THE REPUBLIC OF UGANDA

KABALE DISTRICT LOCAL GOVERNMENT

In Conjunction with

NILE BASIN INITIATIVE

NILE EQUATORIAL LAKES SUBSIDIARY ACTION PROGRAMME (NELSAP)

KAGERA TRANSBOUNDARY INTEGRATED WATER RESOURCES MANAGEMENT PROJECT

FINAL REPORT FOR THE DESIGN AND DOCUMENTATION OF KATUNA GRAVITY FLOW SCHEME

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EXECUTIVE SUMMARY

BACKGROUND

This is a design report for the Katuna Water supply and Sanitation Scheme. It is part of the Kabale District Local Government Water Supply and Sanitation Development Programme in conjunction with Nile Basin Initiative's Nile Equatorial Lakes Subsidiary Action Programme (NELSAP) / Kagera Transboundary Integrated Water Resources Management Project (KTIWRMP). BIOSCA Consultants Ltd. was contracted to undertake the design and documentation of the Katuna Gravity Flow Scheme.

A feasibility study of the Katuna water supply scheme was done and this included topographic and baseline surveys of the project area with the help of the Kabale District Water Office Officials.

Project area

The Project area is situated in Katuna. The communities which were focused on during the Baseline Survey were Kabaliisa/Buranga, Rwakakobe, Nyamengo/Kanyanjokye, Mayengo, Burambira, Hakabungo and Ryaruhinda. All these communities are in Kamuganguzi sub-county, Ndorwa County, Kabale District. The larger parts of these communities make up Katuna, a town found at the South-Western border of Uganda with Rwanda. The project area is about 22 Km from Kabale town. The water supply system is intended to serve a current population of 3,791 in 782 households and a combined institutional population of 4,556.

Sanitation

The principal facility for excreta disposal in the town are pit latrines, but only a few can be rated as being structurally, functionally and hygienically adequate. The majorities of pit latrines are constructed out of mud (out of these 90% have a san plat and 3.2% don't have) Ventilated Improved Pit (VIP) latrines take 1.2% and eco san takes 2% of the total .pit latrine coverage.

In addition, there are few proper sullage water disposal facilities such as soak pits. The few soak pits available are silted and floated, with no proper final disposal system.

The absence of properly-organised sanitation facilities and systems, combined with the growing population in the town, is now becoming a considerably serious problem.

Environmental Impact Assessment

The positive environmental and social impacts of the proposed water supply and sanitation schemes should be quite obvious. The benefits to be derived from the provision of good quality and safe water and improved sanitation for domestic use in order to improve the health situation and subsequently the economic productivity of the beneficiaries, cannot be overemphasized.

The potential negative environmental and social impacts would arise both during the construction phase and the operational phase of the proposed new schemes. Many of these impacts would be rendered insignificant, if reasonable low-cost mitigation measures are implemented as recommended in this report.

Project Justification

Two Gravity Flow Systems were constructed for some parts of the target area this consultancy has considered. One Kabaliisa Gravity Flow System was implemented in 1985 by UNICEF under the Water Environment and Sanitation programme (WES).

The second Gravity Flow Scheme was implemented by the Church of Uganda, Diocese of Kigezi Water and Sanitation programe (KDWSP) in 1992 and the target area was Katuna town.

The two systems shared similar problems as highlighted below and led to their collapse;

- Lack of a properly instituted management leading to poor maintenance of the system.
- Some of the sections were constructed out of Galvanised iron (GI) which rusted leading to intermittent flows through the system.
- In sections the pipes were not laid in trenches and it was easily vandalized.
- There were reported cases of vandalism, like stealing tap heads leading to open flows at the taps. With the constant flows, unsightly scenes were common on these water points thus poor hygiene.

The objectives of the project based on the above background can therefore be laid out as follows;

- To assess the efficiency of the existing water supply systems.
- To explore the feasibility of extending water to currently the un served areas.
- To come up with a water supply and sanitation system that puts into consideration community participation, appropriate technology applications, ensuring sustainability by establishing management structures in which the users take lead.

The provision of safe drinking water and good sanitation services is essential for the health and social economic development of the community. **"*Water is life*"** and ***"sanitation is health"***.

Project scope

From the study carried out, the two projects are feasible and would involve implementation of the following;

Kabaliisa

1) Source redevelopment (2 in No.)
2) Supply and installation of pipes (2.6km)
3) Construction of 11 new tap stands and rehabilitation of 19 old tap stands.
4) Soft ware component (sensitization and mobilization of community)

Katuna town

1) Source development (2 in No.) including planting trees and chain link fencing.
2) Supply and installation of pipes (13.9km)
3) Construction of 1.5m3 reinforced concrete sedimentation tank (2 in no.)
4) Construction of 10m3 brick masonry break pressure tank
5) Construction of 90m3 brick masonry reservoir tank
6) Construction of public kiosks (6 in no.)
7) Construction of public tap stands 40 in No.
8) Soft ware component (mobilization and sensitization of community)
9) Road to Nyakatare source

The road to the source has been considered resulting from a condition set by the owner of the land at the source if he's to give it out for source development.

