development and Construction
NGO Non Governmental Organization
NUPI National Urban Planning Institute
RES Reservoir
RUPI Regional Urban Planning Institute
RH Relative Humidity
SP Structure Plan
SWOT Strength, Weakness, Opportunity and Treats
TFR Total Fertility Rate
UN United Nation
WHO World Health Organization

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Abstract

Like in any other developing countries, urban centers in our country are growing rapidly and residing a lot of people. Consequently, alleviation of urban problems has already become one of the prime agenda and attracts the attention of decision makers at all levels (Federal, Regional and City Governments). With such understanding scholars, practitioners, federal and regional governments are giving attention for solutions emanated from scientific research. Accordingly, this study has given a focus to undertake situational analysis on Utility Service/infrastructure provision in Debre Birhan Town in order to compile all relevant data, generate information and document them to enables city planners and engineers understand very well the context and to give required information for municipality administers which capacitate them in their day to day activities of the town particularly to respond for infrastructure demand. In light of this all necessary data based on scientific research methodology has been gathered and analyzed with respect to the nation interest and programs; and norms and standards. The theme under this study covers, major Utility infrastructure which dominantly owned and run by the government like water supply, Electricity, Telecommunication, Drainage and Sewer system. On top of questionnaires, reviewing the compiled documents of each sector a face to face discussion with respected professionals and a focus group discussion was conducted. Finally, after identifying the related SWOT of the town recommendations have been forwarded.

Chapter One

1. Introduction

1.1 Background of the Study

1.1.1 Historical Development of Debre Birhan

1.1.1.1 Historical Foundation and Naming

According to the chronicler of Emperor Zara Yaqob, Debre Birhan was founded by the Emperor Zara Yaqob as a capital for his empire in 1454 in connection with the appearance of Orthodox Church which was ordered and established by the Emperor in response to a miraculous light that was seen in the sky. During this time its name was Debre Eba, which was changed in to the present name (that is Debre Birhan) during his reign in association with that light descended on it (near the present Debre Birhan Sellassie Church).

Figure 1. 1 ***Views of Debre Birhan Sellassie Church and Spot of the Descended Light***

1.1.1.2 Historical Development and Growth Trends

Historical development of Debre Birhan was up and down in the past 5 or 6 centuries from its establishment. The main historical study deals its development by classifying landmark periods that have showed sounded historical development effect for the town. Those significant historical development landmarks were the period until mid 1930s, the Italian occupation (1936 to 1041), after Italian occupation until 1984, and the period after 1984.

1. Prior Development Period (until mid 1930s): The 1878 Leche Agreement (between Emperor Yohannes IV and Nigus Menelik of Shewa) to transfer the capital of Shewa from Leche to Debre Birhan was a turning point in the history of Debre Birhan. Then after, Nigus Menelik was settled in a place which was used to be the residence of King Sahile Sellassie (the former King) that is the place where Menelik's Palace was located, which was taken from the clergy of Sellassie Church (who used to live there and transferred to Qess Amba). Though it was for a very short period of time Debre Birhan has showed significant development during the time of Negus Menelik as it served as his capital. However, later he changed his center from Debre Birhan to Wara Eilu that brought about the moving out of Menelik and his followers. The villages/neighborhoods which were emerged and flourished until then include Qess Amba and Lukanda *Saffer* (along the way to Bulo Worke market area).

2. Italian Occupation Period (1936-1941): This was the other landmark historical period in the development of Debre Birhan. This is due to the fact that, in this period the town showed spatial expansion and development; brought about the emergence of other *saferes* called Deshimo, Kinito, Birinta, Komando, and Banda; the re-establishment of the market center; the re-routing of the Addis Ababa-Dessie-Asmara road; the appearance of buildings (as trading houses and administrative offices); a catholic church was also constructed, and a modern medical hospital was begun (which was finalized in 1946 after they left the town) and growth of population (4500 by 1941 which was around 2500 in previous times).

3. The Period between 1941 and 1983: Immediately after the evacuation of Italians its development seemed to be stagnated until the time it was assigned to be the center of Teguletina Bulga Awraja (one of the awrajas of Shewa province) that had significantly accelerated the development. During this period the population of the town rose to 4700 by 1948 and to 19,000 by the year 1967, and again to 21,550 by 1974 and then to 25,635 by 1984. It was during this time that the Municipality of Debre Birhan was established; basic services and other establishments were flourished (a hydro-electric power was installed in 1959, Debre Birhan Hospital in 1943 E.C., Cinema Hall /which was originally built by Italians/ was re-built around 1959/1960; new roads from 1964 to 1974, 40 m^2 land distribution for shop constructions, Community Training School in 1965,

wool factory in 1960s, …); and its master plan (the 1972/73) was prepared. In early 1970s Debre Birhan had obtained some about 16 notable *saffers* that, among others, include Qess Amba, Tebasie, Arada, Ankober, Asmara Ber, Islam Amba, and Lukanda Safer. After 1974, the town was classified under 8 Kebeles and 2 Kefetegnas.

4. **The Period After 1984:** The other landmark period in the history of Debre Birhan is that of the period after 1986 as this time was signified by status change from Teguletina Bulga awraja capital to a capital of North Shewa Administrative Region and then after it becomes capital of North Shewa Zone (of ANRS) with significant administrative importance. Concomitantly, its economic and social importance has also been growing in relation to its administrative importance since then. And several accomplishments have been registered that include the 2nd 1996 Master Plan, D/Birhan University (started service in 2007), Private Health Collage and Hospitals, Condominium (beginning from 2006); Cobblestones and Asphalts streets (beginning from 2008/9); Factories and Industries (like Aquasafe, Sabela Printing, Terra Plc, Wodera Flour..); Standard Hotel (Eva); Sister-City with Bluemenil of France (2000/2001); etc. The population also increased to 65,231 (CSA, 2007) and the town is classified in 9 *kebeles* under municipal status.

   As it was established in 1454, therefore, this was the first phase of the evolution. Such first phase of settlement was bounded by *saffers* as follows: in North West, by Qes-Abma, in the South by the area where currently Blue Hotel is situated, in the East by Kullo-Beret, in North East by Lukand *Saffer*, and in West by Work Melkemia. The known hotels in the period of second phase include Kebede Hotel, Zara-Yakob Buna-Bet, and W/ro Atsede *Buna-Bet*. The growth trends and evolution phases are presented in Figure 1.1.

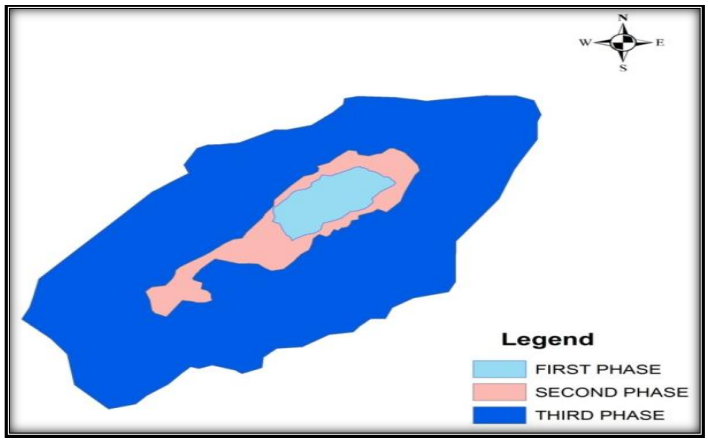

Figure 1. 2Growth Trend /Evolution Phase Map

1.1.2 **Physical Feature of Debre Birhan**

1.1.2.1 Location, Status, Area and Shape

Debre Birhan is found in North Shewa Zone of ANRS. It is astronomically located in an approximate geographical coordinates between 9^0 38'00''-$09^0$41' North Latitudes and 39^0 30'00''-$39^0$32'East Longitudes. In relative terms, it is situated at about 130 kms road distance from Addis Ababa (the national capital) and at about 696 kms from Bahir Dar (the regional capital) on the main highway to Dessie and/or to Mekele. The town is bounded by weredas of North Shewa Zone of ANRS which is an indication of good potential. Currently, it is classified with 9 *kebeles* under municipal status and wereda level and serves as a center for North Shewa Zone and Basonna *Wereda* too.

The total area of Debre Birhan under the municipal (*wereda* level) jurisdiction (including the surrounding rural areas) is estimated to be about 18,000 hectares while the existing built-up area under urban occupation is some about 2200 hectares that, in general, implies the available excessive expansion areas within its jurisdiction. The shape of the town, as identifyied in the existing study, is somewhat linear (elongated) following inlets and/or outlets of major roads which is identified as one of the planning issues in this SP preparation to maintain compact shape so as to optimize the required infrastructure and service expansion expenses(Da-Ya, 2014).

1.1.2.2 Climatic Condition

With an average elevation of 2750 meter above sea level (m.a.s.l), Debre Birhan is classified under Dega agro-climatic zone. With an average maximum temperature of 20.1c^{o} and average minimum temperature of 6.5 c^{o}, the town has got mean annual temperature of 13.3c^{o} (2008 to 2013 G.C). This, though may be cold for some times (October, November and December), is favorable for human settlement and to undertake any developmental activities. Debre Birhan, with mean annual rainfall of 965.25mm (2008-2013 G.C), has moderate annual rainfall amount that is sufficient to undertake any developmental activities, helpfull to sufficiently recharge the ground and surface water, and made the town the most preferable area with ample water supply coverage attracting different investments where water is one of the inputs for production. Thus, this structure plan preparation should consider such favorable climate and aboundant rainfall (via plot assignment). The dominant prevailing wind directions of Debre Birhan are Southeasterly and Easterly winds (that blow from southeast to southwest and from east to west). Thus, pollutant establishments (industries) that emit any smokes, dusts, sounds, and odors should be allocated aginst these directions in the southwest and western parts of the town in this structure plan preparation (EMA, 2014 as cited in Da-Ya, 2014).

1.1.2.3 Hydrology

Debre Birhan has a good hydrological features as it is found in the area having a good rainfall amount (with a mean annual total rainfall of 888.5 mm between 1991/2 and 2012/13 GC), temperature (average mean monthly between 12 to 15^{o}c), relative humidity (with average mean monthly value 72.95% between 1988/89 and 2012/13 GC) sunshine, evapo-transpiration and wind speed (EMA, 2014 as cited in Da-Ya 2014).

Surface Water Potential: Out of the water courses available in the vicinity of Debre Birhan only Beressa River can be considered as being perennial. The water flow data (mean monthly flow of about 2.752 **m^3/sec)** on Beressa river indicate that it do not have dependable potential unless supported by construction of impounding dam, especially for water supply of Debre Birhan(Tropics, 2006).

The quality of Beressa river water in Debre Birhan is found under threats and it is going down below the World Health Organization (WHO) and Ethiopian water quality standards with certain contaminants especially around the industrial sites. Further it will be getting deteriorated as the growth of the town due to investment activities and other factors requiring appropriate monitoring and controlling mechanism by which the nearby industries waste discharging mechanism should be evaluated and regulated. Thus,

- The increasing values of parameters of certain contaminants indicates that the river water located near the industrial zone is not safe and should not be used for drinking and any other agricultural activities.
- The full scale risk assessment on the use of unsafe water supply and water quality monitoring has to be carried out including rural areas.
- The study was conducted within period of four months. It may lack comprehensiveness. Further studies should be conducted in different seasons considering other water quality parameters including heavy metals, trace organic compounds load and underground water quality.
- In order to undertake strong and continuous monitoring, the town environmental department should be employed with well-equipped laboratory facilities and personnel for around the year monitoring this surface water resource of the country.

1.1.2.4 Hydrogeology

1.1.2.4.1 Aquifers, Groundwater Recharge and Discharge

On the basis of production wells drilled for Debre Birhan water supply study, the inter-bedded volcanic rocks of its aquifer is being recharged directly by infiltration of rainfall and/or infiltration from porous aquifer developed in Quaternary sediments covering plateau area. The formation is drained by perennial and seasonal rivers like Chacha and

Beressa. The groundwater flow direction in the study area is mainly controlled by geological structure and partly by geomorphology. Accordingly, the general flow direction of the groundwater is inferred to be northwesterly, aligning to the flow direction of Beressa River.

The main source of recharge to groundwater in Debre Birhan area is mainly from rainfall on the plateau and moderately-gently sloping plains. Although the source of recharge is rainwater for most of the area, recharge to the groundwater is also possible along the surface flow of the perennial river Beressa. As the flow of Dalecha and Derek Wenz streams in the catchment is controlled by structures, localized aquifers along the structural plains will be recharged by the surface water of streams.

Topographically high areas can generally be considered as recharge areas and topographically low areas can be considered as discharge areas. Since groundwater catchment is structurally, lithologicaly and topographically controlled, ground water discharges occur as springs at the highlands and seepages on the valley and escarpments. Groundwater discharge areas are formed by local moderate depressions in the plateau and steep slopes. Groundwater discharge also occurs due to topographic breaks, most of the elevated areas are recharge areas to groundwater.

The Groundwater Potential: The study made on groundwater resources of Debre Birhan area indicates the presence of three potential well field sites, namely Beressa, Dalecha and Derek Wenz (as shown in Figure 1-2).

