Mnini – water project

MOSHI, KILIMANJARO, TANZANIA

September, 2017

Summary

The village of Mnini in Moshi, Tanzania, has a significant shortage of water for household needs. A new water project (SIDA, the Swedish development agency, was involved in the old water project) has been initiated but financial support is needed in the form of purchasing material to enable this project. I hope for a constructive dialog and of course a genuine interest to help this village.

Background

The village of Mnini in Moshi, Tanzania, has a significant shortage of water supply.

In the 1970-ies a water project was initiated and completed by Karl-Gösta Nilsson and Dragon school in Umeå, Sweden, together with SIDA. This water project enabled the citizens of Mnini to collect water in the center of the village instead of spending more than 4 hours every day collecting water.

A tap water system for the whole village was later installed. This tap water system, since 15 years, is significantly undersized due to the population growth in the area. Today each household has access to water from the water system twice a week during some hours. During this time the citizens need to collect the available amount of water in different kinds of vessels for storage (**Figure 1**). These vessels are to varying extent contaminated with for instance soil, which can be a perfect breeding ground for diseases.

The citizens and former citizens of the village have initiated a new water project to provide the village with tap water, designed for a larger population.

Figure 1. Collection of water for household needs in vessel.

New water project

A report (**Appendix 1**) has been compiled by the district water engineer's office in Moshi to provide data and costs for a new water project for supplying the whole village with tap water. The report was finalized in March 2017 and contains detailed calculations of pipe sizes, population growth, required water flows to supply the village also in the future, etc.

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Economics

The cost for this project (about 175-200 000 USD) is by far exceeding the capability of the village and its citizens. I was therefore invited during my stay in Tanzania this summer to discuss the possibilities to get support for this project from suitable organizations in Sweden or other countries. The idea is to have some organization to cover the largest part of the costs, which is the pipes, the fittings of the pipes etc. according to the specification below (**Table 1**). This could be done by purchasing the required pipes and auxiliaries in another country and ship it to Tanzania and Mnini or by purchasing it in Tanzania and transport it to Mnini. The estimated cost for the piping, etc. is about 75-100 000 USD (depending on taxes, etc.). This contribution would be sufficient for this project to be realized.

Table 1. Pipe specifications and costs (note, costs in Tanzanian schillings)

Pipes and diameter	Diameter [mm]	Length [m]	Cost/m [TSHS]	Total cost [TSHS]
GS Class M	100	150	58 000	8 700 000
GS Class M	75	150	25 000	3 750 000
PVC, PN10	150	600	20 000	12 000 000
PVC, PN10	100	2 020	16 520	33 370 400
PVC, PN10	80	830	13 098	10 871 340
PE, PN10	65	3 695	9 322	34 444 790
PE, PN10	50	1 000	6 608	6 608 000
PE, PN10	40	1 992	3 895	7 758 840
Total pipes				*117 503 370*
Add 25% pipe fittings*				29 375 842
Sub total				*146 879 212*
Tax 20%				29 375 842
Final total				176 255 054

* Pipe fittings can be explained as pipe pieces which are manufactured for the purpose of:

(i).Change in direction of pipeline by using bends.

(ii).Branching of pipes by using tee or saddle clamps.

(iii).Changing of pipe size from big to smaller.

(iv).Some fittings are needed to install water mater and valves.

GS=Galvanized steel, PVC=polyvinyl chloride, PE=polyethene
Class M=0-10 bars pressure, PN10= max 10 bars pressure
Exchange rate 1 USD ≈ 2 000 TSHS

I am hoping for a positive response.

With best regards,

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Appendix 1. Report for proposed Mnini water supply by district water engineer's office in Moshi, Tanzania.

Appendix 1
PROPOSED MNINI WATER SUPPLY FROM MFONDO AND MATEMBA SPRINGS

PREPARED BY DISTRICT WATER ENGINEER'S OFFICE

MOSHI, KILIMANJARO, TANZANIA

March, 2017

Abstract

Although nearly 70% of the Earth is covered with water, only 2.5% of this is fresh water. Seventy percent of the freshwater is frozen in ice caps of Antarctica, Arctic and Greenland. The remaining 30% of this freshwater is available as soil moisture, or lies in deep underground aquifers as groundwater and as surface water. Only one third of this water is the water found in lakes, rivers, reservoirs and those underground water sources that are shallow enough to be tapped at an affordable cost. For any design work to be considered as a successful one, it must fulfill the functional design and must also be economical.

The design of this water supply scheme is the outcome of the water resources assessment carried out in Mnini village which experience an acute shortage of adequate, potable and reliable domestic water supply,due to high population growth and insufficient water supply from the existing Mnini water supply from Mfondo spring, which leads to a very high rationing of water almost throughout the year, the situation whichmade the Community through their friends and youngsters living in Dar es salaam to call to the District Water Engineer's office Moshi for assistance. Water being crucially need and a vital item for the development and in the event of solving the water problem in the Mnini Community, a decision to carry out the design work (design and project preparation work) for the Mnini Community water supply scheme was made. The strategies for implementation of the scheme therefore focus on the major concept of beneficiary involvement; community based management and improved institutional arrangement. Therefore in the preparation of this project the focus was to ensure that it is in conformity with the National Water Policy 2002, revised in 2009.

The methodology which has been used in this project is literature review obtained through books, articles, notes and manuals, data collection through discussions and interview with staff from different Water Authorities in Kilimanjaro Region, surveying and leveling, data analysis and design.

Through data analysis the proposed Mnini Community water supply scheme is a gravity supply with a dead end system, the intake (Matemba spring) is to be located at an elevation of about 1200a.m.s.l while the supply area stretches up to an elevation of 980a.m.s.l giving a difference in elevation of 320m.

Hazen Williams (empirical formula) have been used in hydraulic calculations to determine pressure distribution throughout the gravity main as well as the branch lines.

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ABREVIATIONS

1. a.m.s.l	-	above mean sea level
1. DIT	-	Dares salaam Institute of Technology.
2. RSC	-	Rural Service Centre.
3. RL	-	Reduced Level
4. Cap	-	Capita.
5. D.1	-	Ductile Iron
6. C.I	-	Cast Iron
7. W.O	-	Wash out
8. A.V	-	Air valve
9. PVC	-	Polyvinyl chloride
10. l/s	-	Liters per second
11. m^3	-	Cubic meters
12. hr	-	Hour
13.P.E.	-	Polyethylene
14. Mm	-	Millimeter
15.Pn	-	Future population
16. Q	-	Discharge l/s
17. I	-	Hydraulic gradient (unit less)
18. V	-	Velocity (m/s)
19. f	-	Peak factor
20. P.H.D	-	Peak hour demand
21. G.S	-	Galvanized Steel
22. ID	-	internal diameter of pipe (mm)
23. C	-	Hazen William Friction Coefficient (unit less)
24. m	-	Meter
25. l/c/d	-	Liters per capita per day
26. d	-	Day
27. PT	-	Public Tap

28. LC - Low Class Housing
29. MC - Medium Class Housing
30. DWE - District Water Engineer
31. Qda - Average daily demand
32. Qdmax - Maximum daily demands
33. Kd - Peak day factor
34. Qhmax - Peak hourly demand
35. Kh - Peak hour factor
36. DP - Domestic Point
37. PRT - Pressure Relief Tank

CHAPTER ONE

1.0 INTRODUCTION

Freshwater is a basic natural resource, which sustains life and provides for various social and economic needs. In its natural state, water is an integral part of the environment whose quantity and quality determine how it can be used (Water supply and sanitary engineering (environmental engineering). Water being a prime necessity for life; it has led to the population growth in towns, therefore the requirement of water supply is of prime consideration in design of all units including the intakes, pumps, treatment plants and pipelines of the distribution system.

Water from water works is used for domestic use, industrial use, public use and fire demand. In addition there are certain loss due to negligence of consumers and leakage in pipe joints. The total consumption depends upon the, climatic condition, cost of water, type of water supply example continuous or intermittent, costumes and habits of inhabitants, pressure in pipelines, population, amount of water available from the private source, percentage of area of gardens and lawns if any and the status of the people. Besides these the sewerage system increases the consumption and metering reduces the consumption. Also the total consumption of water per day will be the product of total population and consumption of water per head per day, and it varies widely from 25 liters per head per day to 200 liters per head per day and more (Water supply and sanitary engineering (environmental engineering).

1.1PROBLEM STATEMENT

The Mnini Communityis suffering from lack of adequate, potable water supply due to high population growth and insufficient water supply from the existing Old Mnini Water Supply Scheme which leads to a very high rationing of water almost throughout the year, as a result the Mnini Community depend on river and furrow water which is not potable.

1.2 BACKGROUND

The Mnini Community is located along the southern slopes of Mt. Kilimanjaro in Uru East Ward, Hai Mashariki Division,Moshi District Council in Kilimanjaro Region. The Project area lies between 316250E to 319130Eof Greenwich Meridian and between 9634750N to 9638835N of the Equator.

The altitude of the area ranges from 1200m to980m above mean sea level (a.m.s.l), along the southern slopes of Mt. Kilimanjaro.

But the levels during surveying work were arbitrary set.

The main occupation of the people is agriculture for both food and cash crops,

food crops includes bananas, maize and beans, while coffee had been the main cash crop, some small scale livestock and poultry is also practiced at zero grazing.