Project cost

From the above breakdown, the two water supply and sanitation systems are estimated at a cost of **Ug Shs. 497,319,613/=** (Four hundred ninety seven million three hundred nineteen thousand six hundred thirteen only.

Taking Katuna GFS alone, the capital investment per person is Ug Shs.27, 800/= an equivalent of US$17 which is much below the maximum recommended value of US$75

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1 NTRODUCTION

1.1 BACKGROUND

Kabale District local government, in conjunction with Nile Basin Initiative's Nile Equatorial Lakes Subsidiary Action Programme (NELSAP) / Kagera Trans-boundary Integrated Water Resources Management Project (KTIWRMP), has received funds and intends to use part of the funds for the study and designs of a Gravity Flow Scheme for Katuna, a town found at the border with Rwanda. BIOSCA Consultants Ltd was contracted as Consultants to carry out the studies and prepare designs for the scheme which will cater for the Katuna town and its surrounding communities.

The assignment was carried out in three phases:

1. Preliminary studies which involved water resources assessment and existing situation analysis. This phase culminated into the recommendations and proposed water sources.

2. Baseline and topographic surveys, by which the suitability of the recommended source to serve the target area (in respect to the population demographics, socio – economic aspects, the altitude and average future demand) was determined and contained in the report.

3. Detailed design phase, for the water supply system.

2 THE PROJECT AREA

2.1 GENERAL

The project area encompasses the entire Katuna border town which includes two cells that is, Mayengo and Burambira; Katuna is a town boarder located in Kamuganguzi Sub County, Ndorwa County, Kabale district. Katuna is located about 20 Km from Kabale Town. The project boundaries are based on the parish sizes, which are the LCII.

The water supply and sanitation system shall target various communities in the target area and the institutions therein, which are water stressed. Consideration shall however be given to areas of dense populations along the pipeline and institutions within a reasonable distance not exceeding 1km, but with no alternative sources of water.

2.2 PHYSICAL INFORMATION

2.2.1 Climate

Kabale district experiences an equatorial type of climate characterized by two rainy seasons with a mean annual rainfall ranging between 1200mm and 1500mm. Minimum rainfall is experienced in the months of May to August.
Temperatures range between 11ºc to 28ºc with minor fluctuations.

2.2.2 Hydrogeology

Katuna is mainly underlain by the granite rocks composed mainly of undifferentiated gneisses, largely layered or banded. High ridges and moderate V-shaped valleys characterize the terrain. Ground water potential is good to moderate in the valleys and at the foot of the ridges.

2.2.3 Topography

The area is generally characterized with steep hills. Katuna Town is located on the foothills of Mayengo hills. Below Katuna town lays a wetland which is partly used for low scale cattle farming. The photographs below show some of the Steep and V-shaped slopes.

Figure 1 *Steep slopes with a lot* human activity *in one the source areas*

2.3 SOCIO-ECONOMIC ASPECTS

2.3.1 Demographic Information

The demographic information of the area was obtained with the help of the consultant's social workers and the local leaders of the area through a house-to-house exercise by counting the number of house members within the proposed supply area.
The tables below give updated household population in the supply area and the number of households.

Table 1 *Population Figures*

	Kabalisa	Rwakakobe	Nyamengo / Kanyanjokye	Mayengo	Burambira	Hakabungo	Ryaruhinda	**TOTALS**
Total Households	71	132	60	133	202	71	113	**782**
Population	366	652	297	574	886	364	652	**3791**
Total Institutions	-	1	-	10	7	2	-	**17**
Population	-	300	-	2257	1127	872	-	**4556**

NOTE: Total population in the Households is 3,791 people

Total population in the Institutions is 4,556 people

From table**,** above, it can be seen that the Total Target Population of the Katuna Water Supply Scheme is **8,347** people. This is the total of all the persons found in the households and all the institutions in the area.

This figure is for people who are staying in the households and institutions of the communities and does not include people who are visiting (for example business people). It was hard to get the number of persons who were operating at the border either as money changers or as sellers or buyers of commodities (mainly on market days – Wednesday and Saturday), or even people going through the border. This, as explained by the concerned leaders was hard to determine because the numbers varied according to various factors like weather, price fluctuations, political activities and educational and health activities.