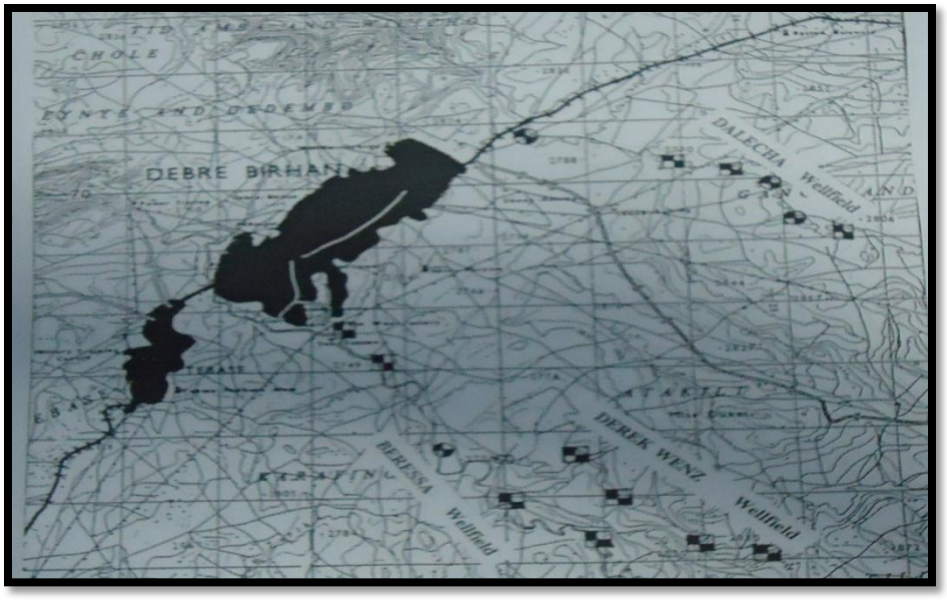

Figure 1. 3Potential Well Field Sites of Debre Birhan

The existing situation assessment reveals the following general findings that include:

- The recharge to groundwater is highly associated with Beressa and Dalecha streams;
- The groundwater in this area has good quality;
- The ground water is highly sensitive to pollution and hence require sensitive considerations; and
- The possibility of groundwater over pumping and interference and hence these also require due attention.
- In general, the town has good groundwater potentials with good quality. Any types of developmental activities in these areas require sensitive environmental protection mechanisms.

1.1.3 Population Characteristics and Dynamics

1.1.3.1 Population Characteristics and Distribution

This sub-topic deals about population characteristics, demographic and non-demographic characteristics of Debre Birhan Town, which will include that of population size, growth,

age, sex, household size, ethnic group, religion, relationship to head of the household, marital status, employment status, educational status, disability, etc based on the CSA (Censuses and Projections) and the Household Sample Survey result of 2014 GC (2006 EC) that has been conducted by the consulting firm (Da-Ya Consulting Planners and Engineers PLC) for the purpose of this structure plan preparation.

1.1.3.2 Population Size and Growth Rates

According to CSA (2013), the latest estimation of Debre Birhan's population reached that of 83,479. Between 1984 and 1994 population size of the town grew at the average rate of 4.12% per annum, and from 1994 to 2007 its rate declined to 4.01% per annum (Table 1-1).

Table 1. 1Population Size, Distribution and Growth Rate for Debre Birhan

Year	Male		Female		Total	Sex Ratio	Growth Rate		
	No	%	No	%					
1984	11637	45.4	13998	54.6	25635	0.83	4.12		
1994	17918	46.3	20799	53.7	38717	0.86		4.02	
2007	31668	48.5	33563	51.5	65231	0.94			4.0
2013	40,527		42,952		83,479				

Source: CSA (1984), (1994), (2007), and (2013)

In any case, all these entailed an alarmingly population growth and increase and if such increasing of population size continuous without any doubt within a certain years. The reason behind such increment might be its high natural growth and in migration to the town since the area is becoming economically active and very much convenient for investment as compared to the area around it. Thus, such issue require due attention.

The Population Projection

Based on the above mentioned assumptions to the future courses of the basic growth components (fertility, mortality and migration) and specific growth contributing factors, exponential method of population projection is used by assuming the population is growing continually at a constant rate of per year taken from the trends of growth of the town.

NB: As per the direction from Amhara Region Urban Planning Institute (RUPI,) during

the first in house discussion with different stakeholders in Debre Birhan Town, the rate of the ANRS population is considered to be 0.06 per annum and hence for Debre Birhan too this figure has been considered.

The CSA 2013 population estimation of the town is taken as a base year population for projection which is 83,479. Thus, the population of the town is expected to reach to a level of **129,618**; **144,690;** and **158,297** at the end of the planning period (2024) with low, medium and high variants, respectively (Table 1-2).

Table 1. 2Population Projections for Debre Birhan (2014-2024)

Years	**1994**		**2007**		**2013**		**2014**		**2024**	
*Growth	M	F	M	F	M	F	F		M	F
Variant and Sex	17918	20799	31668	33563	40,527	42,952			78,498	83,113
Total	38717[1]		65231[2]		**83,461[3]**		**86,875**		**158,297**	

NB: *Higher Growth Variant was taken (R=6%), and it is assumed this growth pattern will continue until the end of the planning period.

Data [123] sources (CSA; 1994, CSA; 2007 and CSA; 2013).

Generally, as the population growth trend stated in Table 3-3, the population of Debre Birhan Town is assumed to grow by an average annual growth rates of **6.0%** under high growth variant throughout the projection period (2014-2024) due mainly to the above mentioned town specific growth favoring factors. Besides, such expected population size includes the population of the newly included five rural kebeles which are now become part of the city administration. Hence the baseline (2014 GC) population is 86,875 and the future planning period population is projected as 158,297 (2024 GC). Such high population projection results from a judgment of maximum probable birth rate (age specific), minimum probable death rates, maximum probable in-migration and minimum probable out migration. However, it is important to note, though the general population projection as a framework is made with high growth variant (6%), other projections for facilities are made with the common/universal medium growth variant (4.01%) with the aim to minimize the risk of service and facility provisions.

1.2 Statement of the Problem

Urban areas face daunting economic, social and environmental challenges that have increased in scope in recent years aggravated by lack of efficient, effective and equitable provision of utilities. Although access to water supply, electricity, telephone and service providing institutions are the most important entities in order to facilitate effective, communication, sanitation and provision of services; and on the top of that they play remarkable role to attract tourist and investment on different social and economic activities, their provision in the towns like Debre Birhan is threatened by the following problems. 1. The demand and /or requirements as client of the scheme are not set by the municipality rather fixed by the provider itself. There is no room (procedure) for the municipality to check or say the plan intended by utility provider is adequate and reliable for the current and projected demand; and aligned with the future growth direction of the town. 2. Although the service is provided in the jurisdiction administered by the municipality, during installation process of the utilities, the respected municipal unit is not well communicated and involved in monitoring and evaluation activities of the project, and 3. The institutional and sectoral standards are not well known and implemented both by the municipality respective personals and by implementers. Because of all the above and related other reasons the scheme does not serve for the intended period of time in reliable and sustainable manner and results in shortage of services and negatively affecting all social, economical and environmental activities of the town.

1.3 Objective

1.3.1General Objective

The study focuses on the analysis of the existing situation of the, utilities and identify the major problems, potential and constraints and to suggest possible solutions which could serve as an input for comprehensive plan preparation of Debre Birhan town.

1.3.2 Specific Objectives

The study has the following specific objectives:

- To assess the existing situation of utility infrastructures such as water supply, electricity, telecommunication, drainage and waste management services in relation to availability, accessibility, location, their distribution system and existing capacities and other related variables.
- To identify planning issues that will be addressed during master/structure plan preparation of the town
- To recommend possible solutions and strategies in order to mitigate the existing problems and constraints of these infrastructures and to suggest alternative planning solutions for future sustainability and more improve the existing infrastructures

1.4 Scope of the Study

1.4.1 Spatial

For study focuses on Debre Birhan town which has nine kebeles with a total area of 5711ha.

1.4.2 Thematic

The study focuses on the analysis of existing utility infrastructures in relation to efficiency, accessibility, effectiveness, compatibility and other related variables.

1.5 Significance of the Study

The main concerns of the study are identifying major problems and constraints in relation with provision of urban utility infrastructures, which are the back bone of every urban development. We can't think of urban growth and development without urban infrastructure. This study has significance for development plan preparation of the town. On the other hand the finding of this study will enable the town administration to thoroughly understand the town existing demand and enable them to put pre condition for any further utility development program in their jurisdiction that ultimately they want achieve by their day to day activities.

Moreover, it could also an important source for further research or study on the same issue.

1.6 Limitation of the study

- Lack of quantitative and qualitative data in certain institutions.
- Reluctance of some households to answer all the questions.
- The unwillingness and carelessness of a few respondents in giving reliable data during socio-economic survey.

1.7 Methodology of the Study

1.7.1 Sources and Methods of Data Collection

In this study primary and secondary data sources are employed. The primary data were collected through house hold survey, field survey, interviews, questionnaire, focus group discussion and physical observation. The secondary data were collected from published and unpublished documents tracts, reports of different offices, previous studies and proposals. In the process of primary data collection, it is conducted in all kebeles of the town using systematic random sampling techniques. The sample survey is made to be representative comprises 10% of the total households found in the town.

1.7.2 The Data Gathering Procedure

To make, first, the information coherent, house hold surveys are conducted. Ten percent of the household of the town dwellers are approached. At the same time, observation to infrastructures or utilities conditions are made at the places where utilities are situated and appropriate photograph is taken and inserted in the document where they are appropriate. After having this information questionnaire is distributed to all concerned offices (Water Supply office, Municipality respective units, Electric utility service office, Ethio-Tele branch office in DB and others) and collected with some structured interviews while needed. Then focus group discussion was conducted of which important information are gathered. Finally, public and expert hearing forum was organized at town level from which

ample information was gathered and in which the data gathered is checked by this forem whether the data is reliable or not .

In parallel with interviews and questionnaire field survey was conducted by data collection members to collect the existing utilities and their level of services and mapping these facilities location with GPS.

1.7.3 Instrument of Data Collection

The instruments employed for data collection were structured pre-coded and open-ended questionnaires separately. The pre-coded once are used for data collection from selected households and both open-ended and closed-ended questions were used for kebele representatives and other concerned organizations. In addition, issues assessed by observation during field survey are prepared and done accordingly.

1.7.4 Methods of Data Analysis

Both qualitative and quantitative methods are used for data analysis. In quantitative analysis statistical tools like ratio, percentage and average have been performed to display the pattern and nature of different characteristics. On top of this qualitative description over some aspect has been done.

Then the result of these quantitative and qualitative analysis were used for identification of constrains and potentials through SWOT interpretation. These techniques are basically suitable in identifying, prioritizing and ranking of problems, issues and intervention areas and hence facilitate and ease subsequent planning works.

1.8 Organization of the Paper

This paper is prepared based on the analysis of existing situation of infrastructure, utilities and services of Debre Birhan town. The first chapter deals with the general introduction of the study and study area. The second chapter presented review of related literatures. From third to six chapters provide data and their analysis and interpretation of the service in Debre Birhan town. The last chapter

deals with the findings, conclusions and recommendations for the problem encountered and for the potential problems.

Chapter two

2. Review Literature

2.1 Conceptual Framework

2.1.1 Water Supply

Water supply is the provision of water by public utilities commercial organizations, community endeavors or by individuals, usually via a system of pumps and pipes. Irrigation is covered separately (Wikipedia, Encyclopedia).

Water supply systems get water from a variety of locations after appropriate treatment, including groundwater (aquifers), surface water (lakes and rivers), and the sea through desalination. The water treatment steps include, in most cases, purification, disinfection through chlorination and sometimes fluoridation. Treated water then either flows by gravity or is pumped to reservoirs, which can be elevated such as water towers or on the ground (for indicators related to the efficiency of drinking water distribution see non-revenue water). Once water is used, wastewater is typically discharged in a sewer system and treated in a sewage treatment plant before being discharged into a river, lake or the sea or reused for landscaping, irrigation or industrial use(Wikipedia, Encyclopedia).

water to be termed as pure and fit for drinking purpose should be colorless, free from all suspended, soluble and colloidal impurities of both organic and inorganic nature, sediments, taste and odor, pathogenic organism, radioactive substances like radium, hardness, corrosive substances, iron, manganese, lead, arsenic and other poisonous materials (Paurchair, 1993 as cited in ECSU)

With regard to water consumption, the use of water varies from city to city, depending on the climate, characteristics of the environment population, level of industrialization, living standard of the residents and other factor. In a given city water use also varies from season, day to day and even hour to hour(Linsely, 1992 as cited in ECSU).

2.1.2 Electric Energy

Electric power distribution is the final stage in the delivery of electric power; it carries electricity from the transmission system to individual consumers. Distribution substations connect to the

transmission system and lower the transmission voltage to medium voltage ranging between 2 kV and 35 kV with the use of transformers. *Primary* distribution lines carry this medium voltage power to distribution transformers located near the customer's premises. Distribution transformers again lower the voltage to the utilization voltage of household appliances and typically feed several customers through *secondary* distribution lines at this voltage. Commercial and residential customers are connected to the secondary distribution lines through service drops. Customers demanding a much larger amount of power may be connected directly to the primary distribution level or the sub transmission level (Wikipedia Encyclopedia).

2.1.3 Telecommunication

Although information systems of some term or another have been around since the beginning of time information technology is a relative new comer to the scene. The facilities provided by such technologies have had a major impact on individual, organizations and society.