The area is well accessible through a tarmac road from Moshi town leading to Mamboleo Road, then a gravel road about 4 km to the intake from tarmac road end.

The area is also served with electricity and telecommunication facilities.

Although Mnini Community is partly getting water supply from the existing Old Mnini and Materuni water supply project still the areaexperience an acute shortage of safe potable water supply, which made the Community leaders through friends of Mnini to call to the District Water Engineer's (DWE's) office Moshi, for assistance. Water being a vitae item for the Communitydevelopment and in the event of solving the water problem to the Community, a decision was made by the friends of Mnini and DWEs office to assist the Community in carrying out the design work (design and project preparation work) for the Mnini Communitywater supply scheme.

1.3 LOCATION:-

LOCATION MAP SHOWING MNINI

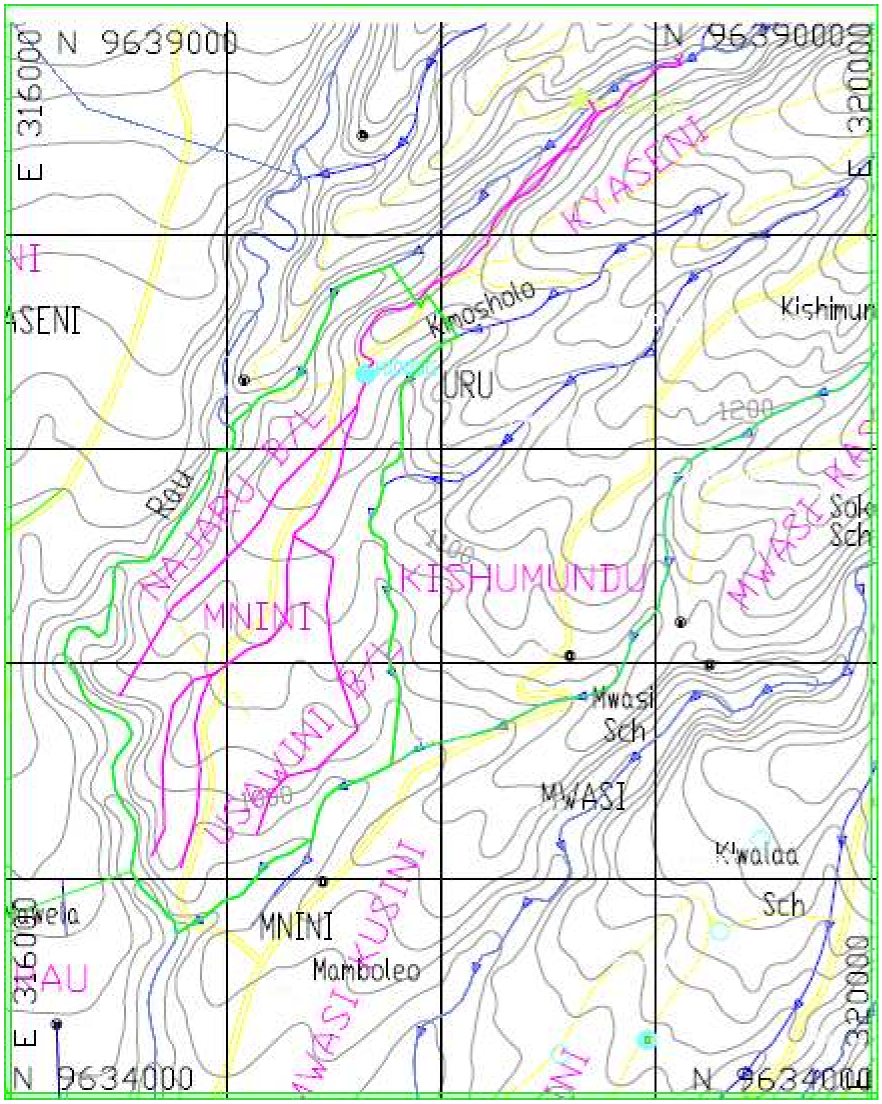

Figure 1.0 Location map

1.4 OBJECTIVE

1.4.1 Main Objective

The main objective of this project is to supply clean and safe water to Mnini Community.

1.4.2 Specific objectives

The specific objectives of the project are as under mentioned:-

i) Design of supply main and distribution system.

ii) Making proposal of intake, storage tank and DP sites.

iii) Ensure the availability of clean and safe water to Mnini Community.

iv) Construction of the project.

1.5 EXPECTED OUTCOME

1. To provide adequate, potable and reliable water supply to Mnini Community at an affordable price.
2. To improve the living standard of Mnini Community.
3. To introduce a good system of monitoring and managing water through METERING so that everybody should pay according to the consumption.

1.6 METHODOLOGY

The following methodology will be used in this project for the correct design of rural water supply project:-

Literature review.

The literature review will be obtained through books, articles, notes and manuals

Data collection (site visites, reconnaissance)

Data will be collected through discussions and interview with staff from Water Authority at Moshi District council, Pangani Basin Board Office, Kilimanjaro and Mnini village water committee.

Reconnaissance

Reconnaissance is done in order to determine the route where pipeline will pass.

Surveying and leveling

Linear Surveying will be done to determine chainage (distance measurement), while leveling will help to determine the relative difference in heights along the pipeline with reference to a known datum.

Data analysis, design and cost estimates

1.7SCOPE OF THE PROJECT

i) Pipeline design.

ii) Supply clean and safe water within a distance of 400m or to a walk which is within 30 minutes to Mnini village Community.

iii) Determination of sites for the construction of an intake structures well as the positions for air valves (AV) and washouts (WO).

iv) Construction of the project.

1.8 LITERATURE REVIEW

The literature review will comprise:-

1. Water sources and intakes.
2. Water quality and quantity.
3. Distribution system methods.
4. Supplying system.
5. Service reservoir.
6. Design consideration.
7. Data analysis.

1.9DATA COLLECTED

1. Water quality data.
2. Water quantity.
3. Population and Institution.
4. Surveying data:-Linear Surveying will be done to determine chainage (distance measurement), while leveling will help to determine the relative difference in heights along the pipeline with reference to a known datum, as well as the preparation of the longitudinal section. (See attachments **Appendix C**)

1.9.1 WATER QUALITY DATA

Water quality report for Matemba and Mfondo Springs.

The water samples has to be collected from both springs for thoroughly analysis so as to ensure for clean and safe water consumption for good health of Mnini community as a whole.

NB: Historically and with some evidences the quality for springs water in the areas has proven good despite the fact that it needs some treatments, like chlorination for instance.

1.9.2 YIELD OF THE SOURCES

The Mfondo and Matemba Springs located along Mware river and its yield were measured during dry season and were as follows:-

Mfondo Spring – 7l/s

Matemba Springs - 3l/s

Total yield of all the two springs is 10l/s

1.9.3 POPULATION DATA

Mnini village has a population of 2610 peoples this year 2016, according to the (2012) census. Therefore by applying the Geometrical progression formula for future population forecasting the present population was forecasted.

Population forecasting to date.

The mostly formula used is Geometrical progression where by:-

$P_n = P_o (1 + r)^n$

P_n = future population (2016)

P_o = Present population (2012)
r = population growth rate in %

n = Number of years

Therefore:-

P_o =4098

r =1.1 % (2012) Census Profile- Moshi District.)

n = 4

$P_4 = 2498 (1+0.011)^4$

P =2610 peoples

Future population forecasting.

$P_n = P_o (1 + r)^n$

P_n = future population (2036)

P_o = Present population (2016)
r = population growth rate in %

n = Number of years

Therefore:-

P_o = 2610

r = 1.1 % (2012) Census Profile- Moshi District.)

n = 20

$P_{20} = 2610 (1+0.011)^{20}$

P = 3249 peoples

TABLE 1. 1POPULATION DATA

S.No	Description	Present Population 2016	Future Population 2036
1.	Mnini village	2610	3249
1	Institutions Mnini day Secondary School	420	630
2	Mnini Primary School	245	365
3	Matoli Primary School	250	375
	TOTAL	**3525**	**4619**
4	Livestock unit	448	560

The above data shows the population of Mnini, the number of institutions and livestock present in the area which will help in forecasting of future population which in turn will be used in determination of water demand.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 GENERAL

The use of contaminated sources poses health risks to the population as evidenced by the incidences of water borne diseases such as diarrhea and cholera. Despite its importance to our lives and development, water is unevenly distributed in time, space, quantity and with great variations in quality. Furthermore, water is a finite and a vulnerable resource.

Water from water works is used for domestic use, industrial use, public use and fire demand. In addition there are certain loss due to negligence of consumers and leakage in pipe joints. The requirement of water supply system is of prime consideration in design of all units including the intakes, pumps, treatment plant and pipelines of distribution system. The total consumption of water per day will be the product of total population and consumption of water per head per day, and it varies very widely from 25 liters per head per day to 200 liters per head per day and more (Water supply and sanitary engineering (environmental engineering).

The total consumption also depends upon the, climatic condition, cost of water, type of water supply example continuous or intermittent, habits of inhabitants, pressure in pipelines, population, amount of water available from the private source, percentage of area of gardens if any and the status of the people. Besides these the sewerage system increases the consumption and metering reduces the consumption.

2.2 WATER SOURCES AND INTAKES

A water supply system may rely on the initialization of either surface water or groundwater sources or the combination. A plate below shows an example of surface water source.

2.2.1 SURFACE WATER SOURCES.

Surface sources are those sources of water in which the water flows over the surface of the earth and is directly available for water supplies.

