General Overview of Wastewater Treatment in Injibara Town

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Abstract
This study was conducted to explore the real problems occur in domestic wastewater treatment of Injibara town, Amhara Regional State, Ethiopia.Domestic wastewater is the water that has been used by a community and which contains all the materials added to the water during its use. It is thus composed of human body wastes (faeces and urine) together with the water used for flushing toilets, and sullage, which is the wastewater resulting from personal washing, laundry, dish washing garbage disposal, food preparation and the cleaning of kitchen utensils.Domestic Wastewater which usually contains relatively small amounts of contaminants but even small amount of pollutants can make a big impact on environment. Domestic waste treatment ensures that all household sewage is properly treated to make it safe, clean and suitable for releasing back into the environment, lakes, or streams. Home sewage systems are designed to treat all of the liquid waste generated from a residence.
Domestic waste consists of four main fluxes: these are grey water, black water, yellow water and brown water.Household sewage treatment plant breaks down domestic wastes via three major stages.The design population is estimated with due to all factors governing the future growth and development of the project area in the industrial, commercial, educational, social and administrative spheres, Based on total numbers of population to determine water assessment and wastewater of the town.There are four types of wastewater treatment methods for futur design, such as preliminary, primary, secondary and tretiary treatment.This papre contains introductio, literatue review, material and methods, result and discusion, overeview of domestic wastewater management, conclusion and recommendation and reference.
Keywords: population forecasting, water demand, wastewater, treatment, effluents.

1. INTRODUCTION

Domestic Wastewater treatment or sewage treatment is a broad term that applies to any unit operation, process or combination of operation and process, which can reduce the objectionable properties of water carries waste render it less dangerous and repulsive to man. Thus, the wastewater should be treated before its ultimate disposal in order to reduce the spread of communicable diseases caused by the pathogen organism's sewage and prevent pollutions of surface and groundwater.

The contaminants (pollutants) in wastewater are removed by physical, chemical and/or biological means, and the individual methods usually are classified as physical, chemical and biological unit processes or operations.

Treatment methods in which the application of physical forces predominates are known as physical unit operations. Typical physical unit operations are: screening, mixing, flocculation, sedimentation, flotation, and filtration and membrane filter operations.

Treatment methods in which the removal or conversion of contaminants is brought about by the addition of chemicals or by other chemical reactions are known as chemical unit processes. Such as Neutralization, oxidation, reduction, precipitation, gas transfer, adsorption, ion-exchange, electro-dialysis etc. are the most common examples of these processes used in wastewater treatment.

Treatment methods in which the removal of contaminants is brought about by biological activity are known as biological unit processes. Biological treatment is used primarily to remove the biodegradable organic substances (colloidal or dissolved) in wastewater. Basically, these substances are converted into gases that can escape to the atmosphere and into biological cell tissue that can be removed by settling. The most common approaches in the biological wastewater treatments are: aerobic processes such as trickling filters, activated sludge, oxidation ponds (lagoons), and anaerobic processes such as anaerobic lagoons, sludge digestion, etc

Usually in the domestic wastewater treatment, but also in other wastewater processing all the above mentioned unit operations and processes are grouped together to provide what is known as preliminary, primary, secondary and tertiary (advanced) treatment.

The term preliminary and primary refers to physical unit operations and in some cases to chemical unit processes; secondary refers to biological unit processes; and tertiary refers to combinations of all three. The contaminants of major interest in wastewater and the unit operations and processes or methods applicable to the removal of these contaminants

The complex question of which contaminants in wastewater must be removed is to protect the environment and to what extent must be answered specifically for each case. This requires analyses of local conditions and needs together with the application of scientific knowledge, engineering judgment based on past experience, and consideration of federal, state and local requirements and regulations.

Wastewaters are waterborne solids and liquids discharged to the sewers and represent the wastewater of community life. In composition wastewater includes dissolved and suspended organic solids, which are "putrescible" or biologically decomposable. Domestic wastewater also contains countless numbers of living organisms - bacteria and other microorganisms whose life activities cause the process of decomposition. When decay proceeds under anaerobic conditions, that is, in the absence of dissolved oxygen in the wastewater, offensive conditions result and odors and unsightly appearances are produced. When decay proceeds under aerobic conditions, that is, in the presence of dissolved oxygen, offensive conditions are avoided and the treatment process is greatly accelerated.The overall philosophy of wastewater sanitation involving the removal, control and treatment of a wastewater in an area that is isolated or remote from the center of activity is important. Over the years wastewater treatment management practices have evolved into a technically complex body of knowledge based on past practice and applied engineering and environmental sciences. The intelligent application of these fundamentals goes a long way toward assuring us that the environment will be maintained in a safe and acceptable condition.

1.1. Statement of the Problem

Injibara town has been experiencing the problem of inadequate safe domestic wastewater treatment, due to lack of proper existing treatment plant of town. The people of this study area are large numbers due to this reason to produces large amounts of wastewater per day. It had been an Administration center from long period of time for the Awi Zone in Amhara regional state, Ethiopia. A rapid and steady growth of population in and around the town has forced Injibara town to give proper and timely response to urban service demands like water supply and sewerage system and wastewater treatment plant. This increases anticipated growing more with the emergence of various governmental, non-governmental and private institutions and job seeking migrants in the future means for rising demand for additional urban services including water supply and sewerage system and treatment plant. So, it has been fast spatial expansion necessitates a suitable action plan to improve their urban infrastructure particularly water supply and domestic wastewater treatment plant. The situation of the domestic wastewater treatment in Injibara is very similar to that of other developing countries' towns where domestic wastewater treatment situation in the town has been deteriorating. The problems associated with inadequate domestic wastewater treatment services in this town contribution to urban environmental degradation and damages to public health. Hence, the dwellers explained problem of domestic wastewater in Injibara town was not only the problem of treatment plant, adequacy and quality but also it has been the problem of sewerage system.

1.2 Questions of research

1. Wastewater – What is it?
2. What is in wastewater that causes problems?
3. What are major perspectives on wastewater and wastewater impacts?
3. How to determine wastewater?

1.3 Objectives of the study

The general objective of this studying is to assess and identify the domestic wastewater of the Injibara town. The specific objectives of the studies are;-

1. To provide basic design skills and knowledge on the wastewater treatment plants and their unit operations and processes
2. To ensure health protection and appropriate wastewater services to the urban population
3. To ensure environmental protection and mitigate impacts from wastewater on the environment
4. To introduce fundamentals of the wastewater treatment plants and their unit operations and processes
5. To experience a design project on a hypothetical wastewater treatment plant
    - Identify kinds and sources of wastewater
    - Describe hazards in wastewater
    - Describe ways of treating wastewater
6. To guide future town investment and development of wastewater services in terms of:
    - legal and institutional framework
    - improvement of the capacity of central/local governments to provide and sustain urban wastewater services
    - application of appropriate and affordable technologies

The overall objectives of wastewater treatment are associated with the removal of pollutants and the protection and preservation of our natural resources.

Specific concern is protection of human health by the destruction of pathogenic organisms present in wastewater prior to treated effluent being discharged to receiving water bodies and land.

1.4 Scope of the Study

The scope of the study is limited to domestic wastewater treatment. This town was selected because of its fast growing nature with inadequate domestic wastewater treatment and as per investigators and it have been get there was no research conducted domestic wastewater treatment and other infrastructure of the study area.

1.5 Limitation of the Study

The study was the limited access of the numbers of population immigration and emigration of Injibara Town due to lack of enough data collection of total population in Injibara town per day, month and year for design of domestic wastewater treatment,

Furthermore, lack of sufficient time and finance limit the size and natures of the study areas to collected the numbers peoples from each household of the town.

1.6 Significance of the Study

Domestic wastewater is the major challenge in entire world predominant in third world countries, like sub-Saharan Africa, particularly Ethiopia. Because the people moving (i.e. immigration and emigration) one place to other place, that means from Ethiopia to other countries or other countries to Ethiopia. These types of problem are occurred in Injibara town. Due to this problem we cannot design proper capacity of wastewater treatment plants and sewerage systems.

Finally, to forward the possible suggestion to the policy makers, academic community, NGOs, community based organizations and other stake holders who are concerned used for designing a more effective method of domestic wastewater treatment plants, there by contributing to narrowing the knowledge gap between domestic wastewater, supply and demand for safe wastewater treatment service; can help private institutions to engage in the delivery of this service, provided they are permitted to get involved in the sector.

2. Literature Review

The design domestic wastewater treatment is estimated with due to all factors governing the future growth rate and development of the project area in the residential, commercial, educational, social and administrative spheres. Special factors causing sudden emigration or influx of population should also be foreseen to the extent possible (WSEE 2011).

The development of a particular city (town) or a region depends upon natural, physical and socio-economic factors. Among these factors the population assumes significance in determining the future pattern of progress and development.

Design of domestic wastewater treatment plant scheme is based on the projected population of a particular city or town, estimated for the design period. Changes in the population of the city over the years occur and the system should be designed taking into account of the population at the end of the design period (Waste water treatment.2012).

Factors affecting changes in population are: increase due to births, decrease due to deaths, increase/ decrease due to migration and increase due to annexation (Water Supply and Environmental Engineering).