As information technology has become more powerful and relatively cheaper, its use has spread throughout organizations is a rapid rate. The aim now is not only to improve efficiency but also to improve business effectiveness and to manage organization more strategically.

It, however not only has the potential to change the way an organization works but also the very nature is business through the use of IT to support the introduction of electronic market. (Gallieries and baets, 1998 as cited in ECSU).

Communication media classified ‘old’ and ‘now’ old media traditionally refer to media that have been used extensively with in organizations in the past for example, written letters, memos, or the telephone; while new media are usually computer mediated. (Kice, 1992, and valocich, 1993)

2.1.4 Drainage

Drainage: is the process of removing and controlling the excess surface and sub soil water with in the right of war. Surface Drainage: - under this category surface water is intercepted and diverted to a natural channel or depression. If it is not done the surface water will flow along the road or across it causing erosion. Drainage basin:- is a region of land where water from rain or snow melt drains downhill in to a body of water: river, lake, wet land.

A drainage system in urban and industrial areas, is a facility to dispose of liquid waste. A **sustainable drainage system** (SuDs) is designed to reduce the potential impact of new and existing developments with respect to surface water drainage discharges. The term **sustainable urban drainage system** is not the accepted name, the 'Urban' reference having been removed so as to accommodate rural sustainable water management practices ([Wikipedia, Encyclopedia)

Stormwater management means to manage *surface runoff*. *Stormwater management* is essential to prevent erosion of agricultural land and flooding of inhabited urban or rural areas. Both cases can cause severe damages and contamination of the environment if *sanitation* facilities are flooded. This results in high costs and notably massive suffering for the local communities (CSIR 2000; PARKINSON et al. 2010 as cited by Beat Stauffer)

Any urban development will affect or make an impact on its environment. Construction of roads or buildings significantly changes the hydraulic properties of an area. Typically, pervious layers are rendered less permeable or even impermeable. Depressions are raised to prevent ponding. Surfaces and conduits are constructed to drain *runoff* more efficiently. Natural vegetation is often removed, causing reduced interception and *transpiration* by plants. Limited vegetation cover exposes the soil to the impact of rain, which may *lead* to increased erosion. Natural meandering watercourses may be canalised to more effectively route flows through the development. *Stormwater management* is the science of limiting these negative impacts on the environment and enhancing the positive impacts, or catering for the hydraulic needs of a development while minimising the associated negative environmental impacts (CSIR 2000).

Because of the impermeable surfaces in urban areas, flooding occurs very often as a human-made event. *Runoff* from such surfaces has a high velocity, which adds to *stormwater* drainage systems. This increases peak flow and overland flow volume and decreases natural *groundwater* flow (as no is *percolation* possible) and *evapotranspiration*. Furthermore, urban *runoff* has an increased pollution load, which *leads* to water pollution (PARKINSON et al. 2010).

The traditional model of *stormwater management* is based on a misconception. It aims the draining of urban *runoff* as quick as possible with the help of channels and pipes (see also sewer systems), which increases peak flows and costs of *stormwater management*. This type of solution only transfers flood problems from one section of the basin to another section. Urban *runoff* contains a

large amount of solids and a higher concentration of metals and other toxic components (PARKINSON et al. 2010).

2.1.5 Sewer System

Sewage is a water-carried waste, in solution or suspension, that is intended to be removed from a community. Also known as domestic or municipal wastewater, it is characterized by volume or rate of flow, physical condition, chemical and toxic constituents, and its bacteriologic status (which organisms it contains and in what quantities). It consists mostly of greywater (from sinks, tubs, showers, dishwashers, and clothes washers), blackwater (the water used to flush toilets, combined with the human waste that it flushes away); soaps and detergents; and toilet paper (less so in regions where bidets are widely used instead of paper). Whether it also contains surface runoff depends on the design of sewer system.

A **sanitary sewer** or "foul sewer" is an underground carriage system specifically for transporting sewage from houses and commercial buildings through pipes to treatment or disposal. Sanitary sewers are part of an overall system called sewerage or sewage system.

Sewage may be treated to control water pollution before discharge to surface waters. Sanitary sewers serving industrial areas also carry industrial wastewater.

Separate sanitary sewer systems are designed to transport sewage alone. In municipalities served by sanitary sewers, separate storm drains may be constructed to convey surface runoff directly to surface waters. Sanitary sewers are distinguished from combined sewers, which combine sewage with stormwater runoff in the same pipe. Sanitary sewer systems are considered beneficial because they avoid combined sewer overflows(Wikipedia, Encyclopedia)

2.2 Practices of Utility Service Provision

2.2.1 Ethiopia water supply profile

In order to make a good use of water resources in the country, the government has launched a long term plan focused on provision of clean water supply, development of irrigation systems and electric power generation. Notable results include provision of access to clean water supply has increased from 23% to 35% in rural areas and from 74% to 80% in urban areas during the period 2001/2 to 2004/05, in respect to urban drinking water supply pre-design studies for 266 projects,

construction of 49 projects and rehabilitation of 46 projects have been undertaken, water supply systems were built or rehabilitated in 83 towns, benefiting some estimated 1.6 million people, studies or design work are under way for another 47 towns(PASDEP, 2005).

The challenges in the water sector include keeping rural system operational and maintained, and financing the large up-front investment costs of city and towns schemes. To address this, government is moving towards a system of organizing communities to take responsibilities for village water supplies, and for commercialization of urban water supply system (PASDEP, 2005).

GTP I (2010/11-2015/16)

Objectives

In the five years time the main objectives of the water sector development plan were to develop and utilize water for different social and economic priorities in a sustainable and equitable way, to increase the water supply coverage, and to develop irrigation schemes so as to ensure food security, to supply raw materials for agro-industries and to increase foreign currency earnings.

Table 2. 1Targets of the GTP

Water	Base line 2009/10	Plan Target 2014/15	
Potable water coverage (%)	68.5	98.5	
Urban potable water coverage (within 0.5km)	91.5	100	
Rural potable water coverage (within 1.5km)	65.8	98	
Developed irrigable land	2.5	15.6	

GTP II (2015-2020)

- Through Improving water and sanitation Service potable water service coverage will be 100% with respect to standards of GTP I
- To raise the rural population with access to potable water within 1km reach from 59% to 85% and urban population from 51% to 75% within their yard. (As per standards of GTP II for Grade 1 Cities 100 litter per capita፡ for grade 2 towns 2 8*0* litter per capita፡ For Grade 3 Towns 60 litter per capita and for grade 4 towns 40 litter per capita.
- To raise total national water supply coverage from 58% to 83%
- Expand small, medium and large scale Irrigation systems

2.2.2 Electricity supply in Ethiopia

Electricity is one of the modern sources of energy. It generates hydro sources which is the most convenience and easy to handle. This unique quality makes it an indispensable element in the energy economy of all modern societies in the world.

Every modern life is provided by reliable electric supply. Electric power is one of the several energy sources that human beings use for different purposes. It is quite clear that electric power sector has an important role to play a remarkable complement for development endeavor of a country. However, Ethiopia has one of the lowest level of energy consumption in the world.

The use of electricity first stared late in the 19th c during the regime of Menelik II (1898), the responsible institution for production, distribution and sell were company Nazionale Imerezi, Italian company (1936-1955) and EELPA (1995-1997) currently the sector is gun by EEPCO as of 1997.

Ethiopia has vast hydropower and promising geothermal energy resources. Its hydropower potential is estimated at being around 45,000 MW from hydro power and unconfirmed report of one million MW from Wind. The topographic features of the country allow at least 20 - 25 % of this potential to be utilized economically.

Up-to-date the aggregated electricity generation is a mere 3.75 billion kwh/a, which is much less than two % of the actual potential. The present regional distribution system of electric services is carried out mainly via the Inter-Connected System (ICS) and via a self-contained system to a certain degree. The main industrial towns are all connected into the national grid.

Almost the entire ICS capability is provided by the ten hydroelectric power plants at Finchaa, Koka, Awash II, Awash III, Melka Wakena, Tis Abay I, Tis Abay II, Gilgel Gibe I, Gilgel Gibe II, Gilgel Gibe III Tekeze, Beles and with Ashegoda I & II and Adama I & II wind mills total installed capacities of about 2400 MW are become operational. Electric energy is supplied at 380/220 volts and 50 Hz AC at low level; the high voltage transmission facilities are 230KV, 132KV, 66KV and 45 KV, while the medium voltage distribution is in 33 KV and 15 KV(EEP, 2015).

Electricity in Ethiopia, generated mostly from hydropower, is relatively cheap. It is supplied by the Ethiopian Electric Power and Ethiopia Electric Service.

2.2.3Telecommunication in Africa & Ethiopia

In Africa telecommunication is one of the most important communication tools in the process of development an efficient and reliable telecommunication service plays decisive role in carrying out administrative and business activities according to Akikherna (1999)

Telecommunication was introduced in Ethiopia 1983 just after the invention of 1876. However coverage of telecommunication in Ethiopia is among the lowest in the world, with approximately 5 lines per 1000 persons, and 83% of the rural, population living more than 5km away from the nearest telephone service facility Ethiopia has made huge investment in basic multimedia infrastructure backbone is executing project to lay fiber optics cables. This has facilitated school net and worda net project take off.

During the PASDEP the plan is to significantly increase fixed line and mobile coverage increasing the number of lines to about 4,264 and 1.64 million respectively and the share of the population within 5km of a telecommunication service to 100%.

There has been a major expansion of telephone coverage, from about 400,000 lines at the beginning of SDPRPI to over one million by the end of 2004/5. The ETC is also implementing a rural telecommunication expansion program, extending telephone service to about 300 towns, as well as introducing a woreda net system to link woreda head quarters (Dagne Amdetseyon. September 2007/8).

GTP (2010/11-2015/16)

Objectives

During the plan period under the sub-sector the following objectives are to be met

- Finish the ongoing network infrastructure building and applications and commence service
- Intensify the need based network expansion work
- Expansion of rural Universal telecommunication access program
- Improve and maintain the quality in fixed line, mobile phone, internet and data service provision
- Create the conducive environment to use latest telecommunication technologies
- Fair and economical utilization of National Frequency, Telecommunication number and IP addresses and increase the revenue from these services

Table 2. 2Targets of the GTP

Telecom:	**Base line 2009/10**	**Plan Target 2014/15**
Mobile density (per 100)	1.5	8.5
Telephone service coverage with in 5km (%)	49.3	90
Fixed telephone subscribers (in millions)	1.2	8.6
Mobile Telephone subscribers (in millions)	7.6	64.4
Internet service subscribers(in millions)	0.20	7.17

GTP II

The Ethio Telecom (ET) targets to boost tele-network access in the second Growth and Transformation Plan (GTP II).

- Mobile telephone service: From 40Million to 103 million subscribers
- Broad band Internet Data: From 1.59 million to 39.1 million subscribers, while overall internet data coverage will grow to 10 percent from the current 3.3 percentage.
- Fixed Line: From 3.05 Million to 10.4 million subscribers

2.2.4 Drainage management in urban center of Ethiopia

Deforestation of fuel or for more urban expansion area reduced the water holding and flow retarding capacity of the catchments areas. Because of high urban land value flood prone areas may also be claimed for settlement. All these and others aggravate the drainage and drainage related problems of urban areas. In this and other respects, Ethiopia towns are no

exception one of the major problems facing urban areas of Ethiopia is that of storm water management accompanying facilities, manifold problems are encountered.

Chapter Three

3. Water Supply

3.1 Water Sources and Production

The water source of Debre Birhan Town is from that of the drilled ground water in two different parts of the town called Berressa and Dalecha basins. There are 9 Boreholes at two different water fields. Three of them are found in Beressa water field and the rests are found in Dalecha water field. These boreholes feed and directly connected to the city line. There are also some more bore holes which is drilled by industries which are being used only by each of the industries like Dashen Beer Factory, Aqua Safe, Metec, etc. At this moment there are about twenty three bore holes including the town water system sources. Their potential and present capacity is indicated in Table 3-1.

Table 3. 1The Potential and Present Capacity of Debre Birhan Water Sources

SN	Name of Boreholes	Drilled Wells Potential	Capacity of Presently equipped Wells
1	Dalecha Boreholes	55 l/s	55 l/s
2	Beressa Boreholes	48 l/s	30 l/s
	Total	**103**	**85 l/s**

Source: Water Supply Office, 2014

Figure 3-1 presents boreholes distribution map that have been located along Beressa and Dalecha Rivers. It also shows the main waterlines that have been found distributed and networked in the town.