1. Direct river abstraction.
2. Rainwater harvesting.
3. Abstraction from reservoir and lakes

Figure 2.0Mware River

2.2.2 GROUNDWATER SOURCES

The water stored in the ground through infiltration and percolation is known as ground water. This water is generally pure because it under goes natural filtration during the percolation through the soil pores. Ground water is generally rich in dissolved salts, minerals and gases. The extent of salts and minerals present in the ground water depend upon geological formations through which the water passes before joining the water table. Ground water is brought to the surface by natural processes such as:-

1. Springs which are natural out flow of ground water.
2. Aquifers which is a direct drilling into the ground.

The process of choosing the source of water supply depends on;-

1. Source availability and water quality
2. Economic feasibility
3. Vulnerability to water pollution

2.2.3 WATER INTAKES

Water intakes are the first points where the water is offtaken from the source. The source may be a pond, lake, river, or stream. Intakes consist of opening, grating or strainer through which the raw water from river, canal or reservoir enters.

When selecting an intake position, the following factors should be considered:-

1. Consider water level fluctuation;
2. Sediment transport;
3. Erosion of river banks;
4. Silt concern;
5. Cost effectiveness of intake structure (wide area against narrow position). The wider the intake area the more the cost.

The above mentioned factors are very important, for the surface water supply.

2.2.4 RIVER INTAKE/SPRING ALONG THE RIVER

A river intake must be in a river position where sedimentation is unlikely to occur and also it must be located at place, which will not erode easily, and that the intake should be located at a place where it can draw water even during the driest period of the year.

River Intake/spring along the river

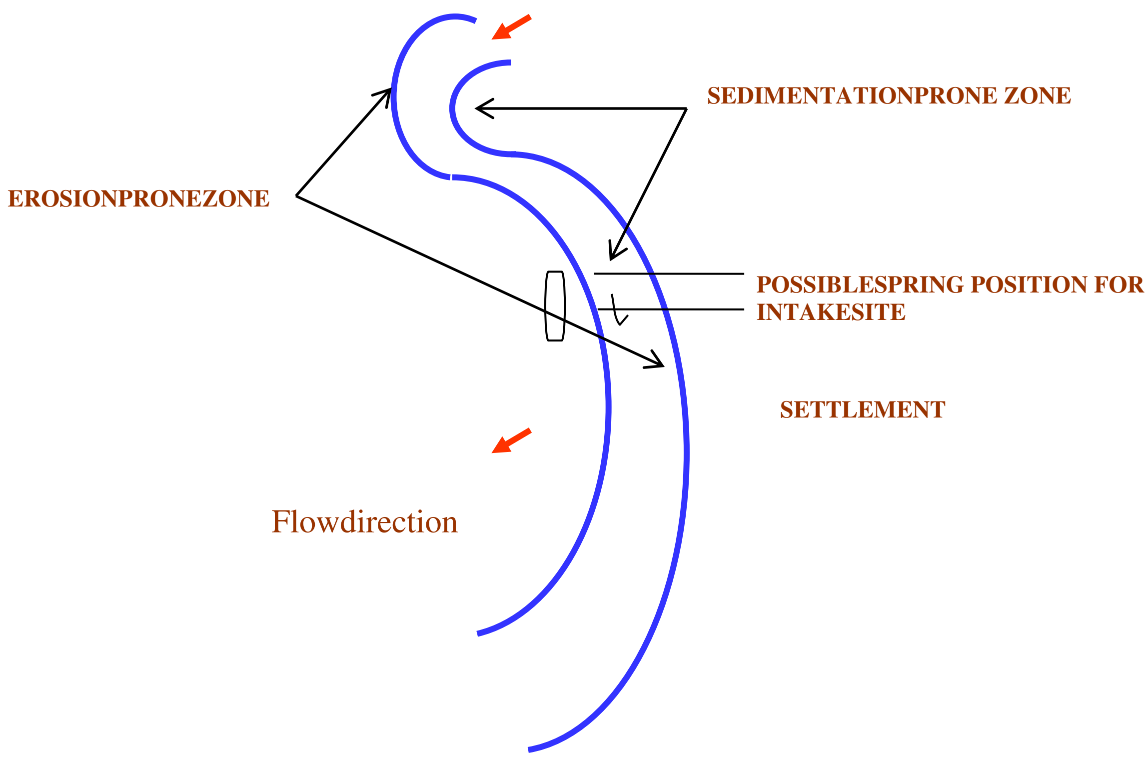

Figure 2.1 River intake/spring along the river

The above figure shows the possible position for a spring intake location.

2.3 WATER QUALITY PARAMETERS AND CRITERIA

When considering water treatment; it is important to understand the water quality parameters requirements for drinking water:-

The water for domestic purpose must meet the following three requirements:

1. The water must be free from pathogens (disease causing organisms). For health reasons water must be potable.
2. The water must not contain undesirable or harmful substances and
3. It must meet the aesthetics threshold of the target community.

(Environmental Engineering part1,No.FOE/CE/MAN/5/92, page 8).

2.3.1 DRINKING WATER STANDARDS

TABLE 2. 1 TANZANIA VERSUS W.H.O.DRINKING WATER STANDARDS

Parameter	Acceptable/permissible		Allowable/excessive	
	Tanzania m/1	WHO mg/1	Tanzania mg/1	WHO mg/1
1. Total Solids	N.M.	500	N.M.	1500
2. Iron (Fe)	0.3	0.3	N.M.	1.5
3. Manganese (Mn)	0.5	0.1	1.5	0.5
4. Calcium (Ca)	N.M.	75	N.M.	200
5.Sulphate (SO4)	N.M.	200	600	400
6. Chloride (C10	N.M.	200	800	600
7. Fluoride (F)	2.0	1.5	8.0	2.0
8. Nitrate (NO3)	100	30	N.M.	N.M.
9.Coli form bacteria per 100 ml	N.M.	N.M.	600	N.M.
10.Coli form bacteria per 100 ml	<5	0	>10	>5

(Ref. Environmental engineering part1,No.FOE/CE/MAN/5/92 page 10).

2.4 DISTRIBUTION SYSTEM

The last stage in water supply scheme is the distribution of water to consumers. The distribution system consists of mains of large diameter, sub-main of intermediate size pipes, minor distributors of small sized pipes, hydrants, valves and meters. The methods involved in distribution system can be:-

1. Gravity system.
2. Pumping system.
3. Dual system with storage

2.4.1 GRAVITY SYSTEM

When the source of water is sufficiently high above the supply area, the gravity is recommended as means of supply, where water flows in the main due to gravitational force. No pumping is required (water supply and sanitary Engineering).

In this system, water is distributed by gravity. Water should have sufficient supply pressure at all points in the system. Usually this system is adopted when the source of supply is available at a sufficiently higher level than the place of distribution. The system is the most economical and reliable; since no pumping is required.

Water gravity main refers to control of water movement from the source in a closed conduit under gravitational force. The main shall always be of such a size that the total quantity required for future projected peak day demand is able to flow through the pipe in 24 hours.

The science of hydraulic structure designs is named as applied hydraulics. Any structure which conveys liquid/ water or that is in contact with liquid/water is called hydraulic structure.

Water supply design is the part of engineering techniques and approach inwhich data are collected and the related information to determine economical engineering structures such as storage tank, intake, dam, pipeline etc.

2.4.2 PUMPING SYSTEM

The water is pumped directly into the water mains of distribution system. Sometimes double pumping has to be installed for purpose of, pumping water from the source to the treatment plant and again from treatment plants to the distribution mains.

2.4.3 DUAL SYSTEM

This system is the combination of gravity and pumping system. The water is pumped from the purification plants to an elevated storage reservoir and distributed to consumers from the reservoir by gravity. The advantage of this system is reliable and economical and also no variations in rate of pumping, hence special supervision are not needed. In the case of fire,water can be drawn direct from the storage reservoir.

2.5 WATER SUPPLYING SYSTEM

There are two systems that may be applicable for supplying water to consumers:-

1. Continuous system.
2. Intermittent system.

2.5.1 CONTINUOUS SYSTEM.

In this system the water is supplied for all the 24 hours in a day. The system is adopted when plenty of water is available from the source. The advantages of this system are:-

1. Water is always available.
2. Water need not be stored by the consumers.
3. Air relief or pressure valves are not required as water is circulating at uniform pressure.

2.5.2 INTERMINTTENT SYSTEM.

In this system, water is supplied only for a few hours in a day, normally during the morning and evening hours. This system is adopted when adequate water from the source is not available and it also assists in carrying out repairs during non-supply period.

The system is criticized as it requires big sizes of water mains and a large number of controlling valves and also vacuum is created in the pipe when the supply is stopped.

2.6 SERVICE RESERVOIRS.

Service reservoirs provide suitable reserve, which enables supply of water to consumers with minimum interruption. Due to failure of pumps, pipe busts etc. When the supply is by pumping, the wide fluctuation of demands can be regulated by these reservoirs. They enable to reduce the diameter of pipes to be used to meet the peak demand.

The design of service reservoirs depends on numbers of hours of supply, rate of pumping and the variation over the day. Service reservoirs are classified in to different ways, according to their position, such as surface storage reservoirs and elevated storage reservoirs.

2.7 DEFINITION OF TERMS

1. Intake

An intake is a structure which is constructed across the surface of water in order to enable the withdrawal of water from the source.