The table below likewise gives the institutional population in the supply area:

Table 2 *Institution population*

Institution Name	**Type**	**Population**	**Location**
Mayengo Primary School (Day)	Educational	378	**Mayengo**
Katuna Primary School (Day)	Educational	409	**Burambira**
Janani Luwum Memorial Secondary School, Kamuganguzi (Kamuganguzi Sec. School)	Educational	581	**Mayengo**
Mukarangye Primary School	Educational	362	**Hakabungo**
Little Angels Nursery School (Day)	Educational	39	**Mayengo**
International Nursery School (Day Nursery & P.1)	Educational	110	**Burambira**
St. Emmanuel's Mayengo Church of Uganda	Religious	10	**Mayengo**
Katuna Roman Catholic Church	Religious	5	**Burambira**
Mukarangye Roman Catholic Church	Religious	600	**Burambira**
Rwakakobe Church of Uganda	Religious	300	**Rwakakobe**
Kamuganguzi Church of Uganda	Religious	600	**Mayengo**
Mukarangye Church of Uganda	Religious	510	**Hakabungo**
Katuna Mosque	Religious	3	**Burambira**
Katuna Pentecostal Church	Religious	-	**Mayengo**
Katuna Customs and Immigration	Economic/Border	107	**Mayengo**
Katuna Market	Economic	-	**Burambira**
Katuna Inn	Economic	-	**Burambira**
New Terrace Hotel	Economic	-	**Mayengo**
Kamuganguzi Health Centre	Health	-	**Mayengo**

From table above**,** it can be seen that the majority of the institutions in the target area are Educational.

However, during the survey, it was observed that Katuna Market has got thousands of people flocking it comprising of residents, non-residents and Rwandan nationals

2.3.2 Institutions

There are 19 institutions considered to be part of the project supply area in Katuna towns. These include **one** health centre, **seven** schools, **six** churches and **one** mosque, and customs and immigrations' office, **two** hotels and a weekly market. These institutions are in the proposed supply area and therefore shall be included in the designs.

2.3.3 Economic Activities

The major economic activities in Katuna town is small scale business enterprises, currency exchange centers and farming on fragmented pieces of land within the fringe areas of the town

Employment by government or private institutions also takes a very small percentage of the economic activities.

Figure 2 *A view of Katuna Lower from Katuna Upper (Mayengo hill)*

2.3.4 Household Incomes

Being an International border town, Katuna has got a lot of economic activity going on. The majority of the population has tried to exploit the nature of the town's setting in order to generate incomes for themselves and their households. The table below shows the major sources of income for households.

Table 3 *Source of income*

Activity	Shop	Kiosk	Workshop	Agriculture	Livestock	Restaurant	Drug Shop	Money changing	Bar	Salary	Casual	Lodge	Catechist	None	**TOTALS**
Kabaliisa	8	-	-	51	5	-	-	-	1	3	1	-	2	-	**71**
Rwakakobe	-	-	-	131	1	-	-	-	-	-	-	-	-	-	**132**
Nyamengo/ Kanyanjoka	3	-	-	57	-	-	-	-	-	-	-	-	-	-	**60**
Hakabungo	4	7	-	56	1	-	-	-	-	3	-	-	-	-	**71**
Ryaruhinda	1	1	1	105	5	-	-	-	-	-	-	-	-	-	**113**
Mayengo	30	8	5	37	0	5	3	4	3	32	0	4		2	**133**
Burambira	32	29	2	100	2	4	2	2	14	11	1	0	-	3	**202**
Total	**78**	**45**	**8**	**537**	**14**	**9**	**5**	**6**	**18**	**49**	**2**	**4**	**2**	**5**	**782**
Percentage	**9.97**	**5.75**	**1.02**	**68.67**	**1.79**	**1.15**	**0.64**	**0.77**	**2.30**	**6.27**	**0.26**	**0.51**	**0.26**	**0.64**	**100**

From table**,** above, it can be seen that the average major Source of income is Agriculture. This has a percentage of 68.67%. It can also be seen that Agriculture is by far the major source of income in all the communities.

Household heads were asked to approximate their average monthly incomes, most especially the monies which were spent on their households. These figures were used to compute the sums and averages below;

Table 4 *House hold incomes*

Area	Total Households	Total Income (Shs)	Average
Kabaliisa	71	2,108,000/=	29,690/=
Rwakakobe	132	700,000/=	5,303/=
Nyamengo/ Kanyanjoka	60	9,710,000/=	161833/=
Hakabungo	202	9,281,000/=	45,945/=
Ryaruhinda	133	11,998,000/=	90,211/=
Mayengo	71	2,353,000/=	33,141/=
Burambira	113	2,877,000/=	25,460/=

3 THE EXISTING SITUATION

3.1 EXISTING WATER SUPPLY SITUATION

3.1.1 Water

Due to the presence of some piped water schemes, and different water sources, the target area is divided into two main groups of communities

Community A: Which has got piped water systems

Community B: Which doesn't have piped water systems

3.1.2 Community A

Community A is mainly Kabaliisa and Katuna Upper. During the reconnaissance and Baseline survey, it was observed that Katuna Upper (partly Burambira) has got a piped water system that may be sufficient for the population that it supplies. However, Kabaliisa has got a piped water system that has broken down and needs to be rehabilitated, or better still, reconstructed.