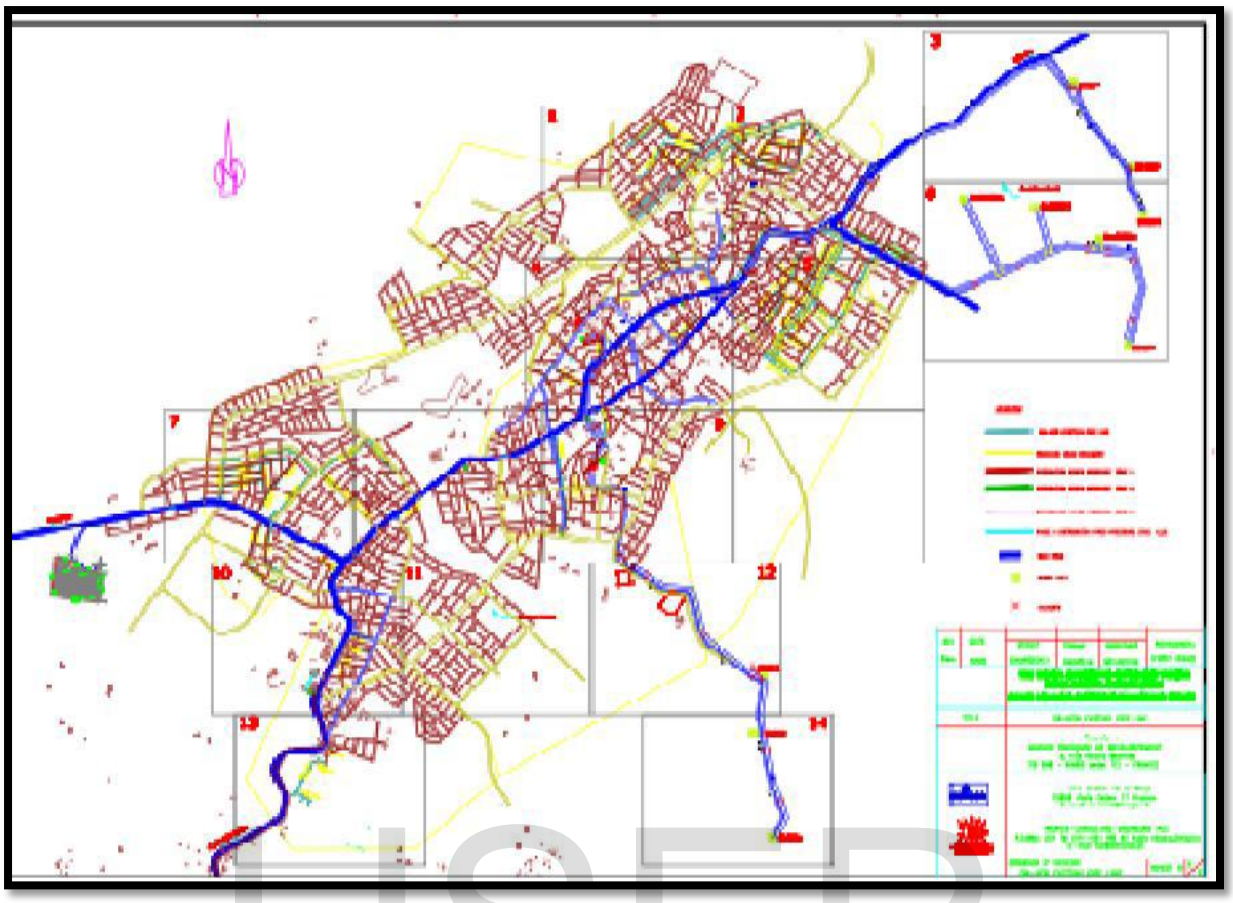

Figure 3. 1Distribution of Boreholes along Beressa & Dalecha Rivers and the Main Waterlines

Table 3. 2 Annual Water Production Trends in Debre Birhan Town

SN	Year	Quantity Produced (M^3)
1	2006/2007	554247.86
2	2007/2008	779119.19
3	2008/2009	903594.08
4	2009/2010	991512.34
5	2010/2011	1159278.23
6	2011/2012	1339983.37
7	2012/2013	1,466,631.00
8	2013/2014	1,632,104.00=51.7l/sec

Source: Water Supply Office, 2014

Table 3-2 indicates the total annual water production in the town and hence it increases from 2006 to 2014 by 1,077,856M^3 or by 66.04% which shows a higher growth rate. The figures also indicate the production of water increases with up and down rates.

3.2 Storage

Table 3. 3The Reservoirs and their Capacities in Debre Birhan

SN	Name of Reservoir	Capacity	Specific Location	Zone/Basin being served
1	R1	2000 m^3	Kebele 06	I
2	R2	1000 m^3	Kebele 04	II
3	R3	250 m^3	Kebele 06	III

Source: Water Supply Office, 2014

The existing water network system is divided into three zones or water basins based on the topographic nature of the town and these three zones are getting water from different reservoirs as depicted in the table above. Water storage facilities of the town comprise two ground levelled and one elevated (the 250 m^3 which was constructed and financed by Le Blank Mesnil, the twining program). The first ground reservoir (R1) is situated at elevation of 2845.80 m.a.s.l with 2000m^3 capacity and diameter of 20m and an overall depth of 7.0m including the free board. It is located within the previous Debre Birhan Water Service compound which is one of the most elevated available locations in the town (Tropics, 2006).

The second ground reservoir (R2) with a capacity of 1000m^3 is situated near to the prison at elevation of some 2827.20 m.a.s.l. This reservoir has a diameter of 16m and an overall depth of 6.3m including the free board. R2 commands water supply to zone II which covers the south western part of the town. The following two plates show the service reservoirs of R1 and R2, respectively (Tropics, 2006).

*Figure 3. 2**Views of Service Reservoirs (R1)*

Figure 3. 3 ***Views of Service Reservoirs (R2)***

Both R1 and R2 are equipped with standby gravity chlorination system equipment. In addition to the chlorination by dosing pumps, manual and electronic water level indicators are also included. The associated valve chamber is equipped with an altitude valve, which controls shutdown of borehole pumps when reservoirs reach overflow level. Furthermore, all required compound works and fencing have been carried.

3.3 Pumping Stations

Zone III, which has the highest average elevation compared with the surrounding area and the elevation of RES I, is designed to be supplied from an elevated reservoir located in RES I compound. Thus, a pumping station is constructed and equipped with the required equipments such as lift pumps and standby generator. The building has an overall area of 28.86m^2 (7.40m x 3.90 m).

*Figure 3. 4****View of the Pumping Station at R2***

Since the water demand of Zone I is higher and production capacity of Bressa well field is higher than that of the Dalecha well field a pumping station is built to transfer water from R2 to R1. Accordingly, the pumping station is constructed at R2. The Pumping station is equipped with the required equipment.

3.4 Water Quality

Bacteriological water quality is sampled and tested periodically by the local office of the Department of Health. A test for fiscal coli form contamination of water in the bulk storage Reservoirs has been undertaken many times in the previous months and all of the results have

come out negative and been declared suitable for human consumption. Table 3-4 depicts the water quality tests in Debre Birhan.

Table 3. 4 Water Quality Test in Debre Birhan

NATURE OF SAMPLE/SOURCE	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH
DATE OF COLLECTION	28/11/03	18/12/03	29/06/03	9/6/2003	8/6/2003	4/2/2004	16/02/04	28/01/04	20/01/04	10/2/2004
DATE RECEIVED	16/12/03	30/12/03	29/07/03	16/6/03	16/6/03	19/02/04	19/02/04	4/2/2004	28/01/04	19/02/04
CLIENT'S ID. NO.	Dalecha_BH1	Dalecha_BH2	Dalecha_BH4	Dalecha_BH5	Dalecha_BH5	Dalecha_BH6	Dalecha_BH7	Beressa_BH2	Beressa_BH4	Beressa_BH5
LAB. ID NO.	168/96	184/96	019/96	384/03	383/95	228/96	230/96	215/96	203/96	229/96
Colour (app)	-	-	-	-	-	-	-	-	-	-
Turbidity (NTU)	2	3	3	4	3	1	2	2	6	Trace
Total Solids 105° C	154	134	148	205	205	128	144	140	174	130
Total Diss. Solids 105° C	146	124	132	162	164	116	128	132	150	123
Electrical Conductivity (□s/cm)	204	205	210	253	252	188	194	203	229	190
Ph	7.27	7.12	7.69	7.73	7.78	7.28	7.15	7.16	7.93	7.24
Ammonia (NH_4^-)	0.283	0.31	0.06	Trace	Trace	0.219	0.243	0.27	0.25	0.245
Sodium (Na)	9.7	8.2	10	20	20	7.7	7.4	9.6	13	8.7
Potassium (K)	3.2	3	2.2	4.5	4.5	2.6	2.7	3.8	4.1	3
Total Hardness as $Caco_3$	84	76	92	98	100	84	86.1	81.9	92.4	84
Calcium (Ca^2)	25.2	25.2	28	31.2	30.4	25.2	25.2	25.2	30.24	24.4
Magnesium (Mg^{2-})	5.1	4.1	5.35	4.86	5.84	5.1	5.6	4.6	4.1	5.6
Total Iron (Fe)	0.017	0.04	Trace	Trace	Trace	0.008	0.011	0.007	0.024	0.012
Manganese (Mn)	0.2	0.1	Trace	Trace	0.02	Trace	Trace	0.1	0.1	Trace
Fluoride (F)	0.58	0.42	0.96	0.96	0.8	0.35	0.46	0.84	Trace	0.42
Chloride (Cl)	5.96	5.78	3	7.94	7.94	2.9	3.9	5.8	5.8	3.9
Nitrite(No_2)	-	-	-	0.02	0.01	-	-	-	-	-
Nitrate(No_3)	-	19.8	4.8	7	7.5	7.5	11.9	7.04	13.6	7.04
Alkalinity ($Caco_3$)	88.8	72	92.4	107.8	110	84	81.6	96	93.6	88.8
Carbonate (Co_3)2^-	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
Bicarbonate(HCO_3)	108.34	87.84	112.73	131.5	134.2	102.5	99.6	117.1	114.2	108.3
Sulphate (SO_4)2^-	0.6	0.6	0.79	7.65	6.6	0.3	0.4	0.1	1.1	0.4
Phosphate ($PO4^{3-}$)	0.155	0.209	-	-		0.269	0.358	0.216	0.359	0.312

Boron (B)										
Silica ($SiO_{2)}$										
REMARK: Unless stated in bracket all Concentrations are in Mg/l										

NB: All samples are analyzed by Water Works Design & Supervision Enterprise Laboratory

Source: Debre Birhan Water Supply office, 2014

3.5 Water Consumption

The amount of water consumption varies according to income levels, climatic conditions, culture, level of development, availability of water, and tariff rate of water.

Table 3. 5 Water Consumption Trends (2006/7-201314)

SN	Year	Water Consumption in M^3	Growth Rate(% age)
1	2006/2007	452,543.39	-
2	2007/2008	647,681.78	11.64
3	2008/2009	761,006.93	35.86
4	2009/2010	848,536.26	8.8
5	2010/2011	998,254.48	18.28
6	2011/2012	1,170,207.49	
7	2012/2013	1,247,371.80	
8	2013/2014	1,395,449.00	

Source: Debre Birhan Water Supply Office, 2014

Table 3.5, above, shows the water consumption from the year 2006/7 – 2013/14. It indicates that the growth rates various accordingly and hence fluctuating up and down, but in general consumption of water is increasing (over three folds during the period under consideration).

3.6 Loss of Water

Loss of water is one of the factors to expand the gap between demand and supply. The total annual water loss trend of Debre Birhan is computed and presented in Table 3.6 based on the production and consumption data (Table 3.2 and 3.5).

Table 3. 6 Water Loss as Percentage of Total Production

Year in EC	Production in M^3	Consumption in M^3	Loss in M^3	Loss as percentage of total production
2006/2007	554247.86	452543.39	101704.48	18.35
2007/2008	779119.19	647681.78	131437.41	16.87
2008/2009	903594.08	761006.93	142877.15	15.8
2009/2010	991512.34	848536.26	142976	14.4
2010/2011	1159278.23	998254.48	161023.75	13.9
2011/2012	1339983.37	1170207.49	169775.90	12.7

2012/2013	1466631.00	1247371.8	219259.35	14.9
2013/2014	1632104.00	1395449.00 = 51.7 l/sec	236655.00	15.9
				11%=Design Consideration

Source: Debre Birhan Water Supply Office, 2014

As it can be observed from the data displayed, the amount of water loss is too much compared with the estimated and taken in to account during design of the scheme, but such loss rate was decreasing in the early years of this new scheme though when the time goes the loss is going up which needs the attention of the respective bodies. According to Debre Birhan Water and Sewerage Office, the main causes of the losses are leakage from the pipeline, illegal connection and use of the water before meter.

Table 3. 7 Water Consumption of Different Customers

SN	Type of Customers	Consumption l/capita/day
1	Public	2.64
2	Domestic	16.7
3	Commercial and Institution	9.15
4	Industry	2.75
5	Loss	2.5

Source: Debre Birhan Water Supply Office, 2014

Table 3.7 shows water consumption by different customers. Thus, the highest consumption rate is registered by domestic users (that is about 16.7 l/capita/day) and the industry consumption rate which seems low is still acceptable with respect to the considered design parameter while the scheme was planned.

Table 3. 8 Trends of Water Consumption for Different Users (in m^3)

Year	Institution	Domestic	Industry	Commerce	Public Use	Losses %
2011/2012	9,620	227,524	138	17,288.5	1,259.62	12.7
2012/2013	13,165	213,102	132	32,834.0	1,450.00	14.9
2013/2014	--	--	--	--	--	
Increment in %	26.393	-6.8	-4.5	47.3	13.1	14.8

Source: Debre Birhan Water Office, 2014

One can understand that from the above table the service consumption share is increasing at the expenses of domestic and industry demand. This is an indicator for the need of more production and developing and increasing the capacity of the scheme before the designed life time of the project.

3.7 Water Demand Projection

For this plan preparation, a sample survey has been conducted for every five housing unit in the entire town. Thus, the study includes all the necessary variables that are the number of Housing Units, House Connected Taps, Yard Connected Taps, Public Taps and dependent population. The summary of such statistical output is depicted in the table below (Table 3-9).