The present and past population record for the city can be obtained from the census population records. After collecting these population figures, the population at the end of design period is predicted using various methods as suitable for that city considering the growth pattern followed by the city and based this population to determine the capacity of domestic wastewater treatment plants (WSEE 2011).

Perhaps no single factor is more important for local government planning than the size and composition of a town's population and the way it will change in the future. Even though the total population may remain constant, changes in its composition can fundamentally alter the need for public facilities and services:- Klosterman (1990),

3. Material and Methods

3.1 Description of Study Area

The study was conducted in Injibara Town, Amhara Regional State, Ethiopia. Its relative location is in the south western part of the region and North western part of the county, Ethiopia. It is about 447 km away from the capital city of Ethiopia, Addis Ababa and 118 km from Bahir Dar, the capital city of the Amhara Regional state. Geographically, Injibara is found in 10059'N and 36055'E longitude. The highest and lowest altitude of Injibara is recorded to be 2540m.a.s.l and 3000m.a.s.l respectively (Zenebe consultant, 2009). According to the town's Administration the total area of the town is estimated to be 28.3 km2. It is divided into three urban Kebeles under the town administration. The current development plan for Injibara Town was prepared in 2004 by National Urban Planning Institute. The development plan shows that there are areas allocated for residential, commercial, industrial and service-giving institutions. With the growth of the private sector in the economical activity of the town, there will be a high demand for basic services among which water is the prime necessity

(National Administeration.2004).

The proposed town development plan supplemented with on-site observation, topographic maps and consultation with the local community, governmental and non-governmental organizations are among the basis for water demand computation and design of future water supply system.

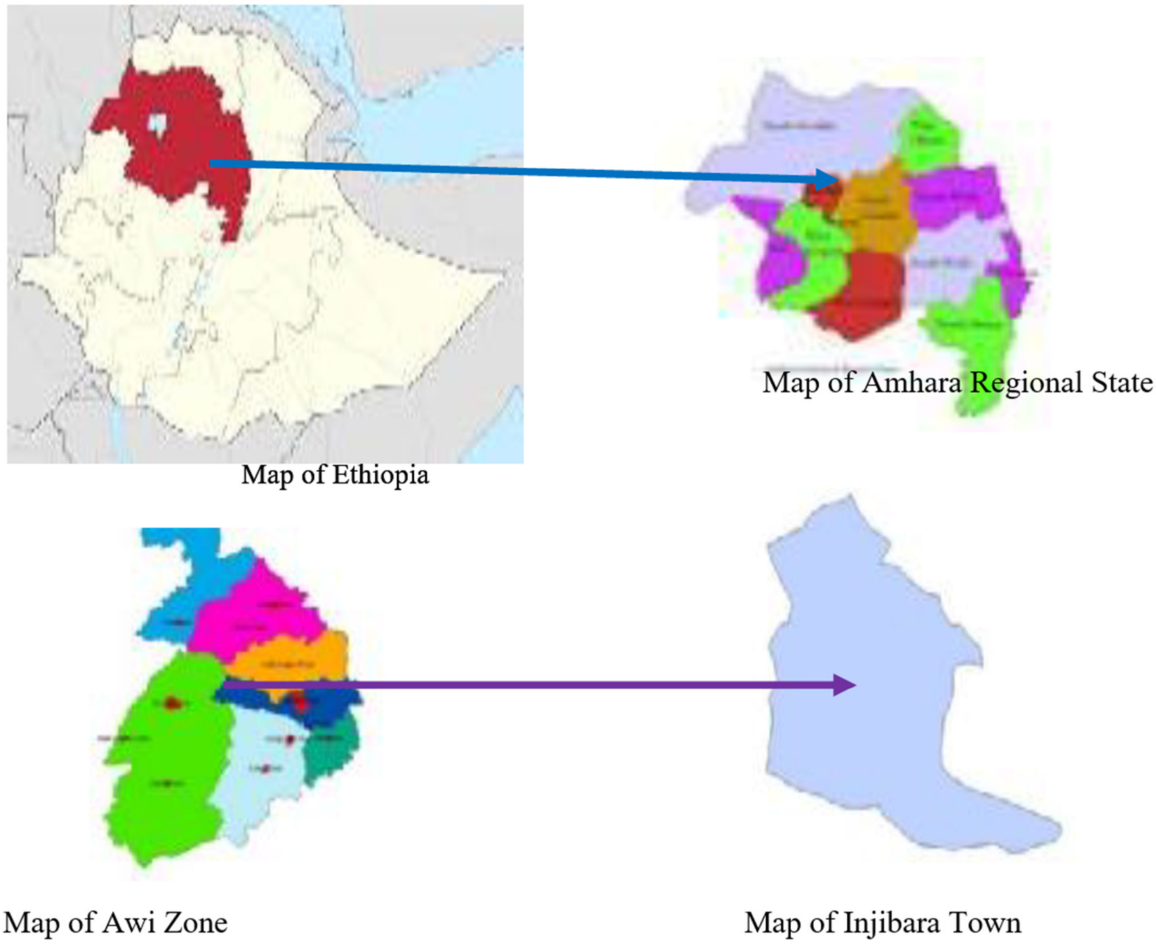

Figure 1 Map of Ethiopia, Amhara Regional State, Awi Zone and Injibara Town

3.2 Climate

According to the metrological data obtained from the National Metrological Service Agency, the average annual rainfall at Injibara town is 1813 mm and its mean monthly precipitation is 38 mm (Meteorological agency.2015). The average maximum monthly temperature is $29.90C^0$ while the average minimum temperature is $2.60C^0$. The months maximum temperature are from February to April the lowest temperature is recorded during the months of December& January (Meteorological agency.2015).

According to the climatologically classification, Injibara area belongs to the “Dega” Temperate Rainy climate".

3.3 Geology and Hydrogeology of Injibara Town

The Hydro-geological Map of Ethiopia Classifies Injibara area as follows;-Highland I water Resource Region; wide spread moderate to large quantities of surface water and ground water of good chemical quality (TDS 0-1500ppm) most streams are perennial; cold springs are common. Recharge condition Region 2; recharge to groundwater from rainfall is widespread and high, and from localized stream runoff is low Recharge is estimated at 150- 250mm. Discharge from ground water is classified moderate to high.

Injibara town and the surrounding areas are located on Quaternary volcanic of Lake Tana area which is characterized by vesicular lava flows and scoria forming cones and spatter cones, crater lakes, plains and ridges.

Around Injibara this volcanic formation is characterized by basaltic lava flows, spatter cones and scoria cones composed of vesicular basalt and scoria.

3.4 Infrastructure and Services

Injibara has road connections by asphalt road and is accessible all year. Injibara enjoys the benefits of a digital automatic telephone system. Mobile telephone and postal service are also available. Injibara receives a 24 hour electric supply from the country's hydroelectric grid system. There are about 20km of gravel roads within Injibara. The existing water supply source is a spring located in the western outskirts of the town (Injibara Town Administration.2004). .Government and public institutions in Injibara town are given in the below table:-

Table 1 Government and Public Organizations of Injibara town

Name of Organization	Number
Government offices	54
NGO offices	2
Orthodox Churches	5
Protestant church	4
Mosques	1

Source: - Injibara Town Administration 2004

3.5 Economic Situation

Injibara is a Zonal capital and is therefore an important administrative and communication centre with more population. Injibara is also major transit centre as it located on the main road from Addis Ababa to Bahir Dar. The town also serves as a major marketing centre with thousands of rural people flocking into the town.

The major economic activities according to the town's administration office are trading, hotel services and small-scale industries.

According to the development plan of Injibara, social and personal services are the dominant sector in the town's economy followed by trade and tourism.

The status of Injibara town as a Zonal Capital means that administrative and law enforcement institutions are centered here.

Manufacturing is the other dominating sector providing employment. It is mostly grain and oil milling activity but the potential to diversification and growth is high. The construction sector is a relatively young sector linked to the growing demand for modern buildings.

Table 2 Business Institutions in Injibara Town

Type of Enterprise	Number
Hotels	38
Bars and Restaurants	20
Metal and wood work	41
Garages	15
Retail &Wholesale trade	156
Grain Mills	20
Transport service	5
Small and micro industry	23
Town Agriculture	11
Abattoir	1
Tea rooms and Cafeteria	135
Fuel Stations	3
Oil mill	6
Bakery	8

Source:-Injibara Town Municipality

3.6 Future Development of the Town

A Master Plan for the town was prepared in 1994. According to towns administration the town's development plan in terms of land use and area is: - Residential 273.4 hectare, Commercial 93.75 hectare, Institutional 7.68 hectare, Recreational 3.6 hectare, Agricultural 3.6 Hectare, Manufacturing 2.63 Hectare and Others 1.05 Hectare (Injibara Town Administration.2004).

According to the information from the town's administration office the economy of the town is expected to improve significantly. The office believes that almost all sectors of the economy are expected to grow in the coming years.

It is expected that small scale industries will grow substantially followed by the building sector and hotel industry. Trading and transport sectors are also to grow significantly. Planned investment projects in the town, according to the information of the municipality are: - Real state, Hotel and tourism and Social services.