2. Water main.

This is a pipe laid by water undertakers for the purpose of giving general water supply and it includes any apparatus used in connection with, such a pipe.

3.Service pipe.

A service pipe is one that runs between the distribution main in the street and the riser, in the case of multi-storey buildings, or the water meter in the case of an individual house, and is subject to water pressure from such main.

4. Communication pipe.

That part of a service pipe, which is under the control of the water, undertakes is called a communication pipes. It starts at the water main and terminates at a point, which differs according to the circumstances.

This is the pipe used for distributing water in a building that is not water pressure from the water main.

5. Water meter.

A water meter is a device used for measuring the amount of water flowing through it.

6**. Average daily demand (Qda)**

Is a result of adding together domestic, agriculture/livestock, public institutions, industries/commercial, fire fighting demands and losses.

7.Maximum daily demands (Qdmax)

Is a result of multiplication of the average daily demand (Qda) by the peak day factor (Kd). It represents the consumption of the day in the year, which the maximum consumption is registered.

8. Peak hourly demand (Qhmax)

It is obtained by multiplication of the maximum daily demand (Qdmax) by the peak hour factor (Kh). It represents the peak hour flow during the day with maximum flow.

2.8 DESIGN

The design of water supply considers population, which is forecasted to 20 years life time. Mostly population census is used as source of data that gives an actual population at the time of design.

The great consideration in design is the water demand/ requirement which is used to design all the water works form the intake to consumers. Water consumption per capita and water consumption per livestock unit is multiplied by per capita to get average water consumption. This average is multiplied by day factor to get peak day demand. Peak day demand is multiplied by peak hour factor to get peak hour demand. Peak day demand is used for the design of intake structure and gravity main, while peak hour demand is used for the design of main pump stations, storage facility and distribution main. (Water engineering & sanitation)

CHAPTER THREE

3.0 WATER REQUIREMENT/ DEMAND FORECASTING

The quantity of water required depends very much on three main considerations:-

(i) The population of the area to be served.

(ii) Rate of consumption (demand)

(iii) Design period of the project.

The consumption of water supply for public is categorized into two namely urban and rural areas.

Through experience and researches ear marked that the minimum rate of consumption of 25l/day per person ((l/c/day) is adopted in rural areas, and 70 l/day to 120 l/day are used for semi urban and urban areas respectively.

That means the Per capita water demand should not be less than the above mentioned value of water demand (25 l/day).

For the case of Mnini, the water consumption rates for domestic use is taken as 70 l/day per person per day.

3.1TYPES OF WATER DEMAND

3.1.1 DOMESTIC WATER REQUIREMENT

This includes water required in private buildings for drinking, cooking, bathing,lawn sprinkling gardening, sanitary purposes etc. The amount of domestic water consumption per person shall vary according to the living condition of peoples living in the area; this is because more water is used for rich living in air cooling, air conditioning, automatic household appliances, fully sewer house, car washing, etc.

On the other hand it is at lowest when it is distributed through public taps within certain walking distance from the house.

In rural area the target is to reach as many persons as possible with a controlled water supply while in urban area the final target is to provide house connection to every dwelling. The rate of consumption depends on the level of service provided. The present situation can be found by site visit, studying the present records of water supply organization, etc.

For the future forecast it is necessary to find out the proposed kind of dwelling and the standard of service of the area, with the help of local planning officers.

3.1.2 INSTITUTIONAL WATER REQUIREMENT

It consist of the quantity of water required for different public uses such as schools, hospitals, Administration offices prisons, mosques, churches public gardens, markets cleaning of streets etc. (Design manual, page 137 table 4.5). Refer table 2.0.

3.1.3AGRICULTURAL AND LIVESTOCK WATER DEMAND

For Agricultural purposes it is advised to use natural sources such as shallow wells, furrow water, open channels, ponds, rivers etc. Since the piped water supply will be out of proportion if irrigation will also be included. For livestock purposes, water is grouped into stock units and liters per unit stock are set. One stock unit is equal to 25l/day

3.2 LEAKAGES AND LOSSES IN THE SYSTEM

These are caused mainly by operational activities such as reservoir leakage, defect pipes from manufacturer, cracks during implementation, defective valves, treatments units etc[design manual for water supply page 143]

Experience shows that for a proper managed water supply project, total losses are 20% of the total water demand [class lecture transcripts]

3.3 PEAK FACTOR

The different water consumption variations are combined by multiplying by different units of water supply to get actual average water consumption.

Peak factor (f) = maximum day demand/average day demand

Maximum day demand = Average day demand x Peakday factor

Maximum hour demand = Maximum day demand x Peak hour factor.

3.4 PEAK FACTOR FOR SMALL TOWN CONSUMPTIONS

The maximum day factor is ranging from 1.8 to 1.5 and the maximum hour factor is considered as 2.4 for small towns areas. In this project the maximum day factors and maximum hour factor is 1.8and 2.4respectively.

3.5FORECASTING OF POPULATION

The population of a village or town generally goes on increasing, thus the determination of the population increase in various periods should precisely undertaken when the design period is fixed and the growth rate is known.

Methods used for future population forecast are:-

(i) Geometrical method.

(ii) Arithmetical method.

(iii) Incremental method.

The mostly used formula is the Geometrical Increase method where by

$P_n = P_o (1 + r)^n$

P_n = pressent population

P_o = present population

r = population growth rate in percentage per year

n = Number of years.

3.6DESIGN PERIOD.

Optimum design period is between 5 – 10 years and should not exceed 15 years.

(i).Short term 5 years.

(ii).Future 10 years and

(iii).Ultimate period 20 years.

3.7 POPULATION GROWTHRATE

The water supply design is controlled by the annual growth rate for different water users at present and in future. In this case the design is done at Low Potential Urban areas where the growth rate is taken as 1.1% (according to National census results conducted in Kilimanjaro Region in 2012)

TABLE 3. 1POPULATION GROWTH RATE

CLASSIFICATION	TENTATIVE ANNUAL GROWTH RATE		
	LOW POTENTIAL %	MEDIUM%	HIGHT POTENTIAL%
City center	5	7	8
Municipal	4	5	6
Urban	3	4	5
Rural	3	4	5

The above table shows the guide for the design of water supplies for the annual growth rate of different areas. (Ministry of Water design manual,March2009).

Thus the rate of demand is expressed as so many liters/capita/day. Hence if **P** is the population served, and **Q** is the quantity of water required per year in liters, then per capita demand is given by the formula,

Per capita demand = **Q /P**x 365 liters per day

3.8LIVESTOCK

The actual growth rate for animal may be taken as 25% - 50% in 10 years and 50% - 100% in 20 years especially in rural areas where the Land allows the large livestock farming. Also consultation may be done to competent authorities. (Ministry of Water design manual, July 1997page 135). But for the case of Uru East where the land does not allow large livestock farming, the livestock growth rate is taken as zero. Where every household is considered to have1-2 livestock unit.

3.9LIFESPAN OF WATER SUPPLY SCHEMES

The life span of different water supply facilities is governed by their economic life span. This leads to replacement of different assets to water supply scheme periodically. But generally the span or design period of water supply is considered to be 20 years, but in Tanzania experience proved that some projects do last over 40 years.

3.10WATER SUPPLY TECHNOLOGY

The design of any water supply project must have the limited resources such as labour, material, plant and funds. Depending on the available resources water designer must select the technology of supply depending on these resources. Also depending on the type of water sources available consideration for selection must be made in regards to the sources of water such as river, lake, bore hole, rain water and rarely ocean water, if desalination will be done but it is very expensive. This water can be extracted from sources through pumping or gravity supply. The gravity supply is the mostly advised supply technology in respect of economy in construction operation and maintenance.

Therefore in the case of Mnini water supply scheme, a gravity supply technology is recommended as the source is located at a higher elevation than the supply area.

The intake is proposed to be located at an elevation of about 1200a.m.s.l while the supply area stretches up to an elevation of 980a.m.s.l.

TABLE 3. 2HYDRAULIC CALCULATIONS FOR THE DESIGN OF TRANSMISSION AND DISTRIBUTION LINES.

DESIGN SITUATION	KNOWN VARIABLES	REQUIRED VARIABLE	TYPICAL EXAMPLE FROM W/S PRACTICE
A	Q H	DIAMETER	GRAVITY LINES (TRANSMISSION, DISTRIBUTION)
B	Q DIAMETER	H	PUMP (RISING) MAIN
C	DIAMETER	Q	DETERMINING CAPACITY OF EXISTING SYSTEM; OR PARTS THEREOF

3.11 PIPE NETWORK

(Ministry of Water design manual, March 2009 page 51)

The design of pipe network (system) depends on the quantity of water required in the area. There are two formulas widely used which are.

Hazen Williams (empirical formula) and Darcy-Weisbarch formula.

1. By Hazen Williams formula

$V = 0.457 \times 10^{-2} \times C\, D^{0.63}\, I^{0.54}$

$Q = 0.359 \times 10^{-5} \times C\, D^{2.63}\, I^{0.54}$

Where:

$Q = A \times V = (\pi \times D^2/4) \times V$

A = Internal cross-sectional area of the pipe

V = Velocity of flow in m/s

Q =quantity of water/discharge l/sec

D = Pipe internal diameter in mm

I = Hydraulic gradient – unit less

C = Hazen Williams friction coefficient – unit less

2. Darcy-Weisbarch formula

$$Hf = \frac{fLV^2}{2gD}$$

Where:-

Hf = Head loss (m)

F = Darcy-Weisbarch friction factor (unit less)

D = Pipe diameter (m)

L = Pipe length (m)

V = Flow Velocity (m/s)

g = Gravitational acceleration constant (m/s^2)

In order to create self cleaning(self cleansing of pipes) to silt and eliminate high friction in pipes, the following velocities have been suggested in the design manual for water supply 2009.