Figure 3 *A functional Community tap stand for Katuna Upper (Burambira)*

3.1.3 Community B

Community B comprises of mainly the remaining communities which rely mainly on water from Protected Springs or streams. Due to the lack of adequate water supply facilities, even the few protected springs were constructed for these communities have been overwhelmed by the demand and have thus been depreciated to levels where the water quality and supply is not established but is apparently very low.

Community members do not pay a user fee for any of the water collected from these tap stands. They only try to mobilize resources when a tap has broken down or a pipe has been cut. It was learnt that even when something like this does occur, the community members are still reluctant to release money for the necessary repairs.

This shows the number of households using a particular water source and for water quality results; (*see annex*).

Table 5 W*ater sources*

Water source	Community tap stand	House hold tap stand	Protected springs	Stream	None
Kabaliisa	58 (Rely on three functioning tap stands out of the initial 18 taps)	7 (these are private household connections)	NIL	6	NIL
Rwakakobe	NIL	1 (Private connection)	131 (Rwakakobe P. Spring)	NIL	NIL
Nyamengo/ Kanyanjoka	NIL	4(private connections)	56 (Community relies on 1 P. Spring)	NIL	NIL
Burambira	28 (25 use community tap in Katuna Upper, 3 use tap in Nyiramurinzi)	173 (use one Protected spring in Burambira)	NIL	NIL	1
Mayengo	55 (community tap stand)	NIL	77 (use protected spring)		1
Hakabungo	NIL	NIL	71 (Hakabungo P. Spring)	NIL	NIL
Ryaruhinda	NIL	NIL	96 (Ryaruhinda) 17 (Hakabungo)	NIL	NIL
Percentage	***18.03***	***23.57***	***57.29***	***0.77***	***0.26***

From table above, it can be noticed that the majority of the Households in Katuna rely on water collected from the protected springs. These make up 57.29% of all households.
The approximate average distance from a household to a water source is 325metres.

3.2 EXISTING SANITATION SITUATION

3.2.1 General community sanitation

According to the Baseline Survey the sanitation of the area leaves a lot to be desired. The general cleanliness levels of the area were low and there were many basic sanitation facilities lacking in many of the households. The following table shows the general summary of the sanitation situation of the area.

Table 6 *General Sanitation Situation*

Sanitation Facility	**Present (Households)**		**Absent (Households)**		**Not Applicable**	
	No	%	No.	%	**No.**	**%**
Excreta Disposal (Toilet, Latrine)	725	92.71	57	7.29		
Kitchen	530	67.77	252	32.23	-	-
Drying Rack	294	37.6	488	62.4	-	-
Drying Rack	294	37.6	488	62.4	-	-
Compost Pit	147	18.8	635	81.2	-	-
Animal House	187	23.9	244	31.2	351	44.9
Clean Water Collection Containers	656	83.9	126	16.1	-	-
Drinking Water Storage facilities	525	67.1	257	32.9	-	-

Figure 4 *A household kitchen that doubles as a brewery*

The general community sanitation standards of the target area greatly vary. In areas which are hilly and on higher altitudes, the sanitation is relatively okay, mainly because of the absence of stagnant water and also because these areas are predominantly households, and the community members try to keep their households clean and swept.

However, in the busier, more flat areas (especially the Katuna market area), the sanitation is very poor, with rubbish, human and animal excreta strewn in many places. Household waste, most especially polythene waste, is thrown everywhere, including the drainage facilities and on the roads. The poor community cleanliness may be attributed to the fact that there is a bi-weekly market that has a lot of waste which does not have an appropriate disposal place.

A channel that runs behind Katuna Lower is very filthy covered with a lot of waste, this channel, believed to be an extension of a river that runs from Kabale to Rwanda poses a great health risk to the people of the community, because it is used a dumping ground for the community.

Figure 5 *Drainage channel in Katuna*

3.2.2 Pit latrine/toilet coverage

Several households and Institutions in Katuna lack Human Excreta Disposal facilities. A total of 57 Households (7.29%) do not have pit latrines. A community institution, Katuna Market, which is flocked by thousands of people, does not have a pit latrine or any other faecal disposal facility.