3.7 Basic Social Services

3.7.1 Educational Service

In addition to the existing ones, considering the fair distribution of educational services for every corner of the town this study reserved sites for: one teacher education college and one university at Chagni and Bahir Dar exit respectively and one technical college and two private colleges and one primary & junior secondary school in western & another junior secondary school in the northern part of the town, Bahunk primary & junior secondary school is recommended to grow to high school. This additional land adjacent to Bahunk School is added for future expansion, one primary school is also proposed as the western part (to Chagni exit) of the town and, kindergartens should be built in every neighborhood at a minimum of children walking distance during detail plan preparation. The University site called Awi University shows the map in the southwestern part of the town (filed observation)

3.7.2 Health

One Hospital, health centre and two private clinics are found in Injibara town. The hospital has more bed room and laboratory class and health centre has 6 beds. The number and percentage of incidences (Ten top diseases) in the year 2007/08 is given in Table 3.

According to officials of the health institutes in Injibara, intestinal parasites and skin infections are the most common water related diseases linked to poor water quality. High prevalence of these is an indication of the status of water supply and personal hygiene

Table 3 Top Ten Diseases of Injibara town

Name of Disease	No of Patients	%
Intestinal parasites	529	22
Rheumatisms	311	13
Pleurisy with infusion	265	11
URI	251	10
Infection of skin	205	8
Gastritis	198	8
Dog bit	198	8
Skin disease	176	7
Lober Pneumonia	150	6
Other Diseases	147	6
Total	2430	100

Source: Health office of Injibara Town in 2007/2008

3.7.3 Water Supply Service

Generally sources of water in injibara town are two types which are surface water and groundwater. Surface water is like river, stream, Zenegna Lake and ponds and also ground water is springs, deep and shallow hand dug wells.

The primary source of water supply for Injibara town is from springs. The spring source is known locally as Sutang Spring constructed in 1993. The spring is located on the South side of the town's boundary and The capping structure of Sutang Spring has eight outlet pipes, each pipe with 4" diameter, two outlet pipes are connected to town water supply system and collect from 10m3 collection chamber at about 50m from the eye of the spring, two are connected to "Top-land" water bottling system and the other four pipes are left for overflow at the eye of the spring.

The over flow is 6.4l/s after sharing with top-land water bottling company at the eye of the spring. The existing production of water supply for Injibara town is 5l/s, (252m3/day) for 14 hours of pumping. Water from the spring box gravitates in to a 10m3 collection chamber and is pumped in to a 75m3 existing Stone Masonry reservoir from where it gravitates into the distribution system. The water is distributed to the consumers through house and yard connections and public fountains.

Water shortage is the major problem with the existing system. According to the information from the water supply office and consumers because the consumers can not gate water every day that means the distribution system of injibara town is intermittent system still know. Almost all the households are dissatisfied with the quantity of water supplied, while all of them considered the quality as good. Also all hotels and businesses center are dissatisfied with the quantity of water. Domestic supplies are supplemented from secondary sources from the river, small springs and hand dug wells. Due to this reason to excavate additional ground water (i.e.4 boreholes) around town during 2017, but does not give function at this time because under construction, After finish constructions of ground water to avoid the shortages of water supply from injibara town.

3.7.4 Existing Sanitation Services of injibara town

The overall sanitation of the town is poor and sanitation associated diseases are prevalent. There is no system for collecting, transporting, and dumping solid waste and wastewater in the town (Water Supply Office of Town.20016). The sanitation condition in the town is discussed in the following paragraphs.

3.7.4.1 Solid Waste management
The majority of households have no containers for storing garbage. There are few garbage collection facilities located in the community, therefore, residents of the town dispose of domestic waste in any open spaces especially on the road verge and in drainage ditches. But this time injibara town is uses the Conservancy system: is an old system of solid Wastes collect such as night soil, garbage etc. are collected separately in vessels or deposited in pools or pits and then removed periodically at least once in 24hours.In this system, the waste products are generally buried underground, which may sometimes pollute the city's water supplies.
3.7.4.2 Wastewater Disposal
There is no wastewater disposal system in the town. Wastewater resulting from bathing room, kitchen room and other domestic washing activities is almost entirely thrown out into the streets. There is no specific site for wastewater treatment and disposal. But storm water or rain water can be discharged into streams and rivers water without any treatment required by separate system. Because does not polluted stream or river water that means there is not more sanitary wastewater through sewer line of storm water from injibara town.
3.7.4.3 Toilet Facilities
Most of the excreta disposal facilities in Injibara Town comprise pit latrines which are frequently poorly constructed, offensive and over filled. According to the town's municipality the majority of households use toilets in their own compound and the prevalence of open defecation is also significant and demands improvement.
3.7.4.4 Sludge Disposal Method
The municipality does not own a vacuum truck for sludge disposal and accordingly all households that have a latrine dig a new pit when the old one is filled. But now day sludge can be transport by vacuum truck by three month, six month, one year or more than one year depends on owner's interest.

3.8 Population
The population or universe of the study is the whole population residing in the planning boundary of Injibara town.

The population of the town is increasing due to rural to urban migration, as well as because of natural population increase within the town. Due to the capital city of Awi zone, people migrate to Injibara town for searching for work and also the weather condition is favorable for life, the total population of the town was rapidly increasing through time. The total numbers of population in 1994 and 2007 Central Statistical Agency (CSA) 0F Injibara has an estimated population of 5129 and 21,065 of whom 10,596 are males and 10,469 are females respectively and also 2009 and 2015 is 27,251 and male 18,540 (51.7%) female 17,306 (48.3%) total 35,846, (Injibara town Administration, Finance and Economic development office, 2009 and 2015) respectively.

3.9 Research Design
The study was performed through comprehensive approach for to asses' domestic wastewater treatment in Injibara town.

Exploratory method was also employed in a few extents to gain background information. This provides better understanding and clarity of the situation in sufficient manner significantly in sighting into it. The study followed qualitative and quantitative approaches because the study requires both qualitative and quantitative data which are obtained from primary and secondary data.
3.9.1 Source of Data
In this research work Investigator used only secondary sources, because it is not possible to collect primary data from each household.
Secondary data was collected from published and unpublished documents, maps, plans, journals, magazines, books, standard documents, central statistical agency information and other related material collected from different sources etc that helped to review the overall population forecasting situation in the area of study.
3.9.2 Data Collection Instruments
To obtain sufficient information from the selected sources, different data collection tools were used which were questionnaire, key informant interviews, personal observation and document analysis. Where, the questionnaires were the major tools of data collection for the study that were used and other tools were used to make stronger or fill the gap that might seen the data collected by questionnaires which was the major tools of the data collection. But for this research using only document analysis because it is not possible to collect data by questionnaire and key informant interviews due to lack of time and money.
3.9.3 Document analysis
It was used to collect appropriate information to investigate the existing problems in the town with reference to municipality that with water supply problem due population forecasting and consequences. Due to its strengthen the consistency of scheduled interview data like other primary techniques. Particularly, for this study the investigator was used total population issue related articles and written materials in the sectors of the town.

3.10 Methods of Data Analysis

After the completion of data collection, coded, tabulated, analyzed, described, interpreted properly and descriptive statistical techniques (percentages, using table, using figures, frequency and rank order etc) were employed as methods of data analysis that means both quantitative and qualitative. In addition the data was analyzed by using different techniques.

Additionally, qualitative data collected through close-ended and open-ended questionnaires, interview, observation and document analysis data were logically interpreted and analyzed to strengthen and support the quantitative data collected through questionnaires.

Relevant computer software, like GIS, Micro Soft Excels, Global Positioning System (GPS), etc. with sufficient verbal description was used for data processing.

4. Results and Discussion

4.1 Population Forecasting

Population Forecasting is estimated with due to all factors governing the future growth and development of the project area in the industrial, commercial, educational, social and administrative spheres. Design of water supply and sanitation scheme is based on the projected population of a particular city or town and also estimate the design period of the components of all structures of water supply and sanitation are depends on projection of population. Changes in the population of the city over the years occur, and the system should be designed taking into account of the population at the end of the design period.

Factors affecting changes in population are:-Increase due to births, decrease due to deaths, Increase/ decrease due to migration, Increase due to annexation, change(in education, politics, recreation and economic), increase in facilities of transport system and sudden increase in religions importance of the city of town (Water supply and Environmental Engineering 2011 and town administration 2016).

The present and past population record for the city can be obtained from the census population records. After collecting these population figures, the population at the end of design period is predicted using various methods as suitable for that city considering the growth pattern followed by the city.

4.2.1Methods of Population Forecasting of Injibara Town

There are four methods population forecasting of future population of Injibara town for 20 (2018-2038GC) years of design period. These are: - Arithmetic progressive method, Incremental increase method, Geometric progression method and Exponential growth rate methods.

1. Arithmetic progressive method

Arithmetic progressive method is the average rate of increase in population is assumed to be constant from decade to decade. Average increase per decade is found out from the previously available census data. The product of this amount obtained and number of decades for which the population is to be worked out is added to the present population of the subjected area to get the approximate population after n decades (WSEE.2011). By using the formula given below the future population is worked out.