TABLE 3. 3PIPE SIZE AGAINST RECOMMENDED VELOCITIES**.**

Pipe Size	Allowed Velocity m/s
Pipe 50 –100mm diameter	0.6 – 1.0
Medium150 – 250mm diameter	1.0 – 1.5
Pipe300 – 500mm diameter	1.2 – 2.0
> than500mm diameter	Recommendation by manufacturers.

TABLE 3.4 NORMAL WORKING PRESSURE IN DIFFERENT PIPE CLASSES.

Material	Classes	Pressure range in meters
PE / PVC	B	0 – 60
PE / PVC	C	60 - 100
PE / PVC	D	100-120
PE / PVC	E	120-160
GS	M	0 – 105
GS	HD	105 -240

TABLE 3.5 RECOMMENDED VALUES OF C IN HAZEN WILLIAMS FORMULA

CONDUIT MATERIAL	VALUE OF C
Ductile pipe	100 - 140
Cast iron	100 - 120
Galvanized steel below 50mm	55 - 120
Steel	100 - 120
Concrete	100 - 140
Asbestos cement	120 - 140
Plastic pipes	120- 140
Glass reinforced pipes	140- 145

3.12 PIPE MATERIALS

Always pipes are available at different materials, pressure resistance, sizes, and classes. The widely known pipe materials are:

(i) Polyethylene (vi) Galvanized steel pipe

(ii) Polyvinyl Chloride(vii) Asbestos Cement pipe medium

(iii) Ductile iron pipes (viii) Cast iron pipes.

(iv) Concrete pipes. (ix) Bamboo or wooden pipes.

(v) Sand pipes.

3.13 PIPE FITTING MATERIALS

Pipe fittings can be explained as pipe pieces which are manufactured for the purpose of:

(i).Change in direction of pipeline by using bends.

(ii).Branching of pipes by using tee or saddle clamps.

(iii).Changing of pipe size form big to smaller.

(iv).Some fittings are needed to install water mater and valves.

Pipe fittings are available at different type according to the pipe materials and sizes e.g. all gate valves are of diameter less than or equal to 100mm diameter. All sluice values are of diameter greater than or equal to 100mm diameter.

All rolled polypipes are of diameter less than or equal to 90mm diameter and therefore polypipe fittings are of the same diameter as the pipes.

CHAPTER FOUR

4.0 DATA COLLECTION AND ANALYSIS

4.1 DESIGN CONSIDERATION

The data collected for design is based on the following considerations:-

(i).The amount yield of the sources.

(ii).The population.

(iii).The population growth rate (2012 official census considered).

(iv).Livestock is taken as zero grazing.

(v). Design period is taken as 20 years (2016 - 2036).

(vi).Population growth rate is taken as 1.1% (according to Kilimanjaro region available census data profile 2012). Pupils in primary and secondary schools assumed to grow according to the entire population growth.

(vii).Water consumption rates for domestic use is taken as 70l/c/d, Primary school, Health centers (outpatient) consumption is taken as 10 l/c/d.

(viii).Boarding Secondary School consumption is taken as 50l/c/d.

(ix).Livestock – 25 l/livestock/day.

(x).Consumption rate at each domestic point is taken as 0.81 m^3/hr(for single tap) and 1.62 m^3/hr(for double tap).

(xi).Losses taken as 20% of total water demand.

(xii).Head losses in pipes is calculated by using HAZEN WILLIAMS'FORMULA.

(xiii).Storage capacity is taken as 50% of future daily water demand.

(xiv).Treatment plant is not needed as the water quality is good but according to the laboratory a finding boiling of drinking water is recommended see appendix-

(xv). Peak hour factor is taken as 2.4.

(xvi). Peak day factor is taken as 1.8.

(xvii).Energy source is gravity.

4.2YIELD OF SPRINGS

The Mfondo and Matemba Springs located along Mware river and its yield were measured during dry season and were as follows:-

Mfondo Spring – 7l/s

Matemba Springs - 3l/s

Total yield of all the two springs is 10l/s

4.3 WATER DEMAND CALCULATION

The table 4.1 below/overleaf shows the data collected from Mnini village for the determination of water demand for the design of the project.

The Mnini village population in the year 2036 is estimated to be 3249 people according to (2012) census.

TABLE 4.1 POPULATION DATA AND AVERAGE WATER DEMAND.

	DESCRIPTION	PRESENT 2016			FUTURE 2036		
		POPULATION	RATE L/c/day	TOTAL m^3/day	POPULATION	RATE L/c/day	TOTAL m^3/day
1.	Mnini village	2610	70	182.7	3249	70	227.43
3	Institutions Mnini Secondary school	420	10	4.2	630	10	6.3
4	Mnini Primary School	245	10	2.45	365	10	3.65
5	Matoli Primary School	250	10	2.5	375	10	3.75
6	Livestock	448	25	11.2	560	25	14.0
	Sub total			203.05			255.13
	Add 20% losses			40.61			51.03
	Total water demand			**243.66**			**306.16**

Therefore as to the above table the daily water demand for 2016 years is 243.66m^3/d and for the year 2036 will be 306.16m^3/d.

4.4 FUTURE POPULATION FORECASTING

The mostly formula used is Geometrical progression where by:-

P_n = $P_o (1 + r)^n$

P_n = future population

P_o = Present population

r = population growth rate in %

n = Number of years

Therefore:-

P_o =2610

r = 1.1%

n = 20

P_{20} = $2610(1+0.011)^{20}$

P_{20}= 3249 peoples.

4.5 PRESENTWATER DEMAND 2016

Peak day and peak hour factors have been chosen as 1.8and 2.4 for both factors consecutively.

Peak day flow = $\frac{243660 \times 1.8}{24 \times 60 \times 60} = 5.1 l/s = 18.36 m^3/hr$

Peak hour flow = $\frac{243660 \times 2.4}{24 \times 60 \times 60} = 6.8 l/s = 24.48 m^3/hr$

4.6 FUTURE WATER DEMAND 2036

Peak day flow = $\frac{306160 \times 1.8}{24 \times 60 \times 60} = 6.4 l/s \approx 23.04 m^3/hr$

Peak hour flow = $\frac{306160 \times 2.4}{24 \times 60 \times 60} = 8.5 l/s \approx 30.6 m^3/hr$, say 31 m^3/hr.

Design of distribution gravity main will use 30.6m^3/hr, say 31 m^3/hr.

Therefore Q = 31m^3 / hr which is the Future Peak Hour Demand.

4.7DATA ANALYSIS

For the reliability of the source Mfondo and Matemba Springs, analysis of data was examined to find out the possibility of the above mentioned sources to be a reliable source of water supply (quality wise and quantity wise) to the Mnini community, also if the quantity can accommodate the future maximum daily water demand.

4.8 WATER QUALITY FOR MATESHA SPRINGS

It is advised that the laboratory test should be carried out in order to justify the water quality.

Though the quality is assumed to be good, but it is strongly recommended to have a simple drip feeder chlorination point at the first storage tank before consumption.

4.9 YIELD OF THE SPRINGS.

The Mfondo and Matemba Springs located along Mware river and its yield were measured during dry season and were as follows:-

Mfondo Spring – 7l/s

Matemba Springs - 3l/s

Total yield of all the two springs is 10l/s

4.10 DATAANALYSIS AND DESIGN

4.11WATER DEMAND

TABLE 4. 2WATER DEMAND TABLE

Project	PRESENT 2016		FUTURE 2036	
	Peak day demand m^3/hr	Peak hour demand m^3/hr	Peak day demand m^3/hr	Peak hour demand m^3/hr
Mnini village	18.36	24.48	23.04	30.6

The selected maximum day factor and maximum hour factor are 1.8 and 2.4consecutively.

PRESENTWATER DEMAND 2016

Peak day and peak hour factors have been chosen as 1.8and 2.4 for both factors consecutively.

Peak day flow = $\frac{243660 \times 1.8}{24 \times 60 \times 60} = 5.1 l/s = 18.36 m^3/hr$

Peak hour flow = $\frac{243660 \times 2.4}{24 \times 60 \times 60} = 6.8 l/s = 24.48 m^3/hr$

FUTURE WATER DEMAND 2036

Peak day flow = $\frac{306160 \times 1.8}{24 \times 60 \times 60} = 6.4 l/s \approx 23.04 m^3/hr$

Peak hour flow = $\frac{306160 \times 2.4}{24 \times 60 \times 60} = 8.5 l/s \approx 30.6 m^3/hr$, say 31 m^3/hr.

Future peak hourflow =31m^3/hr or8.5l/s which will be used for the design of the distribution main.

As the yield of the source is 10l/s therefore we will have to design gravity main for base flow of 6.4l/s say 23.04 m^3/hr

Storage capacity.

Daily future water supply including safety factor is306.16m^3/day

Assume 40% of the future daily demand as storage capacity

Then storage capacity required is 123m^3, say 125m^3.

Take 1×100 m^3 storage tank.