The table below shows the pit latrine situation in the target area for Katuna Gravity Flow Scheme

Table 7 *Pit Latrine coverage*

	Present	**Absent**	**Dirty**	**Clean**
Kabaliisa	61	10	18	43
Rwakakobe	118	13	29	92
Nyamengo/ Kanyanjoka	59	1	6	53
Hakabungo	189	13	88	101
Ryaruhinda	118	15	49	84
Mayengo	71	-	29	42
Burambira	110	3	43	67

Table 8 *Type of Excreta Disposal facilities*

	Slab/ Permanent	V.I.P.	Ecosan	Traditional with San Plat	Traditional without San Plat	Flush	**Total**
Kabaliisa	3	2	1	-	55	-	**61**
Rwakakobe	-	-	1	-	118	-	**119**
Nyamengo/ Kanyanjoka	-	4	-	2	53	-	**59**
Hakabungo	6	1	12	2	167	1	**189**
Ryaruhinda	3	1	1	10	98	5	**118**
Mayengo	-	1	-	4	66	-	**71**
Burambira	-	-	-	5	104	1	**110**
Total	**12**	**9**	**15**	**23**	**661**	**7**	**727**

Form table above, it can be seen that the most common type of Human excreta disposal facility in all communities the traditional pit latrine without Sanitation platform (san plat). In a situation where sanitation standards are low this type of pit latrine can be quite hazardous.

Figure 6 *Typical household pit latrine*

Figure 7 A *school's toilet facility*

3.2.3 Faecal Matter Disposal

The Sanitation situation in Katuna is poor. The common Faecal Disposal system is Ordinary Pit latrines.
There is one public Ecological Sanitation Toilet in Katuna town which is poorly managed and used improperly. Ecological Sanitation Toilets would otherwise be the best in the area because of agricultural and farming practices and of course Katuna lower, the water table is low because of the neighboring wetland.

3.2.4 Refuse Collection and Disposal

No proper system for solid waste disposal is in place. 84% of households have no compost pits as a means of solid waste disposal.
In some households however, solid wastes are collected and damped in the farmyards or nearby bushes.
Refuse disposal is a big problem as non-putrifiable components do pollute the environment. Many petroleum byproducts like used plastic containers and polyethylene papers, which degrade the soil fertility, are damped in gardens or in the nearby bushes. The town center is littered with a lot of polyethylene papers.

3.2.5 Waste Water

Grey water [silage] disposal so far is not a serious problem because of the nature of the terrain, grey water is drained down stream to the existing swamps and stream. Water is only used for domestic purposes. Otherwise, much of it is disposed of in water channels and in the gardens/compounds. Now that the swamps have been cleared into farms, as the town expands waste water generation will definitely increase and therefore polluting the streams below the town and thus posing danger to aquatic life.

3.2.6 Storm Water Drainage

There is no defined system of drainage though the nature of the topography also favors the area from flooding since storm water easily flows down hills. Drainage from the individual households is the responsibility of the occupants. The lower Katuna town floods during the rainy seasons. The floods take long to clear and provide a vulnerable condition for mosquito multiplication.

4 WATER RESOURCES

4.1 GROUND WATER

There are five springs that were identified in Kamuganguzi Sub-county;

1. Two (2) springs in Kabalisa and records available indicate that the yield is 0.4 l/s and can will needs redevelopement.
2. One (1) spring in Rwembogo with a yield of 0.9 l/s. and can be gravitated to the reservoir tank to supply Katuna town
3. One (1) spring in Nyakatare with a yield of 0.6 l/s and can be gravitated to the reservoir tank to supply Katuna town.
4. One (1) spring in Kiniongo with a yield of 0.4l/s and is lower than Rwembogo and Nyakatare sources and would thus require pumping to the proposed Reservoir tank position. For this project, it was not considered as the water source point for the system for the proposed GFS.

Figure 8 *Rwembogo Spring (total yield is 0.9 l/s)*

Figure 9 *Community springs in Ryaruhinda Parish*

Figure 10 *Nyakatare Source (yield is 0.6 L/s)*

Rwembogo and Nyakatare sources were chosen for this system, the choice was arrived at basing on the following;

- The location of the sources in relation to the location of the reservoir; it could be gravitated, thus minimum costs would be incurred during transmission.
- The yield of the two sources would comfortably cover the design demand projections.
- From the laboratory test carried out, the water was free from pathogenic (disease causing) organisms.
- Fairly clear (low turbidity and little colour).
- Fresh (not saline, or salty).
- Free from compounds that cause offensive taste and odour.
- Incapable of causing corrosion of the water supply system.

Other existing Water resources

River Kiruruma;

There is a stream, Kiruruma, dividing the Uganda and Rwanda whose water quality is not good. It's turbid because of the human activity along it. However the people use this water for domestic use.

Below Katuna town is a farm land which was originally a swamp, that floods during the rainy season.

4.2 RAIN WATER

Rain Water harvesting is on a very low scale in the project area. Just a few households use rain water as the main source of water.