$P_ŋ = P_0+n*k$ Where, $P_ŋ$ = future population after n decades
P_0 = present population
n = number of decades
k = average increase per decade

2. Geometric increase method

This method is based on the assumption that the percentage increase in population from decade to decade remains constant. In this method the average percentage of growth of last few decades is determined; the population forecasting is done on the basis that percentage increase per decade will be the same (WSEE.2011).
Average percentage increase per decade is found out from the previously available census data. By using the formula given below the future population is worked out.

$P_ŋ= P_o *(1+G)^{n}$ Where, $P_ŋ$= future population after n decades
P_0= present population
n= number of decades
G= average percentage increase per decade

3. Incremental increase method

This method is improvement over the above two methods. The average increase in the population is determined by the arithmetical method and to this is added the average of the net incremental increase once for each future decade (WSEE.2011). Future population is worked out from the equation given below.

$P_ŋ= P_o +n* (k_1+K2)$ Where, $P_ŋ$ = future population after n decades
P_o = average increase present population
n = number of decades
K1 and K2= per decade

4. Using Ethiopian Statistical Authority (Exponential)

This method is used by the central statistics Authority of Ethiopia. It is expressed by the following equation (WSEE.2011).

$P_n = P_o * e^{r*n}$ where P_n = future population after n decades

P_o= present population

n = number of decades

r=growth rate

e= Exponential

4.2.2 Base population of the town

An accurate population of the town is absolutely necessary since a town or city population determines water requirements for the different purpose of water supply system. It must be includes all peoples, who utilize water for drinking, washing clothes, cooking, bathing, cleaning utensils and watering animals. The base population of the Injibara town is 5129, 21065, 27251 and 35846 in 1994, 2007, 2009 and 2015 respectively (CSA).

Table 4 Base population of Injibara town

Year	1994	2007	2009	2015
Population	5129	21065	27251	35846

Sources: central statistical agency of Ethiopia and (Injibara town Administration, Finance and Economic development office, 2009 and 2015)

Population Growth rate: - The "population growth rate" is the rate at which the number of individuals in a population increases in a given time period, expressed as a fraction of the initial population. Specifically, population growth rate refers to the change in population over a unit time period, often expressed as a percentage of the number of individuals in the population at the beginning of that period (National population growth rate.2015). This can be written as the formula, valid for a sufficiently small time interval:

Population growth rate = $\frac{P(t2)-P(t1)}{P(t1)(t2-t1)}$ Where P = population of town

t1=the beginning of that period

t2=the end of the period

A positive growth rate indicates that the population is increasing, while a negative growth rate indicates that the population is decreasing. A growth ratio of zero indicates that there were the same number of individuals at the beginning and end of the period a growth rate may be zero even when there are significant changes in the birth rates, death rates, immigration rates, and age distribution between the two times.

Table 5 population projection (2018-2048)

Year	2015	2018	2023	2028	2033	2038
Annual growth rate	4.41%	4.31%	4.13%	3,93%	3,73%	3,53%

Sources: the 2007 Central Statistical Agency National figures are used as a base

Table 6 population projection using four different methods

Year	Arithmetic	Geometric	Incremental	Exponential
2015	35846	35846	35846	35846
2018	41597	41036	41907	40799
2023	51183	51407	52010	49881
2028	60769	64401	62112	59748
2033	70354	80679	72217	70150
2038	79940	101070	82316	80732

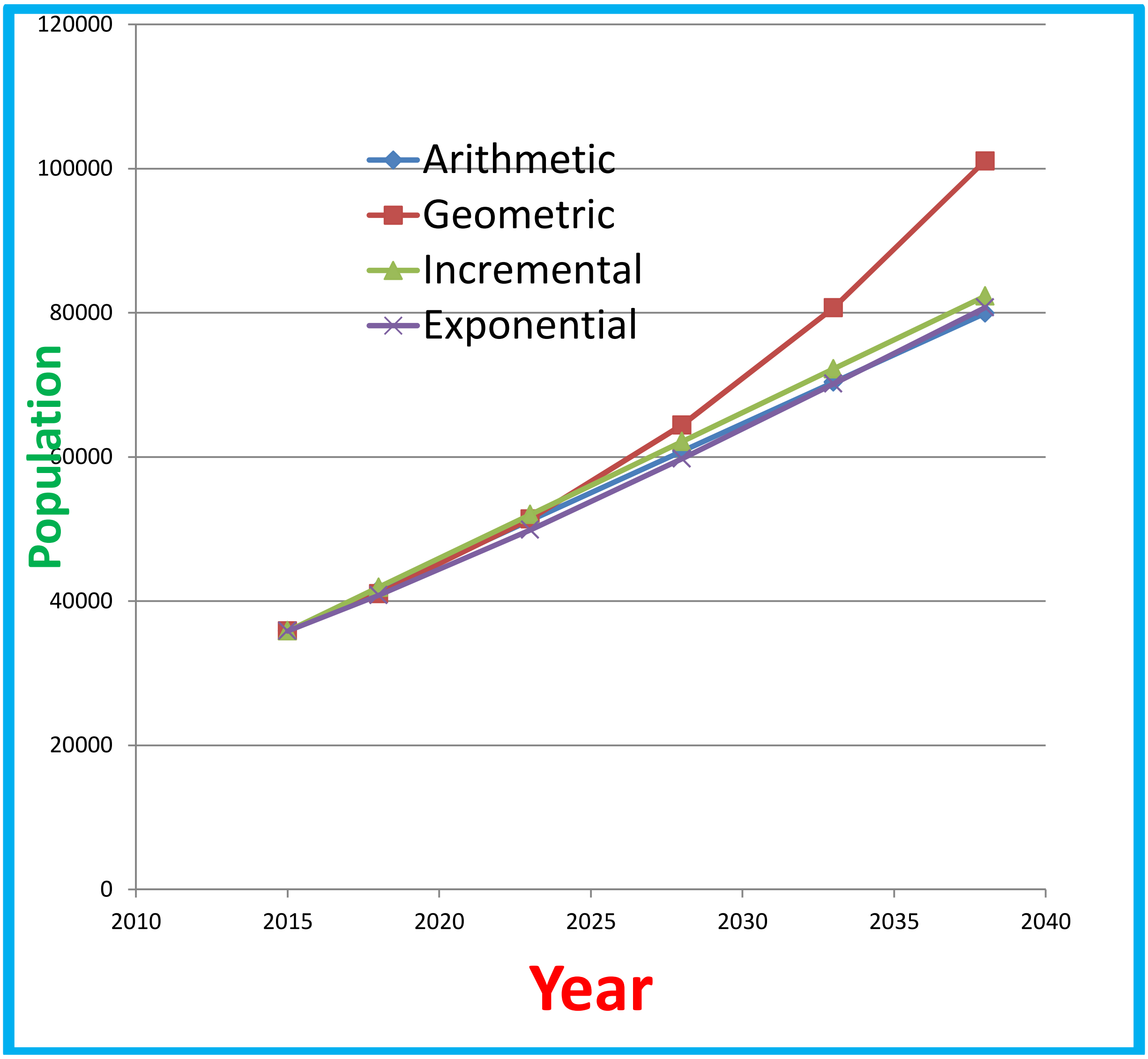

Figure 2 Population versus year

Selection of most reliable method

For the selection of the best methods for the Injibara town we have considered the following factors. The number of present population of the town, availability of data for the calculating of the projected population , the incremental situation of the population from decade to decade or from year to year, the oldness of the towns, the increment of population due to migration, under estimation of the population and percentage error. The percentage error calculated for all the methods used so that the one with a minimum error is selected as a design parameter of population forecast of Injibara town. The percentage error is calculated by assuming the actual population in the year 2015 is not given and determining it using all the methods. The constants were calculated excluding the year of 2015.

Table 7 Average increase for population projection by different methods excluding year of 2015

Year	Population	Arithmetic	Geometric	Incremental
1994	5129	-	-	-
2007	21065	1225.85	0.24	-
2009	27251	3093	0.15	1867,16
Total	53445	4318.85	0,39	1867,16
Average		2160	0.195	934

K1= 2160 G=0.195 K2=934

Table 8 calculated value for the year of 2015 using four different methods

Year	Arithmetic	Geometric	Incremental	Exponential
2009	27251	27251	27251	27251
constant	2160	0.195	934	0.043
n	6	6	6	6
2015(calculated)	40211	81372	45815	35273

Sample of calculation

For Arithmetic (p_{2015}) $=p_{2009}+k1*n=27251+2160*6=40211$

For Geometric (p_{2015}) $= p_{2009*(1+G)}{}^{\wedge n}=27251*(1+0.195)\ {}^{\wedge 6}=79358$

For Incremental (p_{2015}) $= p_{2009+n(k1+k2)}= 27251+6(2160+934)= 45815$

For Exponential (p_{2015}) $= p_{2009*}e(n*r)= 27251*e(6*0.043)= 35273$

Table 9 true value versus calculated value for the year 2015 using four methods

Year	Arithmetic	Geometric	Incremental	Exponential
2015(actual)	35846	35846	35846	35846
2015(calculated)	40211	79358	45815	35272
percentage error	-0.12177	-1.214	-0.27811	0.1602

Sample calculation:

Percentage error = $\frac{\text{Actual population of 2015} - \text{Calculated population of 2015}}{\text{Actual population of 2015}}$

Percentage error For Arithmetic = $\frac{35846-40211}{35846}$ = -0.12177

Percentage error For Geometric = $\frac{35846-79358}{35846}$ = -1.214

Percentage error For Incremental = $\frac{35846-45815}{35846}$ = -0.27811

Percentage error For Exponential = $\frac{35846-35272}{35846}$ = 0.1602

From all the above methods Exponential increase method is selected. Because percentage error of Exponential increases method is the lowest value (minimum value) than other methods. Also this method is good for developing countries as well as developing town or city like Injibara town. Exponential increases method is used growth rate of population for calculation of the future population of town and also corresponding to population growth rate of given town. For these reason Exponential increase method is best method for forecasting Injibara population for water supply, sewerage system and any infrastructure of the town based these population numbers. So population at the staring design period 2018 is 40799 and also at end of the design period 2038 is 80732.