The sample survey in general came out with the existing average per capita demand equal to 40.15 liter per day per capita. By the same procedure using the projected population size and assuming that the proportion of mode of service remains the same in the planning period the projected average per capita domestic demand will be equal to 40.15 liter per day per capita.

Then after, in light of this, the existing and projected water demand of the town is computed and portrayed in Table 3.10. As it can be clearly observed in this table, there are some figure differences in the design parameter between the designs of the existing system and this projection. These differences are shown in number of projected population and per capita demand. The design considered very small proportion compared with the standard adapted by the Ministry of Water Resource.

Table 3. 9 Mode of Water Supply Services and Average Domestic per capita Demand

Mode of Services	No of Registered connections* 10 (ten times of the sample)	No of dependent Population (Assuming 4 is average family size)	Demand per capita per day (Lit/Day/Capita)	Water Demand per mode	2024(CSA-growth rate) Pop= 129370	2024 (Amhara region high growth Rate) Pop=161,515	Average Per capita per day Lit/capita/day
House Connected	1540	1540* 4 = 6160 = 6160 / 86720= 7.1%	80-standard (63-designed)	6160*80= 492800	9185*80= 734822	11219*80=897520	
Yard Connected	14310	14310*4= 57240 66%	40-standard (26-designed)	2289600	3415368	4171569	
Public Taps	30	26.9%=23328	30-standard (19-designed)	699840	1044016	1275173	
Total				3882240	5194206	6344262	3882240/86720= **40.15 (2014 GC)**

Source: Sample Survey Result, 2014

***Table 3. 10* Water Demand Projections (2014-2024)**

SN	Types of demand	2014	2015	2024 (CSA)	2024 (ANRS high growth rate)
1	Population	86,820		129370	161,515
2	Per capita demand in Lit\day	40.15			
3	Domestic demand in m^3\day	3882	5194	5194	6344
4	Public demand in m^3\day (30%)	1165	1559	1559	1912
5	Industrial demand in m^3/day (18%)	699		939	1142
6	Allowance loss in m^3/day (11%)	632		846	1033
	Total in m^3/day	6378		8538	10431
	in l//sec	73.82			121
8	Peak day factor	1.1		1.1	1.1

9	**Maximum day demand in m^3/day**	**7016**		**9392**	**11474**
10	**Maximum day demand Lit/sec**	**81.2**	**63(Designed)**	**109 (97-Designed)**	**132 (Drilled wells potential=103 therefore it needs two more bore holes with the capacity of about 15 each)**

Source: Sample Survey Result, 2014

3.8 Public Tap

There are thirty public taps installed in various places of the town. At the beginning of the existing scheme their number was 30, but now only 27 are on function. The public taps provide serves for 8 hours per day. Figure 3-2 shows the distribution map of public tap in Debre Birhan Town.

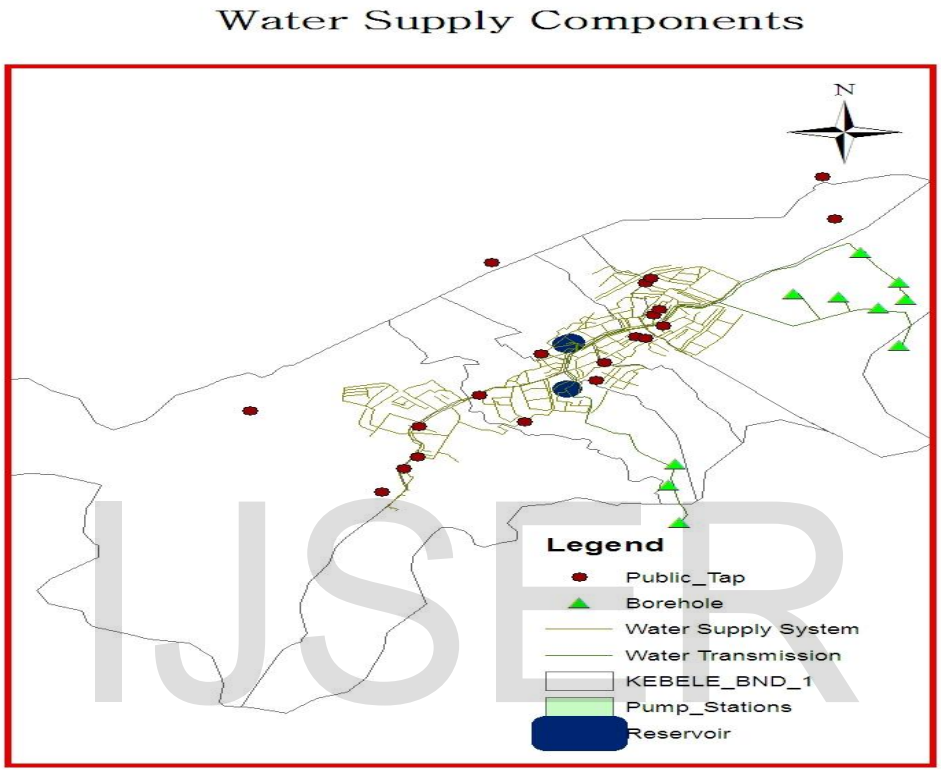

Figure 3. 5 Distribution Map of Public Taps

Table 3-11, hereafter, shows the situation of access for tap water. Thus, some about 91% of the dwellers are fetching potable water from their compound, which is very good in terms of coverage but equal proportion of population are still use dry pit latrine.

Table 3. 11 Access to Tap Water

SN	Modes of Service	No/Frequency	Percent	Design Estimation
1	Tap in house	154	8.8	10%
2	Tap in the compound	1431	82	77%
3	Public tap	43	2.5	13%
4	Tap outside the compound shared	116	6.5	

5	protected well spring	1	0.06	
Total		**1745**	**100**	

Source: Sample Survey, 2014

Chapter Four

4. Electric Service

4.1 Electric Consumption

Electric service is one of the several energy sources that human beings use for different purposes. It is quite clear that electric power has paramount importance and significant role for the development of a town and thereby a region as well as a country. Debre Birhan connected to the national grid system in 1985 GC and hence enjoys it for about thirty years. Before that it was connected with self contained diesel generator.

Table 4-1 depicts overall electric consumptions of Debre Birhan. It, therefore, shows an increasing trend of consumption from year to year. The peak load in each year is in the increasing rate as the investment and provision of residents are increasing.

Table 4. 1 Overall Electric Consumption Trends in Debre Birhan

Years	**Consumption per day(KW)**	**Growth rate %**
2006/2007	4460	0
2007/2008	4640	3.88
2008/2009	5180	10.42
2009/2010	5270	1.74
2010/2011	5440	3.23
2011/2012	6305	15.9
2012/2013	7170	13.72
2013/2014	9560(KW)=9.56MW	33.33
	Average	11.74
2024	Average DD = 30,923.74=31MW-the existing maximum capacity	

Source: ***EEPCO Office of Debre Birhan 2014***

Likewise, Table 4-2 shows electric consumption rates of different customer categories in kilowatt (kw). The figure shows the sum of peak load in a given year and it is the highest kilo watt that the customers used from the sub-station. The number of customer looking for meters at all levels have been increasing from year to year and the supply is also concomitantly increasing. The demand for electric power is rising for residential,

commercial, industrial, etc uses as given away in the above table. With the existing growth rate of demand the existing installed capacity is not enough in the planning period. During discussion with the institution in charge it was possible to reveal the program they have where it is preparing itself to increase the capacity up to 60 MW which is believed to be sufficient according to the analysis in the table 4-1 above.

Table 4. 2 Electric Consumption Trends for Different Uses in KW

No	Customary Category	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	Average	Share in percentage (2011)	Remark
1	Domestic	481680	501120	559440	569160	595680	541,416	30.30	No Data compiled since 2011
2	Institution	160560	167040	186480	189720	198560	180,472	10.10	
3	Commerce	192672	200448	223776	227664	238272	216,566.40	12.12	
4	Street light	24004	25056	27972	28458	29784	27,054.80	1.51	
5	Light industry	401400	417600	466200	474300	496400	451,180	25.25	The share of this three are 45.96%
6	Heavy industry	321120	334080	372960	379440	397120	360,944	20.20(only four industries)	
7	MSE	8025	8352	9324	9486	9928	9023	0.51	
TOTAL Per Year		1605600	1670400	1864800	1897200	1,985,600 or 5440 Kw/day	1,786,656.20		

Source: ***EEPCO of Debre Birhan 2014***

Table 4. 3 Present Electric Consumption for Different Purposes

SN	Purpose	Number of Users	Voltage	Remark
1	Domestic	10709	220	
2	Institutions	6	220/380	
3	Commerce	426	220/380	
4	Street light	659	220/380	By Municipality
5	Light industry	322	220/380	
6	Heavy industry	4	380	
7	MSE	7	380	

Source: Debre Birhan EEPCO, 2014

The above table (Table 4-3) shows the type and number of electric users and the amount of the voltage they are using at present time. The municipality is in charge of the street light system and takes the contract to cover the cost of consumption from EEPCO. Excluding it, the numbers of costumers for domestic and commercial activities are at the highest position. Micro and Small Enterprises are the other which gets such services for different activities in the town.

4.2 Transformers and Substation Capacity

There are 95 transformers installed in the town (including that found in the surrounding hamlets). Additionally the office are planned to install three extra transformers to the new existing settlements. Table 4-4 shows the available transformers with their respective capacities (that have been taken by GPS survey).

Table 4. 4 Number of Existing Transformers and their Capacities

No	Voltage (KVA)	Number/ Frequency	Total Capacity (KW)	Remark
1	25	6	150	
2	50	24	1200	
3	100	41	4100	
4	160	2	320	
5	200	37	4800	

6	315	31	7400	
7	630	6	3780	
8	800	4	3200	
9	1250	2	2500	
Total	**3630**	**95**	**27450**	**Out of 31000KW=88.5% is being used**

Source: Debre Birhan EEPCO, 2014

Table 4. 5 Debre Birhan Substations and Capacities

SN	Substation Name	Capacity (MW)	Used (MW)	Step down (kw)	Location
1	Debre Birhan	9.1	9.56	132/150000	Debre Birhan
2	"	3.3	3.00	"	Mendida
3	"	3.3	3.00	"	Ankober
4	"	3.3	3.00	"	Sheno
5	"	6	1.1	132/33000	Aliyuamba
6	"	6	1.1	"	Enewari
Total		**31**	**20.76**		

Source: Debre Birhan EEPCO, 2014

As depicted in the table above (Table 4-5), even though Debre Birhan substation has a capacity to receive 31MW, it has being received only 12.12 MW, as it distributes to centers such as Mendida, Ankober, Sheno, Aliyuamba and Enewari. Even though the town for this moment has excess power, following high growth rate of population, increasing income of the citizen and the increasing number of industries in the town, the town will get scarcity unless otherwise more power added to the network before the end of the planning period.

4.3 Street Light

In Debre Birhan town there are 659 numbers of street light points stand at different parts which are of Incandescent, Florescent and Sodium types. Most of these points are not florescent that is highly encouraged type of lamp since it consumes less and saves power. The other issues which are noted during the field survey include absence of street light in peripheral areas (which are not yet covered with such street light) and most of the defected street lights are not substituted quickly.

Table 4. 6 Number of Street Light Points and Types (Debre Birhan)

No	Street Light Types	Number	Power (W)	Total Power (KW)	%
1	Incandescent lamp	320	100-150	32	48.55
2	Florescent lamp	210	2*40	16.8	31.8
3	Sodium lamp	129	250	32.5	19.57
Total		**659**		**81.3**	**100**

Source*: EEPCO of Debre Birhan District (2014)*

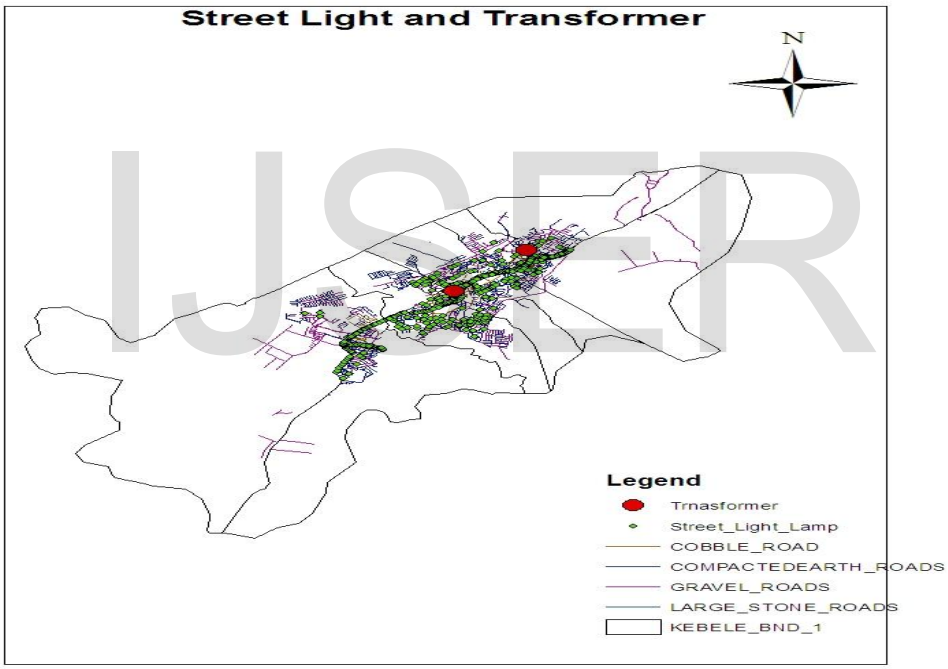

Figure 4. 1Street Light Coverage and Location of Transformers for Street Light

4.4 Energy Sources for Residential Units

Table 4-7 presents energy sources of residential units. As indicated in it, the main source of energy for majority of the population is that of fire woods and charcoals which accounts for about 51.18 per cent. The use of electricity only as a source of energy is still very minimal (only 2.18 per cent) this implies the people do not have a preference because of lack of

private energy meter and the tariff is higher for the low income group and make them dependent on fire wood and charcoal. It is known that such type of energy consumption has negative impact on the environment and hence it needs due attention to reveres it.