It is however very important for the communities especially those that are within the supply area but do not have access to piped water system. Rainwater harvesting can be practiced at household level. Communal Rain water harvesting systems are not cost effective. The investment cost is high and considering dry spells seasons for say three months requires a big investment. People could be sensitized to tap water from their roofs using gutters fixed to the roof eaves.

5 DESIGN CONSIDERATIONS

5.1 Population projections.

The current population was established after a head count exercise carried out by the Consultants' team with assistance from the community members in households, local leaders and opinion leaders of the area. This was during the Baseline survey.

The Table below shows the current population and the projected population through design horizon of 20 years and considering a growth rate of 3% per annum as per the 2002 population National census.

Table 9 *Population projection*

Year	Population to be served
2007	**8,347**
2027	**15,075**

The population in the table includes all the institutions. The details are in the *Annex water demand projections.*

The design horizon of 20years was considered appropriate for this system on weighing the following factors;

- Project size/cost
- Running costs
- Population growth
- Financial constraints
- Durability (service life) of the different components of the system
- Future extensions to be made

5.2 Basis of Design

5.2.1 Design Criteria

As recommended in the Water Supply Design Manual 2000 for the Ministry of Water, Lands and Environment, service levels have been derived from the user's income levels, and the ability and willingness to pay as determined from the baseline surveys. The service levels vary from yard tap to serve a group of people in a particular area. The design criteria comprises unit demand, design horizons, operating conditions, design life and replacement horizon, and design demand.

I. Unit Demand

The unit demand is the design per capita consumption for a given service level. The following are the unit demand rates together with the population and the technical figures, which collectively were considered for the design.

UNIT WATER DEMAND

Population	25 l/cap/day	incl. waste water = 15%
P/school	6 l/cap/day	incl. staff
S/school	6 l/cap/day	incl. staff
S/school (boarding)	25 l/cap/day	incl. staff
Markets	1 standpipe/500 visitors	
Densely populated centres	double standpipes	
Dispensaries	20 l/day	
Health units/Dispensaries	100 l/day for ipd	
	20 l/day for opd	
Hospitals	200 l/bed/day	
	23 l/cap/day	staff and family
Hotels	100 l/bed/day	
Government institutions	500-3000 l/day	depending on size
Churches	500 l/day	
Other institutions	500 l/day	
Private Connections	65 l/cap/day (yard tap)	
In house connections	130 l/cap/day	

POPULATION FIGURE

Growth Rate	3 % pa	
Design Period	20 years	Factor: 1.81
Household	6 members	

TECHNICAL

Location of tap stands with regard to the population		
Max. Walking distance		250 m
Max. Altitude difference to tap		100 m
Max. Number of users per outlet/tap		250
Min. tap flow		0.1 l/s
Max. Tap flow		0.2 l/s
Water demand pattern		
7:00 AM - 10:00 AM	30 % of daily demand	
10:00 AM - 5:00 PM	40 % of daily demand	
5:00 PM - 7:00 PM	30 % of daily demand	
7:00 PM - 7:00 AM	0 % of daily demand (negligible)	
Peak demands		
Peak factor	1.37 – 3.6	
Residual heads		
Min.	7 m	
Max.	56 m	
Optimum for psp	15 m	
Optimum velocity	0.7-3.0 m/s	if less than 0.7m/s a washout provision should be put in place
Reservoir sizing	Storage capacity= ½ the total daily demand for GFS	
Max. Water subtraction from the source	70%	

II. Design Horizons

The design horizon is the time frame to be considered when designing physical components of the water supply systems. The component sizes are designed to meet the demand for water as it can be projected to the design horizon (design demand). After the design horizon the system capacity would require augmentation given that the horizon is less than the life expectancy of some of the components in question.

Taking 2007 as the initial year, the major components of the water supply, i.e. the source works, transmission main, storage reservoirs and the primary distribution network have been designed for a design horizon of 20 years (the year 2027).

5.2.2 Water Demand Projections (See annex)

Based on the results of the socio-economic survey carried out in the project area, the population's economic levels are relatively low. The design of the piped water supply is therefore based on the assumption that the domestic demand will be met by provision of limited house connections and water kiosks and institutional demand will be met by provision of yard connections.

The demand projection is based on the population projections, design criteria and the anticipated service levels.

5.3 Service levels

The different service levels for domestic water supplies as anticipated in relation to the design period form the basis of the water demand distribution. The table below shows the quantities of the proposed service level distributions for the supply areas. The population near the source area shall benefit from the tap provided at the source area and shall not pay the tariff like those in the core area.
The service levels as shown in the table below were based on the field assessments of the existing physical structures and the settlement pattern.