4.3 Water Demand Assessment

The water demand for actual household activity is known as domestic water demand. It includes water for drinking, cooking, bathing, washing flushing, toilet, etc. The demand will depend on many factors, the most important of which are economic, social and climatic. Based on the available data obtained from the Injibara Water Supply Service has four major modes of service were identified for domestic water consumers. These are:

House connections (HC)

Yard connections - private (YC)

Yard connections -shared (YCS), and

Public taps (PT)

Town categories

Analysis of existing data has shown that certain characteristics of towns are strongly linked to their population size. In order to attribute certain characteristics to each town, the towns have been grouped into categories according to their population size due this reason Injibara town is second category (see table below)

Table 10 Connection profiles - percentage of people using certain connection type

		Year					
	Connection type	**2015**	2018	2023	2028	2033	2038
Category 2	**House**	**5,70%**	6,12%	6,94%	7,84%	8,80%	9,70%
	Yard	24,60%	26,58%	30,12%	34,12%	38,32%	42,10%
	Yard Shared	28,70%	30,92%	34,98%	39,64%	44,54%	48,95%
	Public Tap	39,00%	34,62%	26,72%	17,40%	7,40%	0,00%
	Un-Served	2,00%	1,70%	1,20%	1,00%	1,00%	1,00%
	Non Domestic	30,00%	30,00%	30,00%	30,00%	30,00%	30,00%
	UnaccountedFor	30,70%	29,80%	28,18%	27,14%	26,54%	26,00%

Source: ministry of water and energy water supply module for urban, 2003

4.3.1 Population Distribution by Mode of Service

The percentage of population to be served by each mode of service for Injibara town is shown in the table below. Due to data limitation we adopt the calculation of extrapolation to know population percentage distribution of the remaining years. The percentage of population to be served by each mode of service will vary with time. The variation is caused by changes in living standards, improvement of the service level, changes in building standards and capacity of the water supply service to expand.

Therefore, the present and projected percentage of population served by each demand category is estimated by taking the above stated conditions and by assuming that the percentage for the house and yard tap users will increase gradually during the project service period while the percentage of tap users will dramatically reduce as more and more people will have private connections as the living standard of people and the socio-economic development stage come up.

Table 11 Population Percentage by Mode of Service

Year		2015	2018	2023	2028	2033	2038
Connection type	House	**5,70%**	6,12%	6,94%	7,84%	8,80%	9,70%
	Yard	24,60%	26,58%	30,12%	34,12%	38,32%	42,10%
	Yard Shared	28,70%	30,92%	34,98%	39,64%	44,54%	48,95%
	Public Tap (urban)	39,00%	34,62%	26,72%	17,40%	7,40%	0,00%
	Non Domestic	30,00%	30,00%	30,00%	30,00%	30,00%	30,00%

Source: ministry of water and energy water supply module for urban, 2003

4.3.2 Per capita Water Demand

The per capita water demand for various demand categories varies depending on the size of the town, the level of development , the type of water supply schemes, the socio- economic conditions of the town, cost of water, system of sanitation and climatic condition of the area. The per capita water demand for adequate supply level has to be determined based on basic human water requirements for various activities of demand category. In Injibara water supply project we used projected per capita demand as follow.

Table 12 per captal water demand by mode of service

	Connection type	year					
		2015	**2018**	2023	2028	2033	2038
Connection type	**House**	**123**	**127,2**	134,8	138	138,00	138,00
	Yard	34	**35,2**	37,2	38	38,00	38,00
	Yard Shared	25	**25,6**	27,2	28	28,00	28,00
	Public Tap	18	**18,6**	20,2	21	21,00	21,00

4.3.3 Domestic Water Demand Projection

In projecting the domestic water demand of Injibara the following procedures were followed:

- ➢ Determining population percentage distribution by mode of service and its future Projection
- ➢ Establishment of per capita water demand by purpose for each mode of service;
  - Projected consumption by mode of service;
  - Adjustment for climate;
  - Adjustment due to socio-economic condition

4.3.3.1 Adjustment to climate

Injibara is Situated in warm temperate rainy climate.It has a mean annual rain fall of 1813mm. Since the town is grouped Under B, having an adjustment factor of 1.0.

Table 13 Adjustment Factors due to climatic effect

Group	Meah annual Rfall(mm)	Factor
A	900 or less	1,1
B	900 to 1200	1
C	1200 or more	0,9

Source: ministry of water and energy water supply module for urban, 2003

4.3.3.2 Adjustment due to socio economic conditions

The town is located along Zegena Lake and it is near to Zegena national park. That is there is an increase on economy due to tourism. Therefore, Injibara town is grouped under B having an adjustment factor of 1.05.

Table 14 Adjustments factors due to social economic conditions

Group	Description	Factor
A	Towns enjoying high living standards & with very high potential of development	1,1
B	Towns having a very high potential for development but lower living standard at persent	1.05
C	Towns under normal Ethiopian conditions	0.1
D	Advanced rural towns	0.9

Source: ministry of water and energy water supply module for urban, 2003

Injibara is classified as a town of "Towns under normal Ethiopian conditions" and, therefore, categorized as a Group C town and was given an adjustment factor of 1.0. After considering changes in population and changes in the mode of service, per-capita demand and applying the adjustment factors, the domestic demands were calculated and are presented in table below.

Table 15 projected domestic water demand

P0PULATION	YEAR	**2015**	**2018**	2023	2028	2033	2038
	Total	**35846**	**40799**	**40799**	**59748**	**70150**	**80732**
House Connected	% population	**5,70%**	6,12%	6,94%	7,84%	8,80%	9,70%
	Population	2043	2497	2831	4684	6173	7831
	PD	123	127,2	134,8	138	138,00	138,00
	TPD(l/day)	251316,3	317603,8	381677,4	646423,1	851898,3	1080675,3
Yard Connected	TPD(m^3/day)	**251,3**	**317,6**	**381,7**	**646,4**	**851,9**	**1080,7**
	% population(urban)	24,60%	26,58%	30,12%	34,12%	38,32%	42,10%
	population	8818	10844	12289	20386	26881	33988
	PD	34	**35,2**	37,2	38	38,00	38,00
	TPD(l/day)	299815,9	381719,8	457135,6	774665,8	1021492,3	1291546,6
	TPD(m3/day)	**299,8**	**381,7**	**457,1**	**774,7**	**1021,5**	**1291,5**
Yard Shared Connected	% population	28,70%	30,92%	34,98%	39,64%	44,54%	48,95%
	Population	10288	12615	14271	23684	31245	39518
	PD	25	**25,6**	27,2	28	28,00	28,00
Public Tap Connected	TPD(l/day)	257195	322944	388182,4	663152,5	874851,3	1106509,4
	TPCD(m3/day)	**257,2**	**322,9**	**388,2**	**663,2**	**874,9**	**1106,5**
	% population(urban)	39,0%	34,62%	26,7%	17,40%	7,40%	0,00%
	Population(town)	13980	14125	10901	10396	5191	0
	PD	18	**18,6**	20,2	21	21,00	21,00
	TPD(l/day)	251638,9	262716,3	220208,9	218318,4	109012,7	0,0
	TPD(m3/day)	**251,6**	**262,7**	**220,2**	**218,3**	**109,0**	**0,0**
TDD	m^3/day	**1060,0**	**1285,0**	**1447,2**	**2302,6**	**2857,3**	**3478,7**
Socio-economic		1	1	1	1	1	1
Climatic Factor		0,9	0,9	0,9	0,9	0,9	0,9
Total domestic demand		**954,0**	**1156,5**	**1302,5**	**2072,3**	**2571,5**	**3130,9**

4.3.4 Non- domestic water demand

Non - domestic consumption includes light industrial, commercial and public water demand . Light industries including small manufacturing and processing plants that require relatively small amounts of wat er. commercial includes all the hotels, business and trade establish ment. Public include govt's offices, hospitals, schools and public services such as churches ,street flushing , parks, maintenance etc.