Table 4. 7 **Energy Source for cooking Housing Unit in Debre Birhan**

SN	Source	Number/Frequency	Percent
1	Electricity	47	2.18
2	Gas	32	1.48
3	Electricity and gas	60	2.78
4	Electricity, firewood and Charcoal	653	30.23
5	Gas, firewood and charcoal	108	5
6	Firewood and charcoal	1084	50.18
7	Firewood only	165	7.64
8	Other	11	0.51
Total		**2160**	**100**

Source: Sample survey, 2014

With regard to energy for lighting, majority of the sample population (77.78 per cent) use electricity as a major source (Figure 4-3) which is an implication of good deal. In addition, as observed, all settlements of the town have the electric power network which shows the available fair spatial coverage.

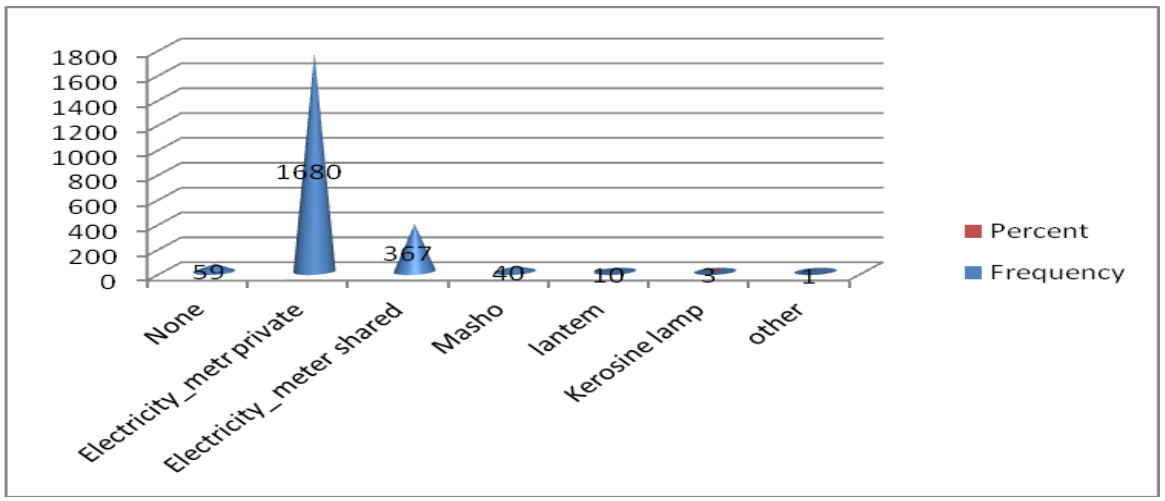

Figure 4. 2Energy Sources for Lighting

Source: Sample Survey, 2014

Chapter Five

5. Telecommunication

The potential of fixed telephone line service in Debre Birhan reaches as high as 7500. Among this only 63.25% is utilized while the remaining 36.755% is still waiting for user. In this regard the sample survey result (2014) shows that out of the total population some about 48 per cent have a fixed line connection. This implies nearly half is connected with this service. Figure 5-1 shows spatial distribution of telephone network and hence the peripheral parts are still devoid of this network.

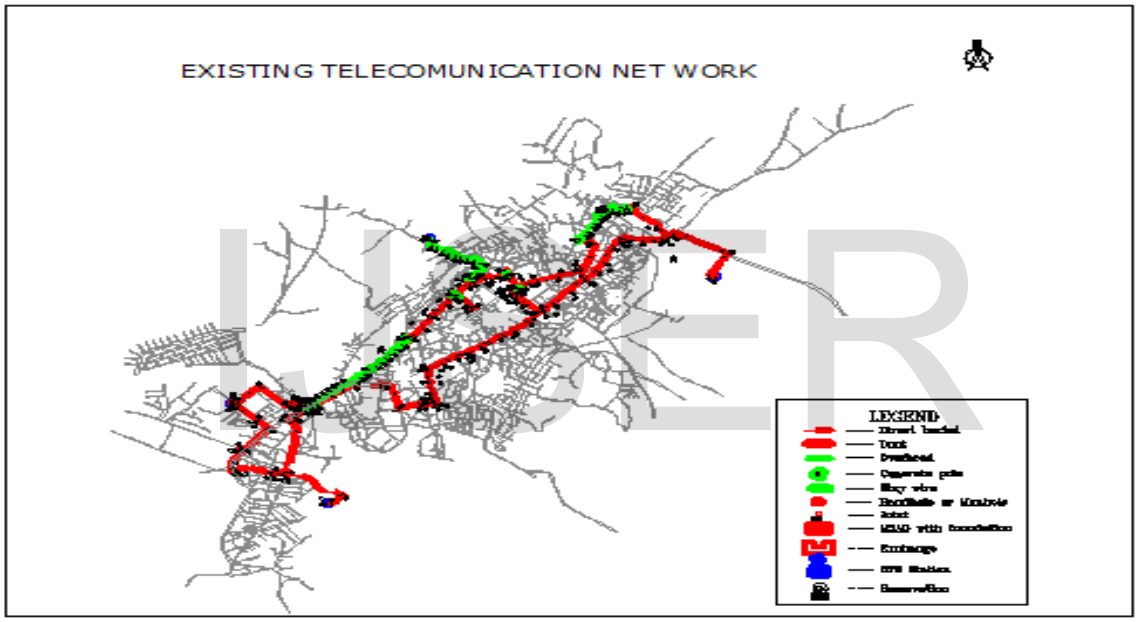

Figure 5. 1Fixed Telephone Line Network

It is difficult to know the number of mobile telephone users in the town. But, it is possible to say that most of the people who have demand for it have access.

Chapter Six

6. Drainage Network of Debre Birhan Town

6.1 Background

In principle provision and analysis of a city drainage system are categorized by tributary areas which finally drop out into natural drainage system.

The rolling and undulating topography of the city was good opportunity for good urban drainage system. However, there are no proper drainage channels as well as well designed drainage systems in most part of the city. This is mainly attributed due to the poor road network system of the city. As we mentioned in the previous section, the existing roads are not properly planned and designed and have no sufficient width for accommodation of other infrastructures. Up until now there was no proper design document of the drainage system as well as proper master plan of the road network of the city.

The previous Master Plan (1996) didn't recommend anything about drainage system and network for the town. In connection to this no plan design drawings are found in the Municipality regarding the existing drainage net work. However, the existing asphalt roads (the main high way to Dessie, the two asphalt roads on left and right sides of this main high way, those which connect these two asphalt roads with the main high way, and the road that dissects to Debre Birhan University, have improved the drainage and flood protection conditions of the town.

6.2 Drainage Pattern of Debre Birhan

The drainage pattern of the city is done on the available maps following the general topographic nature of the city. This has been confirmed on the site and some adjustment has been made on the final maps.

The drainage master plan should be related with the existing road width and the city road network master plan including all utility lines and infrastructures. However, such master plan was not available for Debre Birhan town. The drainage pattern is to indicate the centre line position of the drainage system relative to the road section. The aim of the drainage pattern is

also to indicate the general drainage pattern of major roads within the city and their disposal points.

In the process of drainage network design, it is recommended drainage on both sides of the road network system. Catchment's area for any recommended drainage system may be either the road surface runoff or the immediate adjacent catchment area, depending on the topographic nature of the area.

There are small streams and gullies within the city. Those can be utilized as a disposal point of the drainage system. Still the existing drainage systems are dropping out into those small streams and rivers. Therefore, streams and rivers within the city are serving as part of the city drainage system.

The drainage system of the town is explicitly guided with the two rivers locally known as Beressa and Dalecha rives though some other local streams have also contributed little in such regard. Beresaa River, which is a perennial stream, bisects the town in to two (Debre Birhan proper and Tebassie) has contributed most. It, therefore, drains most parts of the town (the central, southeast, western half including the northwestern and the southwestern). Dalecha, on the other hand, drains the northern parts. Moreover, there are other intermittent streams which end up flowing to one of these two main rivers. And these small streams have also their own contribution to facilitate the drainage though limited in their local areas. All these represent the natural drainage networks of the town which facilitate the surface drainage system of the town in almost all parts having a significant positive implication. And besides, those two rivers are also used as major source of drinking water for livestock, washing, greenery and small scale irrigation.

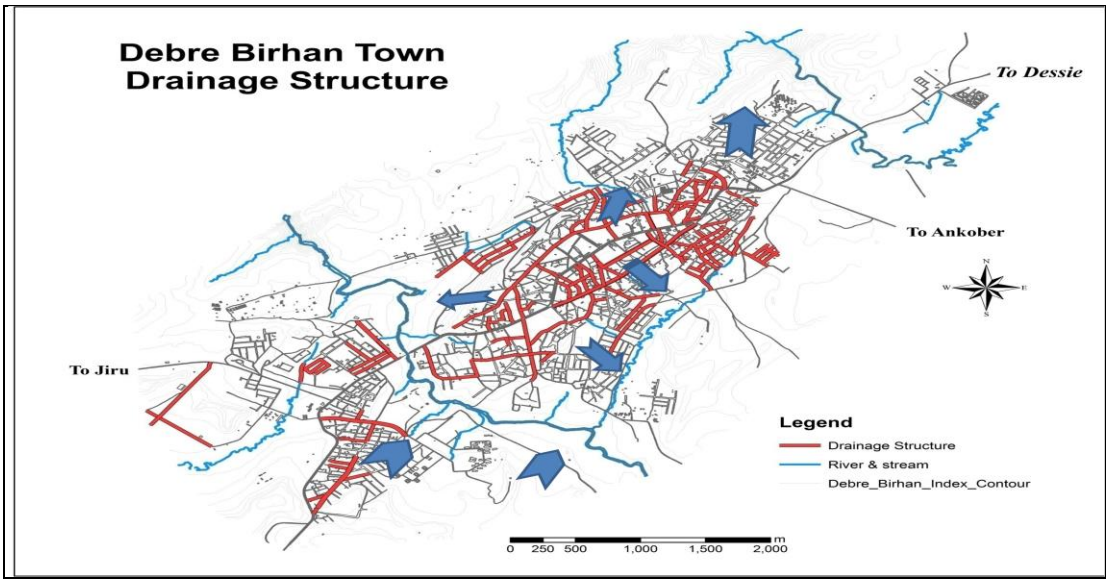

Figure 6. 1Drainage Pattern of the Town

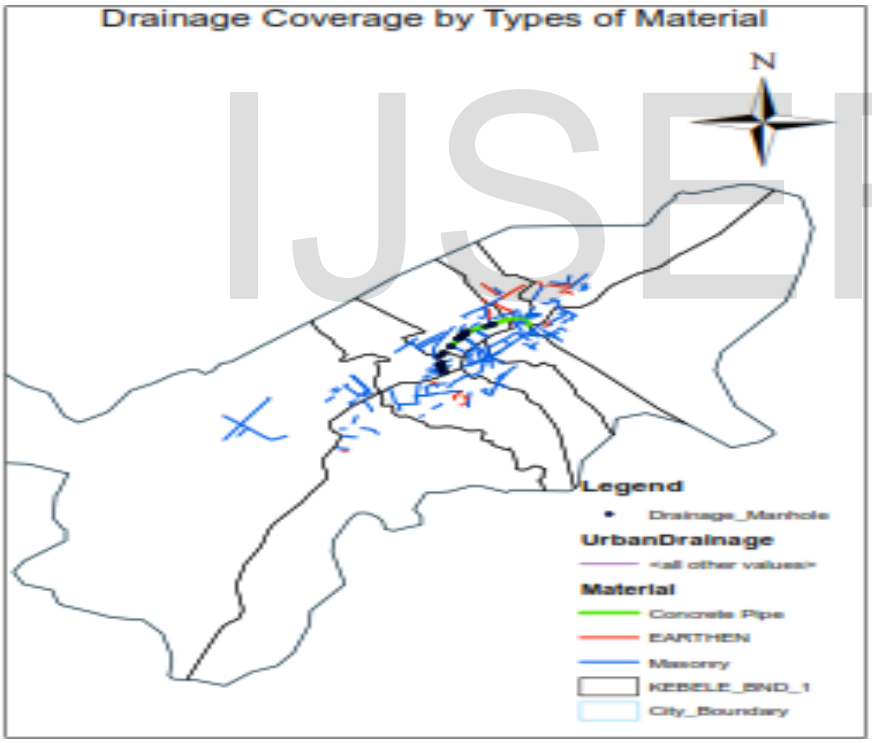

Figure 6. 2Drainage Coverage by Condition, (Da-Ya, 2016)