Table 10 *Service levels*

Service level	Number
Public tap stands (water kiosks)	6
Yard tap stands	40
House connections	20

The quantity of the service level was based on the baseline survey conducted.

The key selection criteria were as follows;

- Well maintained basic service level, standard water supply and sanitation installations functioning for the community.
- The system to be technically sound and was the preference for the community.
- Social economic status of the community and through further interaction revealed the willingness; community can afford to make contributions towards the operations and maintenance costs of the service provided i.e. bringing the water point closer to them.
- Kiosks were considered in a bid to provide an additional security to the structures and fittings to avoid theft of water meters, valves. Theft of tap heads was common in old system and used in the process of making a local brew (waragi).

6 DESIGN FOR THE GRAVITY FLOW SYSTEM

6.1 GENERAL

The feasible water supply system design options selected and recommended have been based on the technologies that are affordable and compatible with the community. The design aimed at providing self sustaining facilities and services for the residents.

Based on the findings, ground water formed the preferred design option. The study therefore proceeded to ground water exploitation. Water shall be abstracted directly from the springs at Rwembogo and Nyakatare all sources located in Katuna, Kamuganguzi sub-county and shall be gravitated through a combination of pipes to reservoir tank.

The quality of the water was found to be within the limits of the Uganda National guideline Values for Rural Drinking water , and so there is no need for disinfections or any treatment, but source catchment protection is vital at this stage to avoid contamination of the sources in future.

6.2 SOURCE CHARACTERISTICS

The water quality results (*in the annexes*) reveal that the spring is not contaminated by faecal coliforms. The spring should therefore be properly protected against the reach of animals and at least 30m away from any pit latrines on the upstream end to prevent human/animal excreta getting into contact with the spring waters.

Though there was no faecal matter traced in the water samples examined, human activity around all the sources might affect the quantity and quality of water in future. Little vegetation cover is left up stream due to cultivation and grazing.

6.3 ABSTRACTION, TRANSMISSION AND DISTRIBUTION

6.3.1 Abstraction and Transmission

70% of the safe yield shall be abstracted from the springs at Kabaliisa, Rwembogo and Nyakatare to undergo primary treatment through sedimentation tanks of 1.5m^3 each, which shall be located at the source. The remaining 30% shall be left for the maintenance of the existing eco-biodiversity system. A 10 m^3 break pressure tank will be constructed to reduce the force with which water would flow through the pipes. The choice of this capacity was to avoid damage of the retaining structure. Water shall then be transmitted through a series of pipelines using HDPE pipes to the reservoir tank. Abstraction shall be done after protecting the spring and construction of intakes works. The works shall also include fencing off at least 50x100m of the area surrounding the spring and planting trees within the fenced area.

The Transmission Main shall comprise different pipe sizes of different classes. Details are in the table below;

Table 11 *Transmission pipeline details*

Pipe size(mm)	Pipe type/class	Section length (m)
90	HDPE PN6	450
90	HDPE PN10	400
75	HDPE PN6	2000
75	HDPE PN10	500
75	HDPE PN16	4000
TOTAL		**7,350**

6.3.2 Reservoir Tank

Based on the design criteria, the capacity of the reservoir was designed to equal half the projected daily water demand in the design horizon of 20 years, which is 90m^3 and shall be constructed out of 530mm thick brick wall masonry structures, installed with water level indicator, overflow pipe wash out, accessibility ladders provisions. (*See drawing details*).

6.3.3 Distribution Network

The distribution network was designed to meet the maximum peak hour demand. This was obtained from the questionnaires compiled during the field visits. It was established that fetching is done approximately in this range of hours with their following corresponding percentages of daily demand as shown in the table below;

Table 12 *Water demand patterns*

Time of fetching	Duration (hours)	Percentage of daily demand
7:00AM – 10:00AM	3	30
10:00AM – 5:00PM	6	40
5:00PM – 7:00PM	4	30
7:00PM – 7:00AM	11	Negligible

The consideration of the peak hour demand was considered to be the best option for rural areas, because it considers the different consumption patterns, and thus avoids people lining up at tap stands. The peak factors used ranging from 1.37 – 3.6.

The Table below gives the section lengths and the corresponding pipe sizes and types:

Table 13 *Distribution Network details*

Pipe size(mm)	Pipe type/class	Section length (m)
Katuna		
110	HDPE PN6	450
90	HDPE PN6	3600
50	HDPE PN6	300
40	HDPE PN6	200
32	HDPE PN6	1,000
25	HDPE PN6	1,000
Total 1		**6,550**
Kabaliisa		
90	HDPE PN6	700
50	HDPE PN6	1000
32	HDPE PN6	700
25	HDPE PN6	200
Total 2		**2,600**
Grand total		**9,150**

The scheme was designed to serve six **(6)** public Water Kiosks with double faucets/outlets, located at maximum walking distance of 250m with regard to the population and flowing at 0.1l/s and 0.2l/s as the minimum and maximum discharges respectively. Forty **(40)** yard taps can also be served under the design, Twenty **(20)** in-house connections were considered (This put into consideration households with in-house water networks system, flush toilet, bath tabs and showers).