A) Commercial and institutional demand

Water furnished to instiutional and commercial establishments such as offices, factories, hotels, chools ect. This quantity will vary considerably with the nature of the city and with the number and type of instiutions and commercial establishments in it. On an average a provision of 10% to 25% of the total water consumption is generally made in the design for these uses.

B) Day school water demand

In Injibara, there are 6,703 students in day schools, among them 64 students are in technical training centers in the year 2001. Using specific consumption pupil as given the design criteria, and the water demand for day school inInjibara town is an average a provision of 5% to 25% of the total water consumption is generally made in the design for these uses.

C) Health centers and hospitals

The water demand for health institutes depends on the number of beds and the number of staffs residing in the Institute demend. Using specific consumption pupil as given the design criteria, and the water demand for Health centers and hospitals inInjibara town is an average a provision of 5% to 25% of the total water consumption is generally made in the design for these uses.

D) Industrial demand

The water required for industries mainly depends on the type of the industries which are existing in the city. The Water required by factories, paper mills, cloth mills, cotton mills, breweries, etc.. comes under industrial use. The quantity of water required for industrial purpose is around 5 to 25 % to the total demand of the city. But there is no any industry in Injibara, we can't account industrial demand in our water demand calculation or there are no plants and infor mation resending the establishment of any industries in the near future in Injibara town.

Since there is no industry in the town and There is no industrial demand is included in this project.

Table 16 Non domestic demand

Tabulated Non Domestic Demand	Year	**2015**	**2018**	2023	2028	2033	2038
	% Popn	30%	30%	30%	30%	30%	30%
	TDD	954,0	1156,5	1302,5	2072,3	2571,5	3130,9
	health 5%TDD	47,70	57,82	65,12	103,62	128,58	156,54
	industrial 5%TDD	47,70	57,82	65,12	103,62	128,58	156,54
	Commercial 10%TDD	95,40	115,65	130,25	207,23	257,15	313,09
	institutional 5%	47,70	57,82	65,12	103,62	128,58	156,54
	Day school 5%	47,70	57,82	65,12	103,62	128,58	156,54
	NDD(m^3/day)	**286,19**	**346,95**	**390,75**	**621,69**	**771,46**	**939,26**

4.4 Water demand variation

4.4.1 Average Water Demand (ADD)

The average daily water demand is the sum of the domestic, non-domestic and unaccounted for water which is used to estimate the maximum day & the peak hour demand. The average day demand is used in economic calculations over the projects lifetime

4. 4.2 Maximum day demand (MDD)

The maximum day demand is the highest demand of any one of 24 hours period over any specific year. It represents the changes in demand with seasons, the local population makes of ther water sources such as wells, rivers, streams, etc. The maximum day factor (MDF) utilized to calculate the maximum day demand is dependent on the population of the town.

Table 17 Maximum day demand factor

population	MDF
0-20,000	1.3
20,000-50,000	1.25
50,000 and above	1.2

4. 4.3 Peak hour demand (PHD)

The peak hour demand is the highest demand of any one hour over the maximum day. It represents variation in the water demand resulting from the behavioral pattern of the total population. Generally two peak periods can be observed, one in the morning and one late in the afternoon. The peak hour demand can be expressed as the average daily demand multiplied the hourly peak factor (PHF), for a particular distribution area this factor depends on the size and character of the community served.

Table 18 Maximum peak hour factor

population	PHF
0-20,000	2
20,000-50,000	1.9
50,000 and above	1.7

Table 19 Summerized domestic and non-domestic demands (m3/day)

Year		**2015**	**2018**	**2023**	**2028**	**2033**	**2038**
Projected population		**35846**	**40799**	**40799**	**59748**	**70150**	**80732**
TDD	**M3/d**	**954**	**1156**	**1302**	**2072**	**2572**	**3131**
NDD	**M3/d**	**286**	**347**	**391**	**622**	**771**	**939**
ADD	**M3/d**	**1240**	**1503**	**1693**	**2694**	**3343**	**4070**
MDF		**1,25**	**1,25**	**1,25**	**1,2**	**1,2**	**1,2**
MDD	**M3/d**	**1550**	**1879**	**2117**	**3233**	**4012**	**4884**
	l/day	**1550201**	**1879288**	**2116536**	**3232794**	**4011586**	**4884139**
	l/sec	**17,9**	**21,8**	**24,5**	**37,4**	**46,4**	**56,5**
PHF		**1,9**	**1,9**	**1,9**	**1,8**	**1,8**	**1,8**
	M3/d	**2945**	**3571**	**4021**	**5819**	**7221**	**8791**
PHD	**l/day**	**2945381**	**3570648**	**4021419**	**5819029**	**7220854**	**8791450**
	l/sec	**34,1**	**41,3**	**46,5**	**67,3**	**83,6**	**101,8**

Generally the wastewater generater from populations of town is assumed as average of 75-80% of water supplies of town. The we take 80% of water supplies of town as wastewater generates from injibara town as shown table below.

Table 20 by assuming 80% water demand of the town appear as wastewater

Description	unit	**2015**	**2018**	2023	2028	2033	2038
Projected PHWD	m^3/d	2381	2826	3175	5059	6272	7601
Quantity of WasteWater	m^3/d	1905	2261	2540	4047	5018	6081

Table 21 hour fluctuation of per capita comsumption and wastewater generatıon flow

Time(hr)	Peak hourly variation	per capita consumption by hourly variation	per capita WW by hourly variation
1	0,25	0,0235	0,019
2	0,25	0,0235	0,019
3	0,25	0,0235	0,019
4	0,25	0,0235	0,019
5	0,5	0,0471	0,038
6	0,75	0,0706	0,056
7	1	0,0942	0,075
8	1,3	0,1224	0,098
9	1,55	0,1459	0,117
10	1,7	0,1601	0,128
11	1,6	0,1506	0,121
12	1,5	0,1412	0,113
13	1,4	0,1318	0,105
14	1,33	0,1252	0,100
15	1,32	0,1243	0,099
16	1,35	0,1271	0,102
17	1,35	0,1271	0,102
18	1,35	0,1271	0,102
19	1,3	0,1224	0,098
20	1,2	0,1130	0,090
21	1	0,0942	0,075
22	0,75	0,0706	0,056
23	0,5	0,0471	0,038
24	0,25	0,0235	0,019

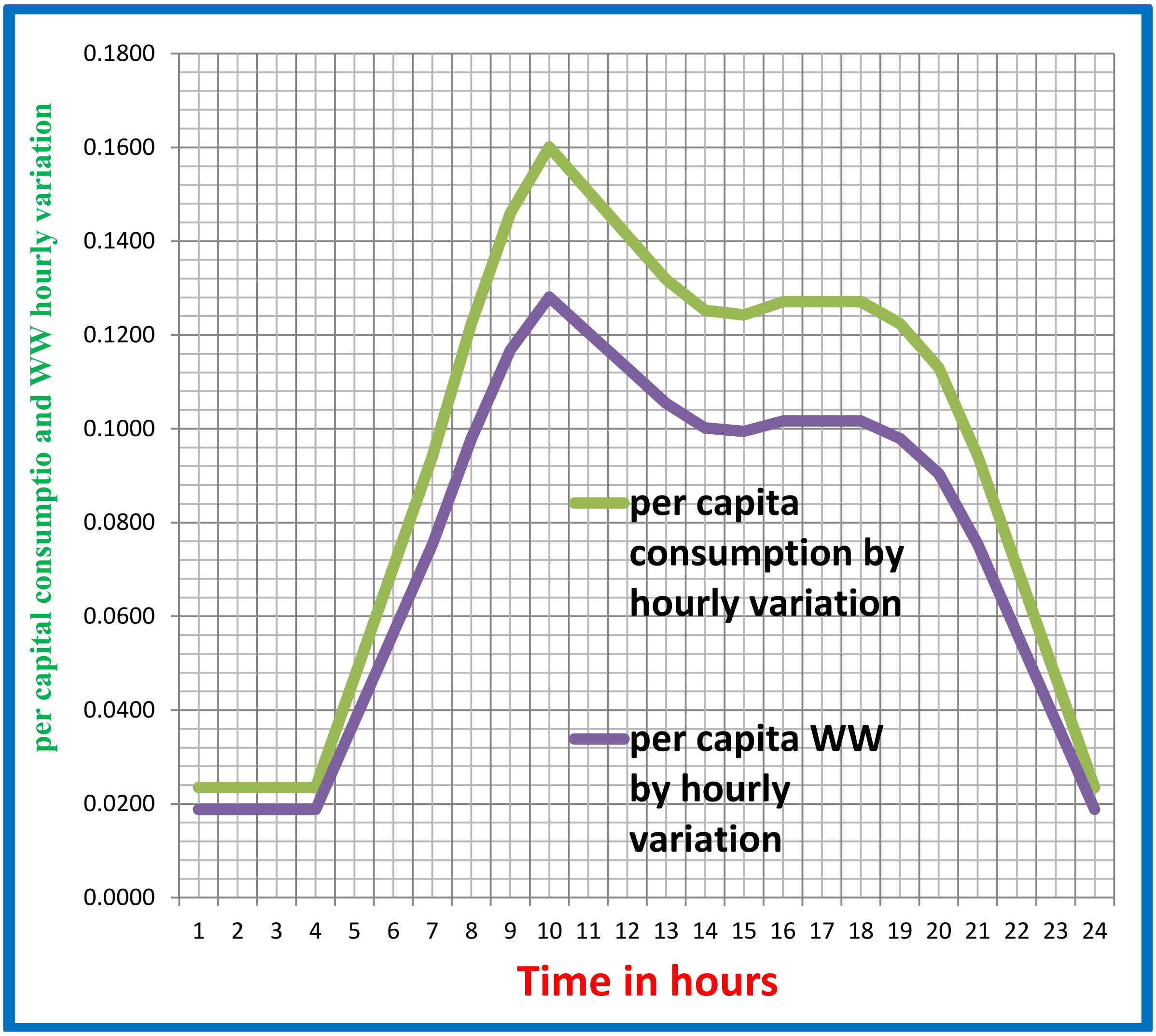

Figure 3 per capita consumption and per capita WW by hourly variation vs time

Wastewater produces each year is various time to time depends on a numbers of population in town. The total wastewater of Injibara town at starting periods of design is 2261m3 per day and at the end of design period is 6081m3 per day. This shows that the wastewater of Injibara town is increase rapidly with growth rates of population.