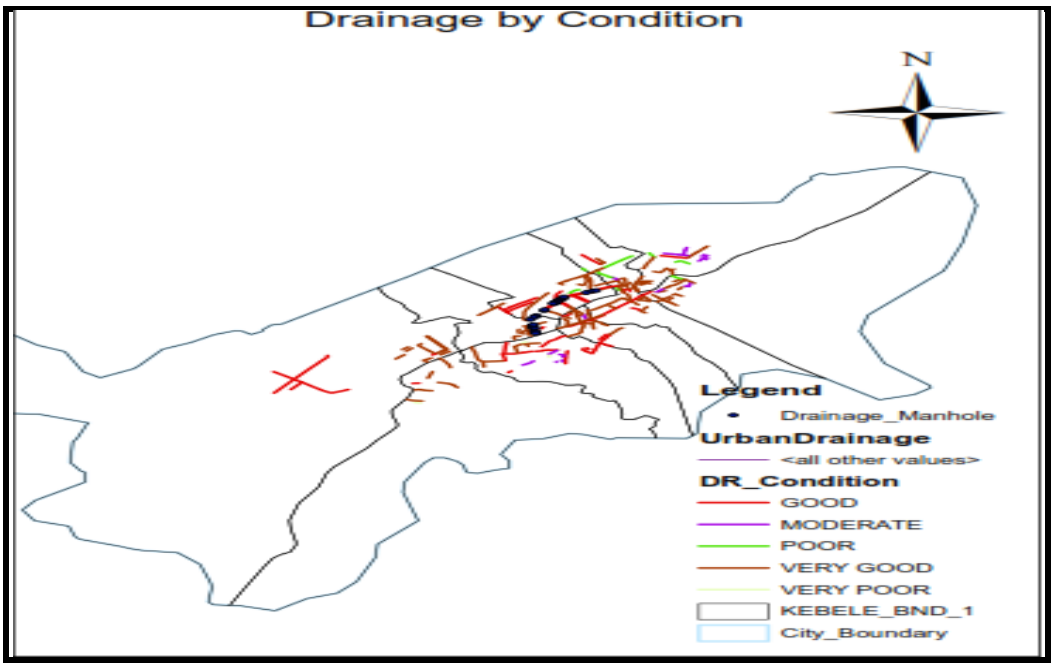

Figure 6. 3Drainage by Condition (Da-Ya, 2016)

In some parts of the town, where there is a flat topography which is observed in the newly expanded area, this needs a careful drainage system design.

6.3 Existing Manmade Drainage

Primary drainage (collecting drains/channels) facilities are those which channel storms on major roads. They collect storm water from road network of the city and drop out in to the natural drainage systems. In most cases those drains are rectangular open drains leading the storm water to natural drainage system.

In principles these are drains from the feeder roads. They catch runoff from the surrounding areas and lead to the side drains of the road systems. The runoff from the pavement surface is collected by the camber or cross slope to the pavement. The rate of this cross slope is decided based on type of pavement surface and amount of rainfall. The water which is drained from the pavement surface has to drain across the shoulders before it is lead to the side drains.

In the case of Debre Birhan Town the total road width is very limited to accommodate carriage way, shoulder, camber, dividing island, walk way and drains.

As a manmade drainage system all roads expected to have proper ditches on their both sides. But

the fact in the town indicates that except some (the main high way that runs to Dessie and those arterial roads connect with this main road) most of the road networks in the town lack standardized drainage ditch. The sample survey result (2014) shows only 19.91 per cent of the households have access to such manmade/artificial drainage system/network while the majority of the households (81.09 per cent) do not have any access to any of the artificial drainage networks.

These manmade road drainage structure networks divided broadly into two categories that include: first, the masonry channels (constructed "in-situ") represent most of the draining in the major asphalt and cobble stone roads either in the form of open system or closed system (covered by pre-cast concrete slabs with drainage slots). The width of the masonry drain is 80cm with 80 to 100cm depth. Second, excavated earth channels which are predominantly constructed for other road networks in the town with only limited sections being lined and which are rarely compacted.

The asphalt roads that have been mentioned above are provided with manmade drainage ditches of open or closed types (though it doesn't cover all parts) either in both sides or in one side. In this regard, one can mention some like the main high way from the inlet off Addis Ababa to the Dessie outlet, the two sub arterial asphalt roads on the left and right sides of this main high way, those connector asphalt roads dissected from the main high way, and the asphalt road that runs to Debre Birhan University, the road to Blanket factory, and some cobble stone roads, have relatively better drainage systems.

These drainage networks run in different directions of the town (in the central part it runs with the main road from southwest to northeast extremes, in the southern part it runs from north to south direction, and in the northern part of the town it runs from south to north direction).

In general, from the overall observation and assessment, it is realized that:

- The flat bed slope and vegetation growth in the open drains hamper and/or impede the free flow of storm water;
- Flows of surface water on roads create formation of cross pothole and erosion across and along the road ways. The repercussion effect of which is that, the roads are easily damaged and creates water pond on the road surface and pavement;

- Most of local and collector road have no road drainage structure on both side. Some of cobble stone road have only one side drainage structure;
- Some of drainage structure doesn't follow the road alignment;
- Most of the drainage systems have no proper start and end point to be terminated and hence dead ends observed on most of the drainage structures construct.

*Figure 6. 4**Views of Poor Drainage Network (Lack of Road Side Drainage Structure)***

Plate 18: Masonry Rectangular Ditch **Plate 19: Poor Cross-fall and Potholes**

*Figure 6. 5**Masonry Ditch and Potholes***

Plate 20: Cross Gully and Dead end Drainage

Plate 21: Dead end Rectangular Drainage

Plate 22: Lack of Drainage Structure and Water Flows along the Road

Plate 23: View of Masonry Structure filled with Vegetation and Drainage end at Baressa River

Figure 6. 6Conditions of Drainage Structure

While most of the asphalt roads have rectangular masonry structural drains, most of the local roads have no any drainage structure at all, some have the natural and excavated earth channels. As a result, the storm water flows everywhere and in every direction creating its own way (without properly designed drainage path). That is why, this mostly observed on the road network itself, near the fences, and even standing still for some times.

However, it is important to note that the drainage network does not cover all sides (even the most requiring once) and all except some (those found along the principal and arterial asphalt roads) are sub-standard and low quality networks. This, therefore, implies how much the drainage coverage of the town is still very much low.

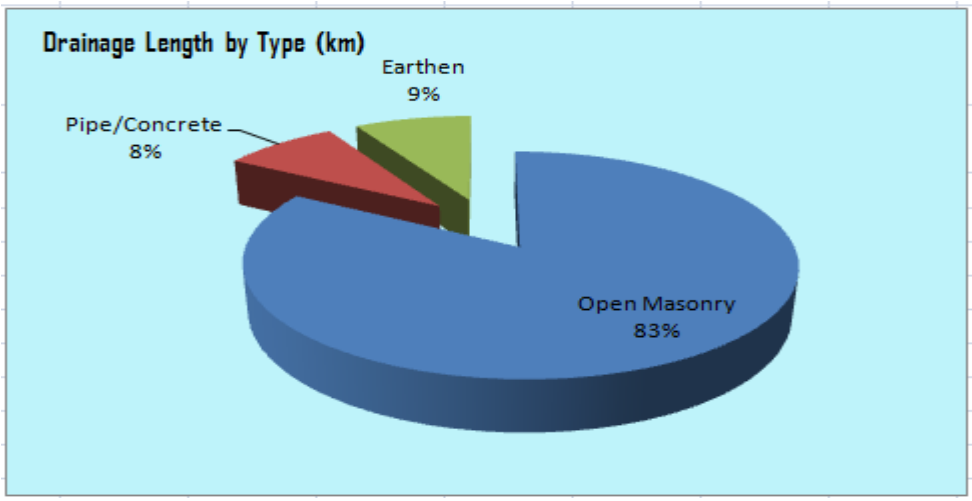

Figure 6. 7 Drainage length by Type

6.4 Interceptor Drain

Most periphery of the town is bounded by small hill. The hills are rolling creating gorge and valley. The hills are densely covered by grass and some trees, the potential for reducing rainfall runoff. The mountain that bordered the town along its north and northwestern parts and other high elevated areas inside the border of the town (like the area along Ankober road facing to the town) which are the potential sources of runoff should also be conserved and covered with vegetation. Therefore, no further recommendations have been made for interceptor drains across the hills.

6.5 The Flood Hazard/Problem

Natural flood hazard, in fact, is a phenomenon that will always existed and will continue to exist due to the prevailing climatic situation and social interactions with the natural environment. Due to its natural topographic setup and high rainfall, Debre Birhan experiences flood problem though its occurrences and impacts are not that much, it is sometimes occurred during the rainy seasons as storm water drainage usually conveys large volume of runoffs that from the urban proper and the surrounding rural upstream. In this regard, Beressa and Dalecha have negative flood hazard (along their embankments and even the nearby settlements), soil erosion and land degradation impact on the urban built-up part. Besides, there courses/gorges in the area restrict smooth, easy and direct access as well as movement from one part to the other side. Almost all the low level areas along those two

main rivers are relatively flood prone areas in the town which are affected due to their lower positioning with respect to the rest part in their surrounding environs. The main problem with the storm water management system is its lower coverage with respect to the extent of the town. During the past public meetings, some of the residences have raised the issue of flooding as one of the foremost critical problems in their local neighborhood especially during the time of heavy rain, the surface runoff sometimes jumps to compounds and it gives inconvenient working environment.

In general, the flooding problems of the town can be expressed in a summary as follows:

- Flooding along the two main watershed drainage patterns of Beressa and Dalecha,
- Runoff launch from the nearby highly elevated areas,
- Developing water logging and swamp areas at the lower and flat plain areas which may result water born and related diseases,
- Shortage of drainage conveniences, the existing drainage system is not capable of holding the entire overflow of the town and nearby environs,
- Unhygienic circumstances of open ditches which are resulting blocking of storm runoff and also creating in environmental problems particularly along road sides and open ditches, and
- Limited dealing with the operation and maintenance of the drainage system with respect to the towns all rounded growth.

Chapter Seven

7. Liquid Waste Management System

7.1 Sewer System

Sewerage system for liquid waste management is totally absent in the town. Waste water stored in septic tanks and pit latrines of households and institutions is emptied and transported by vacuum trucks. The transportation was carried out by private and trucks from the water office. The transported waste is disposed in a waste drying bed constructed and managed by the water office located adjacent to the existing solid waste disposal site. As the natural treatment is under the control of water office, it prohibits private vacuum trucks disposal to the site. The private trucks dispose the waste outside the controlled area on illegal and uncontrolled space mixing it with dispersed solid waste. One can, therefore, observe waste water flowing and polluting the surrounding area creating big health risks to the surrounding community. To curtail this problem, the municipality should discuss with the water office so that all stakeholders that transports the waste could use and/or dispose on the drying bed as it is meant to serve the whole town. The drying bed could serve the town during the planning period.

A structured questionnaire was designed to collect information on socio - demographic factors and waste water management practices in the sample household survey conducted for this SP. Further, consecutive site visits were carried out to know how different institutions and housing units in some selected kebeles managed the waste water they generated.

7.2 Waste Water Handling in the Housing Units

Housing Toilet and Bath Facilities

The situations of toilet and bath facilities have been portrayed in Figure 7-3.

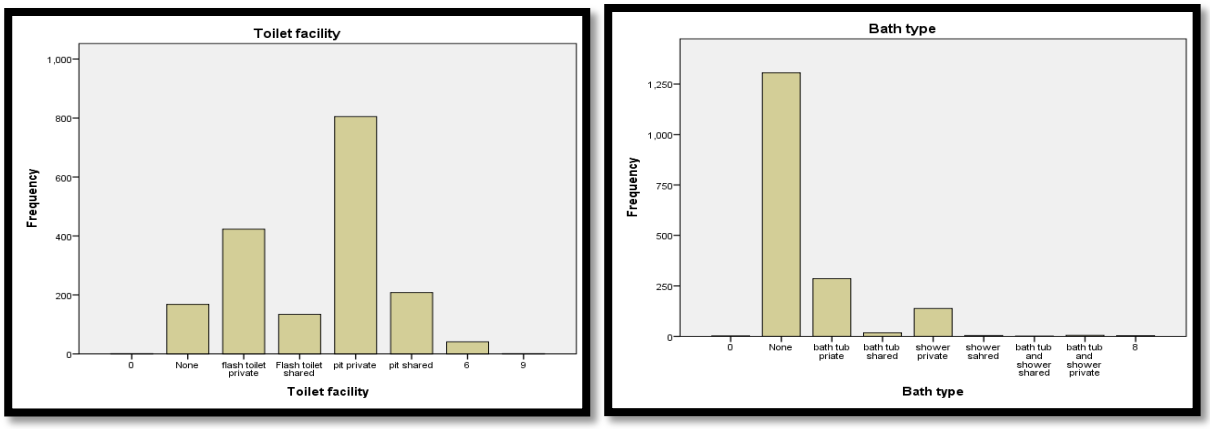

Figure 7. 1Housing Toilet and Bath Facilities

Source: Sample Survey, 2014

Thus, out of the total 1794 sample housing units surveyed (2014), only 9.4% have a private flush toilet and 27.92% have a shared flush toilet. On the other hand, those housing units with a private pit latrine accounts for about 40.56% while the rest 13.52% have that of a shared pit latrine. Regarding bath facilities 77.68% do not have access to bath facilities and only 11.48% housing units have private tub baths. The percentage of housing units having a shared tub baths accounts for 1.25%. The total housing units having access for private shower account only 8.01% while those with shared shower account for about 1.11% together they still made only 9.1% (Da-Ya, 2014).