As there is existing storage tank of 45m^3 therefore provide one 100m^3 storage tank for future use.

4.12WATER SUPPLY TECHNOLOGY

The recommended technology for Mnini water supply scheme is a gravity supply as the source is located at a higher elevation than the supply area. That the intake is proposed to be located at an elevation of about 1200a.m.s.l while the supply area stretches up to an elevation of 980a.m.s.l.

4.13GRAVITY MAIN SIZE

The design of gravity main in any scheme must flow continuously in 24hrs.

The smaller the diameter the least investments for the pipeline but also the smaller the diameter,

(i).the higher the velocity

(ii).the higher the friction loss

(iii).the less the capacity for future expansion

(iv).the higher the risk of surge pressures

4.14LONGITUDINAL SECTION

The longitudinal section should convey the following:-

1. The ground level
2. Static heads, water levels
3. Piezometric heads (hydraulic grade line)
4. Slopes of hydraulic grade line
5. Chainages, distances
6. Pipes material, diameter and class
7. Location of washouts and air valves

TABLE 4. 3:RECOMMENDED VALUES OF COEFFICIENCE

Conduit material	Value of C
DI	100 – 140
CI	100 – 120
G.S	55 – 120
POLY PIPES	120 – 140
CONCRETE	100 – 140
ASBESTOS CEMENT	120 - 140

4.15 PIPE DIAMETER

The appropriate size of the pipe diameter is determined as follows:-

In this project C =140 for all plastic pipes

Take C =140

Q = **6.4**l/s =**23.04**m^3/hr

Velocity = 0.75m/s (from the recommended ranges)

Then Q= Area (A) $\times$ Velocity (V)

$$Q = \frac{\pi D^2}{4} \times V$$

$$D^2 = \frac{4 \times Q}{\pi V} = \frac{4 \times 0.0064}{\pi \times 0.75}$$

D = $\left(\frac{4 \times 0.0064}{\pi \times 0.75}\right)^{\frac{1}{2}} = 0.109m$ diameter $\approx$ **110**mm diameter.

Adopt**110**mm standard size pipe diameter available.

By using Hazen will formulae check for the actual velocity and head loss per meter.

$$Q = 0.359 \times 10^{-5} \times C \times D^{2.63} \times I^{0.54}$$

$$6.2 = 0.359 \times 10^{-5} \times 140 \times 110^{2.63} \times I^{0.54}$$

$$I = 0.0068 \approx 6.8m/km = [head\ loss\ per\ 1000m]$$

$$V = 0.457 \times 10^{-2} \times C \times D^{0.63} \times i^{0.54}$$

$$V = 0.457 \times 10^{-2} \times 140 \times 110^{0.63} \times (0.0068)^{0.54}$$

$$V = 0.79m/s$$

$$V = 0.79m/s,\ it\ is\ within\ the\ range.$$

4.17 FLOW DIAGRAM

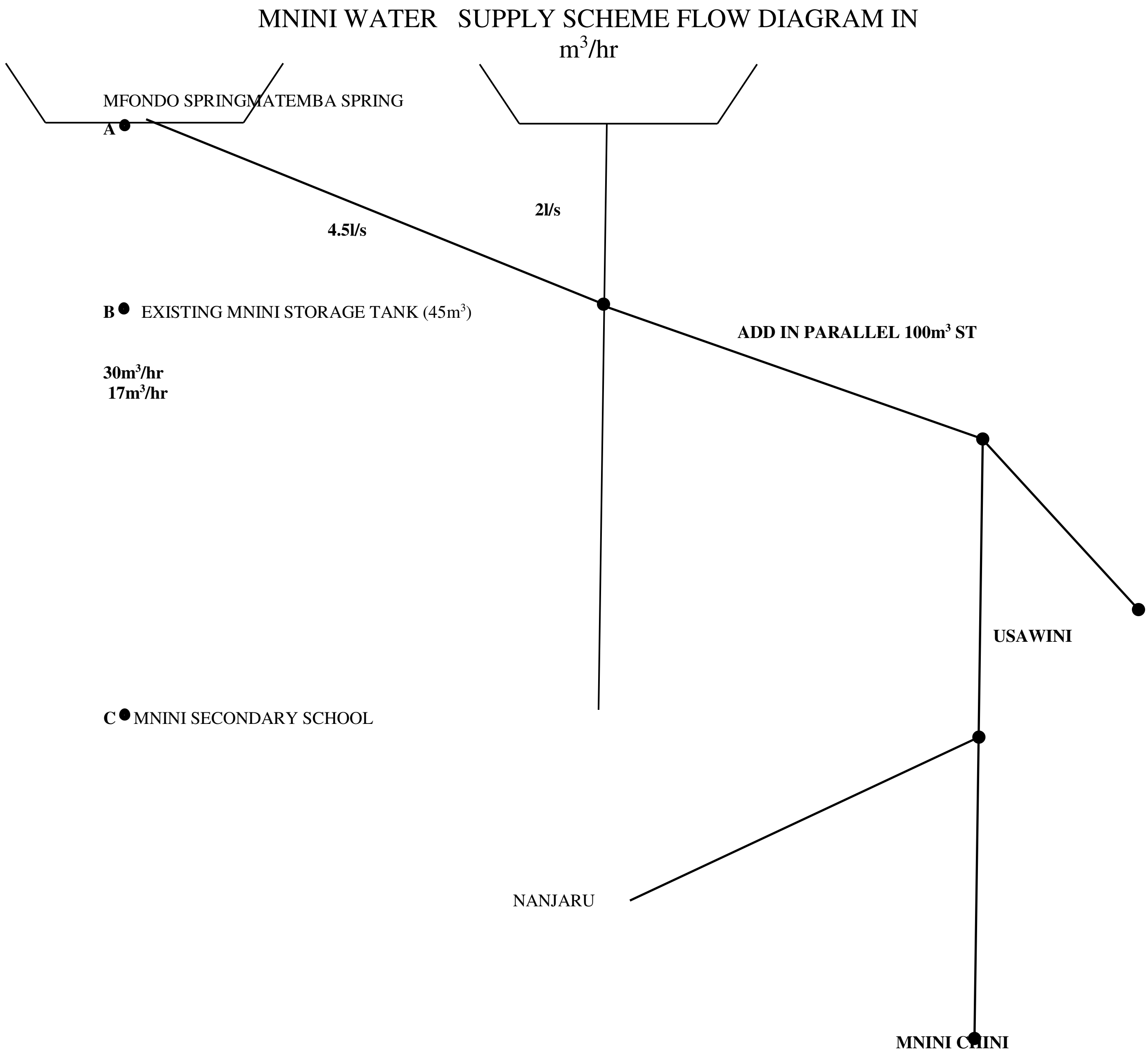

Figure 4.3 Flow diagram

4.18DESIGN OF MNINI GRAVITY MAIN LINE

The gravity main as explained in this chapter item 4.14, it must flow in 24 hours. According to the data collected the flow will be continuously in 24hours at the discharge rate of $6.4l/s \approx 23.04m^3/hr$ as a base flow up to the first parallel storage tanks.

In this design the size of the gravity main ranges from 65- 100mm diameter, of GS, PVC and PE respectively, pipes to a length of2250m as gravity main, The hydraulic calculations have been used to determine pressure distribution throughout the gravity main pipe line.

4.19HYDRAULIC CALCULATION

4.20.1 MAIN LINE AND DISTRIBUTIONS

The design shows the segments of the gravity main and distributions, from Intake point to end points of each branch line, It also shows distances from section to section, discharge, pipe material, class of pipe and diameter. And it also indicates the total frictional loss in each section, pressure of water above the ground level at each point, the ground level of each point as well as the piezometric level of each point**.**

CHAPTER FIVE

5.0 **COST ESTIMATE**

The cost estimates for the project has been presented as follows:

(see **Appendix A**).

5.1 **Structures to build:**

- Construction of Two intakes.
- Construction of $100m^3$storage tank
- Laying of GS pipes 100mm "MEDIUM" – 150m
- Laying of PVC pipes 100mm "PN 10" – ……m
- Laying of PVC pipes 80mm "PN 10" – ……m
- Laying of PE pipes 65mm "PN 10" – ……m
- Laying of PE pipes 50mm "PN 10" – ……m
- Laying of PE pipes 40mm "PN 10" – ……m
- Construction of 15 domestic points
- Construction of five washout and four air valves

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1CONCLUSION

The main objective of this project is to design a water supply scheme to support the existing Old Mnini water Supply project as the existing scheme does not supply adequate, potable water to Mnini village community.

Therefore the design of this scheme if will be used and constructed will help/assist to the provision of adequate, potable water supply to Mnini community, since the assumed water quality has shown that the proposed source (Mfondo and Matemba springs) are reliable in both (quality and quantity wise)

Also the scheme seems to be an economical as it is of gravity supply system and the hydraulic calculations of the gravity main and distributions gives a reasonable design pressure for economical water supply scheme.

6.2 RECOMMENDATIONS.

1. The strategies for the implementation of this scheme should focus on the major concept of beneficiary involvement; community based management and improved institutional arrangement. Therefore during the implementation of this scheme the focus is to ensure that it is in conformity with the National Water Policy 2002, as revised in the year 2009.

2. Is strongly recommended to the authority concern to provide a simple drip feeder chlorination point at the first parallel Storage Tanks before consumption.