An hourly fluctuation of wastewater flow is relative to per capital consumptions of water supply in the town. Due to this reason the out puts or a graph of hourly fluctuation of wastewater flow and per capital consumption is corresponding to each other. This is not good for human health and environmental protection. Due to these reason to design wastewater treatment plant special for domestic wastewater and managements of wastewater and solid waste from generation up to disposal area may be disposal area is on land or water bodies such as sea, lake, river or streams.

5.Overview of Domestic Wastewater Management in Injibara town

Recent reports indicate that more than half of the population of less developed town does not have access to sanitation and more than 80% of the waste water generated is directly discharged into surface and ground water bodies.

In Injibara town,the sanitation facility coverage gap remains unacceptably large and collection and emptying mechanisms are one of the challenges. The habit of open field disposal of liquid waste is one of the main causes of soil and water contamination and consequently a cause of many communicable diseases.

The management of liquid waste at household level is very poor. About half of the households handle grey water (household liquid waste) by openly discharging into any accessible public properties, such as streets, drainage lines and nearby open space. Sewer line application is not that much familiar in the Injibara town as well as ethiopia country.

The odour of sewage is common in most road side drains of the town, and most rivers zones are excessively polluted. These all generates water borne diseases, decreases the quality of life, and undermines the attractiveness of cities to foreign investors, and the competitiveness of tourism, water intensive industries, fisheries and agriculture.

Preparing strategic document is important with strong and indicative action of the plan with the participation of key stakeholders including the public and private sectors are actively engaged.Partnerships are required between government, community, the private sector and non-government organizations (NGO) to prevents impacts of domestic wastewater from the town.

Obligations of Wastewater Disposing Bodies:All stakeholders including the town have to respect their responsibility to save our natural resources. A factory, institutions and communities subject follow the regulation shall prevent or, if that is not possible, shall minimize the generation of every liquid wastes to an amount not exceeding the limit set by the relevant environmental standard and dispose of it in an environmentally sound manner; and every factor shall have the obligation to handle equipment, inputs, and products in a manner that prevents damage to the environment and health.

5.1 Wastewater Management Systems

5.1.1 Domestic wastewater in Injibara town

At present time the principal sources of domestic waste water are residential districts and predominantly public institutional facilities. Other important sources of waste water include commercial facilities and recreational areas. Domestic wastewater consists of four main fluxes: one is grey water which is from kitchen sinks, wash basins, laundry washing, showers, baths etc., second one is black water which is from toilets, yellow water from urine and brown water from black water without urinals. Household sewage treatment plant breaks down domestic wastes via three major stages (primary, secondary and tertiary stages).

There are two types of domestic wastewater management systems. But for Injıbara town a decentralized domestic wastewater management system is better.

5.1.1.1 Decentralized domestic wastewater management systems

Decentralized domestic wastewater management systems are: On-site management, Truck Supported Disposal System, Septage and Recycling.

On-site management: The on-site sanitation facilities are septic tank, Toilets and any chambers used to store wastes based on the suitability of the area. These strategies used in the case containers were placed beneath the seats of privies to collect human excrement and once full containers were emptied at a disposal location near the residence by Vacuum trucks. These systems were gradually replaced by the centralized strategy. On-site sanitation systems for wastewater collection and treatment are effective when little or no piped water is available.

Truck Supported Disposal System: Wastes can be collected by trucks, direct sewer system, transfer sites and disposed of by burial in trenches, by spreading on land/dry beds and on treatment ponds. Unless the sludge has been allowed to decompose until no more pathogens are present, the first two options may pose a threat to the environment, particularly where the emptying of wastes is practiced on a large scale.

Septage: For homes and business not connected to a central wastewater collection system, individual onsite wastewater treatment and disposal facilities would continue to be used. As noted in previous sections, it is anticipated that residential properties outside of the designed system area will continue to use on-site septic disposal systems.

Recycling. Solids removed from wastewater can be digested/stabilized and land spread, land filled, incinerated or composted, or otherwise stabilized prior to beneficial use Sewage, household grey water and wastewater contain potential sources of fertilizer and energy. Treated effluent can replenish water courses or be reused directly for many purposes. Better management of wastewater would contribute to a solution to water scarcity.

Therefore these points are the most important for Injibara town to treat domestic wastewater in proper ways and to prevents human healths and environment as well as water bodies. Then proied awerance from populations of town for purposes of these treatment systems.

5.2 Sustainable Treatment and Reuse of Domestic Wastewater in Injibara for futur time

A key component in any strategy aimed at increasing the coverage of wastewater treatment should be the application of appropriate wastewater treatment technologies that are effective, simple to operate, and low cost (in investment and especially in operation and maintenance). Appropriate technology processes are also more environment-friendly since they consume less energy and thereby have a positive impact on efforts to mitigate the effects of climate change. Appropriate technology unit processes includes the following

1. Primary Stage:

a. This is the first stage of sewage/wastewater treatment that removes about 40-60% of the suspended solids.

b. It involves screening to remove large objects such as sticks, stones etc which can cause damage to tank inlets.

c. It employs grit chamber which slows down the flow of wastewater to allow grit to fall out naturally to the bottom of the tank where it can be removed.

d. Primary clarifier or settling/sedimentation tank in this stage removes sinking and floating contaminants.
e. The partially treated wastewater from the primary tanks then flows to the secondary treatment system.

2. Secondary Stage:

a. This is the stage where the biological (aerobic/anaerobic) treatment of waste water from the primary stage begins and it removes up to 90% of organic matter.

b. It uses activated sludge process which use dissolved oxygen to promote growth of biological floc that substantially removes organic matter.

c. Bacteria-containing "activated sludge" is continually re-circulated back to the aeration tank to increase the rate of organic decomposition.

d. Bacteria attack the dissolved and finely divided suspended solids which are not removed by primary sedimentation.

e. The water is then taken to settling tanks where the sludge again settles, leaving the water 90 to 95 % free of pollutants.

3. Tertiary Stage:

a. When the effluent from secondary treatment is unacceptable, a third level of treatment called tertiary or advanced treatment, can be employed.

b. Its purpose is to provide final treatment stage to raise the effluent quality to the desired level.
C.When the wastewater reaches tertiary stage, it still contain suspended matter and fine particles and are removed in this stage.

d. The water at this stage is almost free from harmful substances and chemicals and which can be reused, recycled or released back into the environment.

e. This stage is also called as disinfection stage is an ideal disinfectant for wastewater since it does not alter the water quality.

To design these treatment plants by using or depends on wastewater which is generates from town and follow properly their procedures. After these treatment use water for different purposes such as for irrigation, for small industries, for recreation, and etc. these is good for development and saving water resource of town as well as the country.

5.3 Operation and Maintenance for futur design of treatment plant

The installation and operation of wastewater treatment systems ensures an environmentally friendly effluent quality meeting the determined border values. Maintenance for wastewater systems caneither be preventive/predictive or corrective activity. Effective maintenance programs are based on knowing what components make up the system, where they are located and the condition of the components.With that information, preventive/predictive maintenance can be planned and scheduled, rehabilitation needs identified, and long-term improvement programs planned and budgeted of the town. These is good for properly working of all wastewater treatment plants.

5.4 Challenges of waste water management in Injibara town

As human population continues to grow and urbanize, the challenges for securing water resources and disposing of wastewater will become increasingly more difficult.