In general, from the above discussions, one can possibly suggest that the situation of housing toilet and bath facilities is not that much appreciable as most of the houses do not have standard facilities. From which it is possible to conclude that such facilities are not yet adequate and sufficient. As these facilities have a lot to do with hygienic and health of people, dealing with these facilities has a paramount impotence for development.

7.3 Wastewater Handling Practices of selected Institutions

Waste water management is poor in the town where waste generated from different institutions was observed polluting the environment. These include condominium houses, the prison camp, factories and the university.

A. Debre Berhan University

The university directly discharges its waste directly to Beressa River without any treatment. As the river is major source of ground water source of the town, any waste discharged in to the river including from the university, have direct impact on the pollution of the ground water resource. The river flows to the lower riparian, the farmer community, resulting in health and economic risks. Moreover, it has affected the marine life by toxicities.

*Figure 7. 2**View of Sample Site near Debre Birhan University***

B. Debre Berhan Blanket and Leather Factories

Theses factories are discharging their waste effluent directly to the Berresa River. Berresa River, high concentration of total suspended solids, Alakalinity, Ammonia, Potassuim and Sulfate are found at the sample site near the factories. The table below shows major effluents discharged to River Beressa.

Table 7. 1 Major Contents of Effluents Discharged to River Beressa

No	Sources/Factories	Major Contents of effluent discharged
1	Blanket Factory	Soda ash, Sulphides, Ammonia, Salts, Toilet sewages
2	Tannery	Sodium Chloride, SO2, Cr,NH3, Acids, Sewages
3	Prisons	Sewages with human excreta, urine

4	Teachers college	Liquid and solid wastes
5	Children Village	Toilet wastes, Detergents, Cattle wastes
6	Municipal sewages	Organic, Inorganic compounds, Plastics, Sediments

Source: (Tropics, 2006)

7.4 The Liquid Waste Site and Management System

There is a liquid waste disposal site with a waste drying bed constructed and managed by the WSSO, located adjacent to the existing solid waste disposal site. The overall compound area of this site is 78,479 sqm (of which the area of the treatment bed is 63,870 sqm) which is even sufficient enough to hold and treat all wastes of the city. However, as the treatment is under the control of WSSO, it prohibits private vacuum trucks disposal to the site. The private trucks dispose the waste outside the controlled area on illegal and uncontrolled space mixing it with dispersed solid waste. There are two trucks that belong to the WSSO for transportation.

Table 7. 2 Summary of Liquid Waste

SN	Asset Components	Unit Measure				
		Location	Quantity (no)	Area (in m^2)	Length (in m)	Remark
1	Vacuum trucks		2			WSSO
2	Disposal sites compound	Kebele 07	1	78,479		WSSO
3	Treatment bed	Kebele 07	1	63,870		WSSO
4	Sewerage line	In all part			663.86	CA
5	Sewerage manhole	In all part	8			CA
6	Treatment Plant	Kebele 01	1	107.86		CA

Figure 7. 3Views of the Liquid Waste Disposal Site

In addition to the above mentioned liquid waste disposal site (and treatment bed), there is also one treatment plant (in Kebele 01) around Basso High School which is still active though its situation is deteriorating. There is also some about 664 meters sewerage line in the city that used to collect & transport liquid waste. The total numbers of manholes for this purpose (inletting liquid wastes) are inventoried as 8.

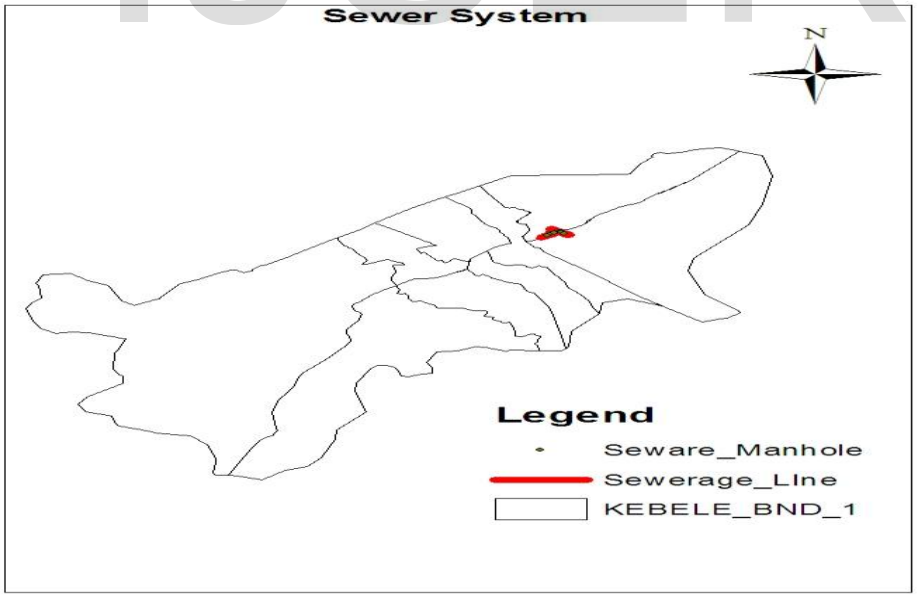

Figure 7. 4Location of the Liquid Waste Disposal Site

Chapter Eight

8. Conclusions and Recommendations

8.1 Conclusions

Table 8. 1 **SWOT**

Strength	***Weakness***
▪ Its location (along the main highway and near to Addis Ababa) and its role as a center for North Shewa Zone, Basona Werena Wereda and its Wereda and City Administration Level; ▪ Suitable climatic condition and its interesting landscape both for habitation and to undertake any developmental activities; ▪ Commitment of the city administration to plan and develop the town accordingly; ▪ The willingness of the community to participate in developmental activities; ▪ Availability of excess ground water resources for water supply; ▪ The presence of Beressa River and Dalecha water field, as source of water for any developmental activities; ▪ Availability of the hydropower source, connection with the national grid system and the presence of 24 hrs electric power supply; ▪ The access to electric lighting and energy for the majority dwellers**;** ▪ The available telecommunication and postal services; ▪ Availability of potential water bodies for recreational purposes; ▪ Establishment of community policing across each kebeles and their commitments; ▪	▪ Dilapidated and poor housing conditions especially in the center of the town; ▪ Absence and lack of legal tenure for many land occupiers and land holdings; ▪ The liquid waste disposed from the slaughter house directly entered to rivers without any treatment and is polluting the resource and environment; ▪ Un even distribution and shortage of street light on the majority of roads and in the entire peripheral parts of the town; ▪ Problem of immediate (or on time) replacement of defected street light pulps; ▪ Problem of organization and management of data in each institutions and even in each sectors;

Opportunity	*Threat*
▪ Current general national and regional governments focus on urban development and support for development of the town; ▪ The presence of supporting government policy and strategy for urban development; ▪ Peace and political stability in the country as well as over all in Debre Birhan; ▪ High investment potential; ▪ High potential to invest on different economic projects/activities; ▪ The government policy that encourages local NGOs to actually participate in the implementation of projects for the needy while it encourages international NGOs to be donors; ▪ The secured twinning sister-ship relation with the France City; ▪ The conducive and enabling grounds for local and international fund raising and resource mobilization undertakings; and ▪ The ongoing local and municipal reform and decentralization programs in the country that would definitely empower local communities to have role in their own affairs.	▪ The flood of 'BERESA' river at downstream; ▪ The possible occurrence of flood hazard; ▪ Rapid price escalation of construction material;

Generalization

It is obvious that infrastructure is the back bone and the basis of a countries welfare and economic development and infrastructure provision cause for deeper analysis and optimal planning exercise. Generally infrastructure plays a critical role in promoting economic growth through enhancing productivity, improving competitiveness, reducing poverty, linking people and organizations and contributing to environmental sustainability that needs to be analyzed and properly planned. As per the site under discussion all physical infrastructures are analyzed to be used as an input for development plan preparation.

Debre Birhan has enormous problems concerning compatibility, accessibility, availability, sufficiency and effectiveness of physical as it has been explained in analysis part in detail. The

Water supply system is new but the design and construction of the scheme will never be in the position of catering the real projected demand of the future even in its own life period because on the one hand estimation of per capita demand is far below from the national standard and on the other hand the number of projected population of the existing facility very low compared to the projection done and taken to this study and will result in shortage of reliable water provision before reaching the design life period. With regard to power supply the substation is serving also other towns, the growth of these towns on top of fast growth of industrialization in Debre Birhan towns already started to demand much more additional substation capacity.

Sewerage system for liquid waste management is totally absent in the town. Waste water stored in septic tanks and pit latrines of households and institutions is emptied and transported by vacuum trucks. The transportation was carried out by private and trucks from the water office.

The town's drainage coverage is still very limited as all the local roads have not at all and storm water flows everywhere and in every direction that calls for immense expansion. Besides, except some, most of the drainage networks are still sub-standard and low quality which requires standardization.

8.3 Recommendations

Water

Quantity of Existing Water sources: The adequate quantity of water supply and acceptable quality is one of the basic needs of human beings. The provision of potable water in Debre Bidhan is adequate right now but will get short in the near future far before the design life period. The projected water demand is 132 liter per second but the Drilled wells potential is 103 litters per second. The city line sources therefore, needs two more bore holes with the capacity of about 15 litter per second each.

Industrialization will have also a good share in the town development and expected to be increase in significant proportion. Hence, the municipality need to increase them to have their own well or not to be connected to the city line.

Loss: As it can be observed from the data displayed, the amount of water loss is too much compared with the estimated and taken in to account during design of the scheme, but such loss rate was decreasing in the early years of this new scheme though when the time goes the loss is going up which needs the attention of the respective bodies. According to Debre Birhan Water and Sewerage Office, the main causes of the losses are leakage from the pipeline, illegal connection and use of the water before meter.

Electric

- The demand for electric power is rising for residential, commercial, industrial, etc uses as given away in the above table. With the existing growth rate of demand the existing installed capacity is not enough in the planning period. During discussion with the institution in charge it was possible to reveal the program they have where it is preparing itself to increase the capacity up to 60 MW which is believed to be sufficient according to the analysis
- The power demand in the expansion area because of the coming industries is very high and urgent. The municipality therefore, must work hard for the increment of the power capacity in the substation and their distribution where they are badly needed.
- Dealing with additional electric capacity in the substation and improving energy utilization in terms of efficiency;
- Realization of even distribution of street light system and sufficient and functional street lighting (solving the problems of shortage of street lights and operations);
- The coverage of this service should also increased to the area where potential needed well in advance like the places of Industry zone, dry port and business areas.

Telecommunication

- Even though telecommunication is delivering digital automatic and mobile services, there is mobile network problem in the town so the concerned body should work in improving the network;

Drainage

- The drainage network line of the town to be designed should be connected and/or aligned to the flow directions of those natural rivers and streams. The undulating topography of the town will also greatly help/facilitate the storm water management and hence the design should be made based on the contour configuration.
- In some places those small commercial houses adjacent to the asphalt road have covered the open drainage channel and are creating immense problem though they have created good business environment and considerable employment opportunity. Likewise, in some places the drainage channels are covered and completely clogged by dirt matter and debris. During rainy season small depressions which form swamps and water loggings are created; by recognizing this problem the municipality should made the necessary effort to avoid such problem.
- As the drainage ditches are open channels there is inconvenience for easy access and specially during evening times dropping of human beings and animals are observed and above all they have been dumping places for all types of waste matters. Other than this the rivers and streams have to be protected from any of polluting activities and assigning the nearby areas for compatible land uses (greenery, urban agriculture, recreation, etc) is recommended.
- The future drainage system construction endeavors should involve the MSE's that will be as hitting two birds with one stone.
- The municipality should devise and implement flood protection mechanisms (like stone ditches, terracing and gabion) as all water courses have not been well protected and this has been and will be the critical area of concern in the future. In some parts gabion construction together with afforestation is among the mechanisms to alter the flood problems along the river embankments which help the embankments stay stable.

- The mountain (that bordered the town) along its north and northwestern parts and other high elevated areas here and there (like the area along Ankober road facing to the town) which are the potential sources of runoff should also be conserved and covered with vegetation.
- The drainage network line of the town to be designed should be connected and/or aligned to the flow directions of those natural rivers and streams. The undulating topography of the town will also greatly help/facilitate the storm water management and hence the design should be made based on the contour configuration.

Waste Water

Considering the above related problems, it is feasible to recommend the following points as a solution to the existing and forthcoming challenges in the sector.

- Discuss with the university to use natural treatment before discharging its waste into Beressa river to reduce the pollution impact;
- Discuss with the water office so that all stakeholders could use the natural treatment for disposal;
- Discuss with farmers to use the resource(fertilizer)properly from the dry bed;
- Follow up new constructions of proper sanitation facilities installment (standard septic tanks, pit latrines, lines) installment;
- Identify those institutions that discharge their wastes directly to the river resources and punish those which don't stop doing so and; and
- Think of options by which the town could design and prepare waste water management master plan in collaboration with stakeholders to curtail related problems sustainably.

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