3. The sizes of the pipes used in the design of the gravity main, allows sufficiently flow of water according to the water demand therefore the design should be adhered to during construction.

4. Air valves should be installed at the highest point to eliminate air lock in the gravity main and Washout valves should be installed at the lowest point to washout sediments in the gravity main as indicated on the longitudinal section.

5. The trench depth to be maintained at a depth of 1.0m throughout the gravity main as well as the distribution mains as well as to the branches.

6. METERING SYSTEM should be adopted in order to minimize water consumption and control water tariff.

6.3REFERENCE BOOKS:-

1. Linsley, K. (1992)Water Resources Engineering,International Editor McGraw Hill Inc.

2. Birdie, G. S.and Birdie, J.S. (1990)Water supply and sanitary Engineering, DhanpartRai& Sons.

3. Dr.Mashauri, D.A. (1992).Environmental Engineering 1 part A,No.FoE/CE/MAN/5/92.

4.Ministry of Water, (July 1997).Design manual for water supply and waste water disposal.

5. Rangwala, S.C. (2006).Water supply and sanitary engineering (environmental engineering).

6. Moshi District Census Profile (2002).Tanzania Bureau of Statistics.

7. National Water Policy(2002).Ministry of Water and Livestock Development.

APPENDIX A

COST ESTIMATES

COST ESTIMATES SUMMARY				
Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme				
District:	Moshi Rural			
Region:	Kilimanjaro			
M	Cost of material		220 997 655,00	
L	Cost of labor		62 881 666,67	
A	Cost of Administration & Supervision		10 450 000,00	
E	Cost of Equipment		1 055 000,00	
T	Cost of transport		16 700 000,00	
Sub total			312 084 321,67	
Add 10% contingency			31 208 432,17	
Grand total			**343 292 753,83**	
Say: T.SHS.	**343 292 754**			

COST ESTIMATE				
Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme				
M – Cost of Material Summary				
Code No	**Description**		**Cost of materials (Tshs)**	
100 -m	Common Objects		1 300 000,00	
200 -m	Roads and Areas		750 000,00	
300 -m	Water Source		11 455 500,00	
500 -m	Pipe line		146 879 212,50	
600 -m	Tanks(storage) - $50m^3$		15 780 000,00	
700 -m	Distributions		8 000 000,00	
	Sub Total		184 164 712,50	
	Add 20% VAT		36 832 942,50	
	M – Total		220 997 655,00	

Cost Estimating:			
Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme			
Cost of labour summary			
Code No	Description		Total Cost (Tshs)
100 –L	Common Objects		500 000,00
200 -L	Roads and Areas		1 500 000,00
300 -L	Water source		8 963 333,33
500 - L	Pipeline		16 291 666,67
600 -L	Storage Tank 100m^3 - 1 No & 50m^{3}on ground - 1No		27 026 666,67
700 -L	Distribution		6 000 000,00
900 -L	Special works		2 600 000,00
	L - Total		62 881 666,67

Cost Estimating:					
Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme					
Cost of Materials – Common Objectives Roads and Areas + water source					
Code No	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**TOTAL TSHS**
100 –M	**Common objects**				
101 –M	1.Accomodation				
	-Camping				
	-Equipment & tool				
	-Replacements	sum	1	800 000,00	800 000,00
	2.Setting out materials	sum	1	500 000,00	500 000,00
	(100 –m) total to				1 300 000,00
200 –M	Roads and Areas				
	Clearing and leveling	sum	1	750 000,00	750 000,00
			(200 - m)		**750 000,00**
300 -M	**Water sources Matemba & Mfondo springs**				
301 -M					
	Cement	180	Bags	12 500,00	2 250 000,00
	Sand	60	m^3	25 000,00	1 500 000,00
	Aggregate	50	m^3	30 000,00	1 500 000,00
	Barbed wire	12	Rolls	95 000,00	1 140 000,00
	Fencing poles	80	Nos	20 000,00	1 600 000,00
	Steel bars 10mm	35	Nos	13 800,00	483 000,00
	Steel bars 12mm	35	Nos	15 500,00	542 500,00
	Fencing wire	12	Rolls	70 000,00	840 000,00
	Fittings		1	1 000 000,00	1 000 000,00
	Miscellaneous		1	600 000,00	600 000,00
	(300-M) Total to summary form M				**11 455 500,00**

Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme					
PIPELINE					
Code No	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**TOTAL TSHS**
500-M	**Pipeline**				
501-M	Pipes				
	GS 100mm "M"	150	m	58 000,00	8 700 000,00
	GS 75mm "M"	150	m	25 000,00	3 750 000,00
	PVC 150mm "C"	600	m	20 000,00	12 000 000,00
	PVC 100mm "C"	2020	m	16 520,00	33 370 400,00
	PVC 80mm "C"	830	m	13 098,00	10 871 340,00
	PE 65mm "C"	3695	m	9 322,00	34 444 790,00
	PE 50mm "C"	1000	m	6 608,00	6 608 000,00
	PE 40mm "C"	1992	m	3 895,00	7 758 840,00
	Sub Total				117 503 370,00
	Add 25% fittings				29 375 842,50
	500-M Total				**146 879 212,50**
600-M	**Tanks – 2Nos**				
	Tanks- 100m^3 ground circular blockwork ST (New),1No (rehabilitation)				
	Cement	500	Bags	12 500,00	6 250 000,00
	Sand	80	m^3	25 000,00	2 000 000,00
	Aggregate	60	m^3	30 000,00	1 800 000,00
	10 mm Ø ms bars	60	Pcs	13 500,00	810 000,00
	12 mm Ø ms bars	90	Pcs	15 000,00	1 350 000,00
	Binding wire	1	Roll	90 000,00	90 000,00
	Timber material	400	Rft	1 200,00	480 000,00
	Forest Poles (3mlong)	100	Pcs	3 000,00	300 000,00
	Piping materials &fittin	sum	1	1 500 000,00	1 500 000,00
	Other Construction Mate	sum	1	1 200 000,00	1 200 000,00
	(600-m) Total				**15 780 000,00**

Cost Estimating:					
Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme					
Cost of Material :Distribution.					
Obj.No					
700-M	**DISTRIBUTION**				
702-M	DOMESTIC POINTS: 10 NOS and 4 PRTs				
Code No	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**TOTAL TSHS**
	Cement	200	Bags	12 500,00	2 500 000,00
	Sand	60	m^3	25 000,00	1 500 000,00
	Aggregates	40	m^3	30 000,00	1 200 000,00
	Hardcore	25	m^3	12 000,00	300 000,00
	Fittings	sum	1	500 000,00	500 000,00
	Timber	sum	1	200 000,00	200 000,00
	Miscellaneous	sum	1	350 000,00	350 000,00
	702 – M Total				6 550 000,00
703-M	VALVE CHAMBERS 10 NOS.				
	Cement	70	Bags	12 500,00	875 000,00
	Sand	5	m^3	25 000,00	125 000,00
	Aggregate	5	m^3	30 000,00	150 000,00
	Timber	sum	1	50 000,00	50 000,00
	XPM	10	Sheets	15 000,00	150 000,00
	Miscellaneous	sum	1	100 000,00	100 000,00
	703 – M TOTAL				1 450 000,00
	(700-m) Total				8 000 000,00

Cost Estimating							
Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme							
Cost of labor – Common Objects, Roads and Areas + Water Source.							
Code No	**Description**	**Qty**	**Unit**	**Qty/md**	**Total/md**	**Cost/md**	**Total cost Tshs**
100-L	Common objects	sum			1	500 000,00	500 000,00
	100-L to summary form L						500 000,00
	100-L Total						500 000,00
200-L	Roads and Areas	sum			1	1 500 000,00	1 500 000,00
	(200 –L) to summary form L						1 500 000,00
	200-L Total						1 500 000,00
300-L	**Water Source**						
300-L	**Matemba and Mfondo Springs**						
	Site clearing and leveling	**800**	m^3	**100**	**8**		
	Diversion work,						
	excavation,	**120**	m^3	**1**	**120**		
	Placing hardcore	**35**	m^3	**0,2**	**175**		
	Concrete work apron &weir		**Sum**	**200**	**200**		
	Masonry retaining walls	**50**	m^3	**0,25**	**200**		
	Stone pitching river bed & slopes		**Sum**	**50**	**50**		
	Trimming of slopes		**Sum**	**10**	**10**		
	Screeding & Rendering	**2,5**	m^3	**0,03**	**83,3**		
	Miscellaneous		**Sum**	**50**	**50**		
	Total				**896,3**	**10 000,00**	**8 963 333,33**
	(500-L) Total to summary form`L`						**8 963 333,33**

Cost Estimating:

Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme

Cost of labor - PIPELINE

Code No	Description	Qty	Unit	Qnty/MD	Total M/D	Cost M/D	Total Cost
500 – L	Pipe line:						
501 – L	Pipelines						
1	Site clearing	100	m2	40	2,5		
2	Excavation	3000	m3	5	600		
3	Pipe laying	7000	m	15	466,7		
4	Pipe testing	7000	m	35	200		
5	Back filling	7000	m	20	350		
6	Others		sum	10	10		
	Total				1629	10 000,00	16 291 666,67
	(500-L) Total to summary form `L`						16 291 666,67

Cost Estimating:

Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme

Cost of Labour – Tank Construction

600-L **Tank – 1No**

601-L **100m^3 ST on ground**

Code No	Description	Qty	Unit	Qnty/MD	Total M/D	Cost M/D	Total Cost
1	Clearing & leveling	100	m^3	5	20		
2	Foundation excavation	15	m^3	0,5	30		
3	Concrete works in foundation	10	m^3	0,03	333,33		
4	All scaffolding & dismantling	5	M	0,02	250		
5	Block work masonry ,screeding & rendering	62	m^3	0,2	310		
6	Curing.		Sum	30	30		
7	Concrete works for top slab	8	m^3	0,02	400		
8	Others		Sum	60	60		
	Total for 1 storage tank - 100m3 on ground				1 433	10 000,00	14 333 333,33
	(Total 601-L)						14 333 333,33

Cost Estimating:							
Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme							
Cost of Labour – Tanks rehabilitation							
600-L1	**Tank – 3No**						
601-L	**100m^3 ST 1No.,50m^3 ST 1No**						
Code No	**Description**	**Qty**	**Unit**	**Qnty/M D**	**Total M/D**	**Cost M/D**	**Total Cost**
1	**Clearing**	**30**	**M^3**	**5**	**6**		
2	**Foundation excavation (around)**	**15**	**M^3**	**0,5**	**30**		
3	**Removal of existing plaster**	**10**	**M^3**	**0,03**	**333,33**		
4	**All scaffolding & dismantling**	**5**	**M**	**0,02**	**250**		
6	**Replastering and Curing**		**Sum**	**200**	**200**		
7	**Concrete works for top slab (parapet)**	**7**	**M^3**	**0,02**	**350**		
8	**Others**		**Sum**	**100**	**100**		
	Total for three tanks				**1 269**	**10 000,00**	**12 693 333,33**
	(Total 601-L)						**12 693 333,33**

Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme

Cost of Labour Distribution and Special works:

Code No	Description	Qty	Unit	Qty M/D	Cost M/D	Rate M/D	Total Cost
700 - L	Distributions						
701 -L	Domestic Points 10 ,Valve Chambers –10 Nos & 4 PRTs						
	Site clearing&levelling		Sum		100		
	Excavation		Sum		180		
	Concrete work		Sum		200		
	Masonry		sum		120		
			(701-L)		600	10 000,00	6 000 000,00
	(700-L) total to summary form L						6 000 000,00
900 – L	Special works						
	Concrete block making		Sum		80		
	External transport		Sum		50		
	Handling & Dispatching		Sum		40		
	Bending, fabrication & reinforcement		Sum		40		
	Carpentry works		Sum		50		
					260	10 000,00	2 600 000,00
	(900-L) total to summary form L						2 600 000,00

Cost Estimates:

Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme

Cost of Transportation

Code	Description	Qty	Unit	Rate	Total Tshs
TM	Transport & Materials				
	Common Objects	20	Trips	100 000,00	2 000 000,00
	Stones	10	Trips	100 000,00	1 000 000,00
	Cement	10	Trips	100 000,00	1 000 000,00
	Reinforcement	1	Trip	100 000,00	100 000,00
	Timber	2	trips	100 000,00	200 000,00
	Pipes from DSM	1	Sum	4 000 000,00	4 000 000,00
	Miscellaneous	1	Sum	1 250 000,00	1 250 000,00
	TM TOTAL				9 550 000,00
T A	Transport of Administration				
	Inspection	Trips	Sum		3 000 000,00
	Payment Trips	Trips	sum		2 000 000,00
	TA Total				5 000 000,00
TE	Transport of Equipment				
	Auxilliary Equipment				
	Concrete mixer				
	Block making machine				800 000,00
	Vibrator	Sum			750 000,00
	TE Total				1 550 000,00
TS	Transport of Site running				
	Transport of Site running				
		Sum			600 000,00
	TS Total				600 000,00
	T - Total to summary form 'S'				16 700 000,00

Cost Estimating					
Project: Mnini Water Supply from Matemba Springs & Rehabilitation of the existing scheme					
Cost of Administration					
Code No	Description	Qty	Unit	Rate	Total Tshs
	Administration and Supervision				
	A1 Engineer	50	Days	100 000,00	5 000 000,00
	A2 Works foreman	120	Days	30 000,00	3 600 000,00
	A4 Site clerk	4	Month	150 000,00	600 000,00
	A5. Watchman	5	Month	150 000,00	750 000,00
	A6. Other allowances	1	sum	500 000,00	500 000,00
	A Total to summary Form 'S'				10 450 000,00

APPENDIX B

Pipe fittings list

LIST OF PIPE FITTINGS FOR PROPOSED MNINI WATER SUPPLY

S/No.	Item Description	Unit	Quantity
1	DCI FF Tee DN 100 (4")	Pc	1
2	Washer m 21	Pc	180
3	Washer m 17	Pc	272
4	Union DN 80 (3")	Pc	3
5	Union DN 75 (2½")	Pc	4
6	Union DN 100 (4")	Pc	5
7	Threaded Water meter DN 40 (1½")	Pc	3
8	Threaded Flange DN 75(2½")	Pc	2
9	Thread seal tapes	pc	550
10	Strainner DN 75 (2½")	Pc	4
11	Strainner DN 80 (3")	Pc	1
12	Strainner DN 40 (1½")	Pc	1
13	Reducing bush DN 75x25	Pc	4
14	Reducing bush DN 50x25	Pc	1
15	Reducing bush DN 40x25	Pc	1
16	Reducing bush DN 80x25	Pc	1
17	Reducing bush (40x25)	Pc	2
18	Plain Socket DN 80 (3")	Pc	1
19	PE Connector DN 40 (1½")	Pc	3
20	PE Connector DN 75 (2½")	Pc	6
21	PE Connector DN 50 (2")	Pc	2
22	Non return valve DN 150 (6")	Pc	1
23	Non return valve DN 100 (4")	Pc	1
24	Non return valve DN 80 (3")	Pc	2
25	Non return valve DN 75 (2½")	Pc	3
26	Non return valve DN 50 (2")	Pc	2
27	Non return valve DN 40 (1½")	Pc	3
28	Nipple DN 25 (1")	Pc	14
29	Nipple DN 80 (3")	Pc	5
30	Nipple DN 75 (2½")	Pc	10
31	Nipple DN 50 (2")	Pc	2
32	Nipple DN 40 (1½")	Pc	6
33	Gs Tee DN 75 (2½")	Pc	5
34	Gs Tee DN 50 (2")	Pc	1
35	Gs Tee DN 40 (1½")	Pc	3
36	Gs Tee DN 80 (3")	Pc	2
37	GS Nipple DN 75(2 ½)	Pc	2
38	Gs bend 90^0 DN 50 (2")	Pc	2
39	Gs bend 90^0 DN 75 (2½")	Pc	12
40	Gs bend 90^0 DN 80 (3")	Pc	5
41	Gs bend 90° DN 40 (1½")	Pc	6

LIST OF PIPE FITTINGS FOR PROPOSED MNINI WATER SUPPLY			
S/No.	**Item Description**	**Unit**	**Quantity**
42	Gate valve DN 25 (1")	Pc	8
43	Gate valve DN 50 (2")	Pc	3
44	Gate valve DN 80 (3")	Pc	3
45	Gate valve DN 75 (2½")	Pc	7
46	Gate valve DN 40 (1½")	Pc	3
47	Gate valve DN 150 (6")	Pc	3
48	Gate valve DN 100 (4")	Pc	3
49	Frange Reducer FFR DN 150/100	Pc	1
50	FP DN 150 (6")	Pc	2
51	FP DN 100 (4")	Pc	1
52	Float valve DN 100 (4")	Pc	2
53	Float valve DN 75 (2½")	Pc	3
54	Flat gasket DN 80 (3")	Pc	30
55	Flat gasket DN 50 (2")	Pc	20
56	Flat gasket DN 100 (4")	Pc	62
57	Flat gasket DN 150 (6")	Pc	26
58	Flap valve DN 150 (6")	Pc	2
59	Flap valve DN 100 (4")	Pc	4
60	Flanged Water meter DN 100 (4")	Pc	2
61	Flanged Water meter DN 80 (3")	Pc	1
62	Flanged Water meter DN 75 (2½")	Pc	4
63	Flanged Water meter DN 150 (6")	Pc	1
64	Flanged Water meter DN 50 (2")	Pc	1
65	Flanged Tee reducer DN 150xDN50xDN150	Pc	3
66	Flanged Tee reducer DN 100xDN50xDN100	Pc	1
67	Flanged Strainer DN 150 (6")	Pc	1
68	Flanged Strainer DN 100 (4")	Pc	1
69	Flanged Sluice valve DN 150 (6")	Pc	3
70	Flanged sluice valve DN 100 (4")	Pc	6
71	Flanged Gate valve DN50 (2")	Pc	3
72	DCI FFP DN 100 (4")	Pc	4
73	Bolt & Nut 20x80	Pc	172
74	Bolt & Nut 16x70	Pc	180
75	Air valve DN 25 (1")	Pc	9
76	Flanged Air valve DN50 (2")	Pc	1
77	DCI wide range adaptor DN 100 (4")	Pc	23
78	DCI Flanged bend 90^0 DN 100 (4")	Pc	2
79	DCI Flanged bend 90^0 DN 150 (6")	Pc	4
80	DCI Flanged bend 90^0 DN 100 (4")	Pc	8
81	DCI Flanged adaptor or universal flange DN 150	Pc	12
82	DCI FFP DN 150 (6")	Pc	3