The main issues in the wastewater management are insufficient stakeholder awareness and involvement and the high mitigation costs, besides here are the basic challenges which identified by different actors in the field of wastewater,

- Wastewater management infrastructures (sewerage lines, vacuum tracks, public toilets, disposing sites, and treatment plants) not adequate.
- There is no guidelines, standards, and manuals that helps to support the implementation
- Low priority given by government and actors when compared to water supply
- There is no clear role & responsibility for town sanitation development program that carries out the specified activities with an adequately organized institutional manpower in Injibara town
- The liquid waste management requires high investment(sewer line installation and absorption trench construction
- Lack of aggregated data on wastewater management status
- High population growth(demand) and incompatible of service
- failure to mobilize the community and make them active participants in wastewater service provisions
- Ground and surface waters pollution due to poor liquid waste management systems in major cities
- Sewer Drains are generally not adequately interconnected and do not form a network.
- Inadequate legal framework and unclear institutional responsibilities;
- Lack of access and monitoring of wastewater services;

Generally to manage and treaments of domestic wastewater is first to creat awerance from town population due to causes of domestic wastewater on human health and environment and also benfites of treatment of domestic wastewater which generates from houses of individual and total towns. After these construct the sewerage system and treatment pants of the town.

5.5 Impacts of Wastewater Effluents

The quality of wastewater effluents is responsible for the degradation of the receiving water bodies, such as lakes, rivers, streams, etc. The potential deleterious effects of polluted wastewater effluents on the quality of receiving water bodies are manifold and depend on volume of the discharge, the chemical and microbiological concentration/ composition of the effluents. It also depends on type of the discharge for example whether it is amount of suspended solids or organic matter or hazardous pollutants like heavy metals and organochlorines, and the characteristics of the receiving waters (Owili, 2003). Eutrophication of water sources may also create environmental conditions that favour the growth of toxinproducing cyano bacteria. Chronic exposure to such toxins produced by these organisms can cause gastroenteritis, liver damage, nervous system impairment, skin irritation and liver cancer in animals (EPA, 2000; Eynard et al., 2000; WHO, 2006). In extension, recreational water users and anyone else coming into contact with the infected water is at risk (Resource Quality Services, 2004). The potential deleterious effects of pollutants from sewage effluents on the receiving water quality of the coastal environment are manifold and depend on volume of the discharge, the chemical composition and concentrations in the effluent (Owili, 2003).

5.5.1 Environmental Impacts

The impacts of such degradation may result in decreased levels of dissolved oxygen, physical changes to receiving waters, release of toxic substances,bioaccumulation or biomagnifications in aquatic life, and increased nutrient loads (Environmental Canada, 1997). Wastewater is a complex resource, with both advantages and inconveniences for its use. Wastewater and its nutrient contents can be used for crop production, thus providing significant benefits to the farming communities and society in general. However, wastewater use can also impose negative impacts on communities and on ecosystems. The widespread use of wastewater containing toxic wastes and the lack of adequate finances for treatment is likely to cause an increase in the incidence of waste waterborne diseases as well as more rapid degradation of the environment. Although the harmful effects of using contaminated wastewater effluents could be delayed for several years using intensive and heavy irrigations, it adversely affect groundwater quality when nutrients leach down the soil (Mahmood and Maqbool, 2006). Eutrophication due to excessive amounts of nutrients contributes to the depletion of dissolved oxygen. It is important to note that other constituents of wastewater effluents also play an important role in the depletion of DO. The bacterial breakdown of organic solids present in wastewater and the oxidation of chemicals in it can consume much of the dissolved oxygen in the receiving water bodies (Borchardt and Statzner, 1990). These effects may be immediate and short-term or may extend over months or years as a result of the buildup of oxygen-consuming material in the bottom sediments (Environmental Canada, 1999). The impacts of low dissolved oxygen levels include an effect on the survival of fish by increasing their susceptibility to diseases, retardation in growth, hampered swimming ability, alteration in feeding and migration, and, when extreme, lead to rapid death. Long-term reductions in dissolved oxygen concentrations can result in changes in species composition (Welch, 1992; Chambers and Mills, 1996; Environmental Canada, 1997). Poorly treated wastewater effluent can also lead to physical changes to receiving water bodies. All aquatic life forms have characteristic temperature preference and tolerance limits. Any increase in the average temperature of a water body can have ecological impacts. Because municipal wastewater effluents are warmer than receiving water bodies, they are a source of thermal enhancement (Welch, 1992; Horner et al., 1994). Also, the release of suspended solids into receiving waters can have a number of direct and indirect environmental effects, including reduced sunlight penetration (reduced photosynthesis), physical harm to fish, and toxic effects from contaminants attached to suspended particles (Horner et al., 1994).

5.5.2 Health Impacts

Diseases caused by bacteria, viruses and protozoa are the most common health hazards associated with untreated drinking and recreational waters. The main sources of these microbial contaminants in domestic wastewater are human and animal wastes (WHO, 1997; Environmental Canada, 1998; 2003 EPA, 2000; WHO, 2006). These contain a wide variety of viruses, bacteria, and protozoa that may get washed into drinking water supplies or receiving water bodies (Kris, 2007). Microbial pathogens are considered to be critical factors contributing to numerous waterborne outbreaks. Many microbial pathogens in wastewater can cause chronic diseases with costly long-term effects, such as degenerative heart disease and stomach ulcer. The density and diversity of these pollutants can vary depending on the intensity and prevalence of infection. The detection, isolation and identification of the different types of microbial pollutants in wastewater are always difficult, expensive and time consuming. To avoid this, indicator organisms are always used to determine the relative risk of the possible presence of a particular pathogen in wastewater (Paillard et al., 2005). Viruses are among the most important and potentially most hazardous pollutants in wastewater. They are generally more resistant to treatment, more infectious, more difficult to detect and require smaller doses to cause infections (Toze, 1997; Okoh, et al., 2007). Because of the difficulty in detecting viruses, due to their low numbers, bacterial viruses (bacteriophages) have been examined for use in faecal pollution and the effectiveness of treatment processes to remove enteric viruses (Okoh, et al., 2007). Bacteria are the most common microbial pollutants in wastewater. They cause a wide range of infections, such as diarrhea, dysentery, skin and tissue infections, etc. Disease-causing bacteria found in water include different types of bacteria, such asE.coli O157:H7; Listeria, Salmonella, Leptosporosis, Vibrio, Campylobacter, etc (CDC, 1997; Absar, 2005). Wastewater consists of vast quantities of bacteria, most of which are harmless to man. However, pathogenic forms that cause diseases, such as typhoid, dysentery, and other intestinal disorders may be present in wastewater.

6. Conclusion and Recommendation

6.1 Conclusion

Wastewater effluents are major contributors to a variety of water pollution problems. Some of these problems include eutrophication, which can stimulate the growth of algae, increased water purification cost, interference with the recreational value of water, health risks to humans and livestock, excessive loss of oxygen and undesirable changes in aquatic populations. Since large amounts of wastewater effluents are passed through sewage treatment systems on a daily basis, there is a need to remedy and diminish the overall impacts of these effluents in receiving water bodies. In order to comply with wastewater legislations and guidelines, wastewater must be treated before discharge in to environments.

In Injibara town,the sanitation facility coverage gap remains unacceptably and collection system is emptying mechanisms. The habit of open field disposal of liquid waste is one of the main causes of soil and water contamination and consequently a cause of many communicable diseases.

The management of liquid waste at household level is very poor. About half of the households handle grey water (household liquid waste) by openly discharging into any accessible public properties, such as streets, drainage lines and nearby open space. Sewer line application is not that much familiar in the Injibara town as well as more ethiopian towns. From sewer lines separate sewer is beter for Injibara town,because separate sewer systeme is economical after construction that means to reduce the load on each treatment plant through life of design period and also Injibara town is developing with time due to these reason it is good for futur time.

To treat Wastewater of Injibara town first to known backgrounds or topographies of the town and also to determine the design period and numbers of population by using different populations forecasting methods.

Water demands of town is the most important to determine the amounts of wastewater of town depends on design period, numbers of population and adjusted by using different factors.

Water variation is good to fix or meeting the fluctuation of water and wastewater in daily or hourly as well as monthly or yearly.

Wastewater produced each year is various with time depend on a numbers of populations. The total wastewater of Injibara town at starting periods of design is 2261m3 per day and at the end of design period is 6081m3 per day in 2018 and 2038 years respectively. This shows that the wastewater of Injibara town is increase rapidly with growth rates of population.

Operation and mantanance of domestic wastewater treatment system is the most important for protections of the system and also protections human health and environment.

There are a numbers of challenges to manage domestic wastewater of the town due to these reason every one has the responsibily to control and reduce these challenges of domestic wastewater the town.

6.2 Recommendation

In Injibara town there is not domestic wastewater treatment and sewerage system due to these reason cause a numbers of diseas. Then geoverment and people of town **to costruct** the sewerage system and treatment plants of wastewaters which generates from town, should be better for protections of environment and human health of town.

Population of Injibara town have lack of awerance of domestic wastewater challenges on on human health and environments, then the geoverment to **creat awerance** from populations of town due to couse of domestic wastewater in the town.

Every one in the town has the resiponsibility to manage and reduce domestic wastewater from individual house and the total town.

After treatments of domestic wastewater reuses for different purposes, like for irrigation, recration, small industries and so on.

Treatment of domestic wastewater is the **most important** for developments of one town and also protection of down stream countries, **therefore** each country geoverment to do effectivly treatments of wastewater from each generation of wastewater.

Treatment of wastewater used for reduce **inffection** of under groundwater and surface water by controlling from

generations of them at sources.
Each sectors of town must be do hard to controll and manage the wastewater sources by construct the treatment plant and work together.

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