6.3.4 Pipeline Summary

Table 14 *Pipe line summary*

Mains	Total Length (m)
TRANSMISSION	7,350
DISTRIBUTION	9,150
TOTAL	**16,500**

6.3.5 Supply Area

Considering the water and sanitation situation in the area, it has been realized that some parts of the supply area have piped water supply systems, a case being Kabaliisa Parish, Rwakakobe. Fringe areas of upper Katuna have an existing GFS.

6.3.6 Intervention Strategy

Kabaliisa GFS needs rehabilitation and areas of focus are the source areas, tap stands and management structure, and extension along Katuna road to serve Kanyanjokye and Rwakakobe. To make Kabalisa sustainable, we propose the system to be metered and an affordable tariff be instituted. However, this option needs political intervention and rigorous sensitization of the communities.

7 SANITATION PROPOSAL

7.1 General

As part of the activities, sanitation and safe hygiene practices associated with the water supply and sanitation facilities shall be promoted.

Alternative sanitation systems like Ecological Sanitation should be explored especially for households because of high water table on the lower part of the town and the hard rocks on the upper part of the part of the town which are hard to excavate for pit latrines.

Ecological sanitation (Eco-san) is an alternative sanitation system that attempts to address the shortcomings of the traditional systems (pit latrines, and flush toilets). It is based on the Eco-system approach and treats human urine and feaces as valuable resource to be recycled and preventing pollution rather than attempting to control it. It takes away smell, reduces quantity to handle and makes the human excreta harmless too be used as fertilizers.

7.2 Eco – san versus conventional system

In comparison to Eco – san toilets, these are some of the disadvantages of the conventional systems of sanitation which would compel one to adapt the Eco - san:

- Most of them contaminate water sources through ground infiltration.
- High risk of disease spread and contamination (disease transmission route, e.g. leaking sewers, sludge production, open defecation).
- Conventional system uses a lot of water and hence reduction in quantity for other uses (especially, flush systems) and considering that the system proposed is a gravity flow, the quantity of water supplied is constant. With increasing population there would be a high need for flushing which would end up in some sort of competition for the different uses.

  Research has shown that on average that a person uses 15,000Litres of water (***drinking water quality***) to flush; this water could be put to other useful purposes. It is easier to handle feaces alone without mixing with the water and urine and feaces potentially dangerous to pollute thousands of litres of safe water.

- They provide an opportunity for vectors to breed, especially leaking sewer which are favorable for pathogens to breed).

7.3 Eco – san versus pit latrines

Pit latrines are most common in these areas and widely used but have their shortcomings;

- Require a lot of land as they keep shifting to different sites when ever the pit is full.
- Contaminates ground water resources as they are normally deep.
- Does not work in areas that are densely populated, flooded, have soft soils, or rocky which was evident during the baseline survey.
- This system above all wastes the nutrient value that is found in the human excreta; urine as a fertilizer, and feaces are very good soil conditioner. Considering that this is an agricultural community, the components would be put to good use.

Basing on the above comparisons, it is generally accepted that eco - san would best suit the community in question. Sanitation promotion will strengthen the need for sanitation facilities while emphasizing hygienic aspects.

8 ENVIRONMENTAL IMPACT ASSESSEMENT (EIA)

EIA is the systematic examination conducted to determine whether or not the project will have any adverse impacts on the environment. Katuna Water Supply and Sanitation Scheme shall pass through forests, steep hill slopes, roads shoulders, cross roads. Therefore, as regards to the scheme, the following impacts have been identified;

a) Abstraction of water from the spring shall have an impact on the natural flora and fauna that has resulted and existed along the stream.
b) Soil erosion (minimal) from construction works along the steep slopes.
c) Interruptions in road traffic during the construction of road crossings
d) Reduction in water related diseases due to the provision within reasonable distances of clean and safe water.

Furthermore, no historic sites shall be interfered with. No population relocation shall be required.

For the above impacts, the following mitigation measures are proposed;

a) Abstraction shall be limited to 70% of yield
b) Soil erosion control
c) Phased road crossing constructions so that traffic is flowing at any one time.
d) Provision of adequate water.

Environmental Impact Assessments for the above mentioned Water and sanitation schemes were carried out and mitigations for the identified negative impacts detailed in the Environmental Impact Statement report. Following the commencement of source protection, it was an Environmental requirement to assess the effectiveness of the proposed mitigations and mitigate any unexpected arising negative impact. Therefore, a team from the Consultant's ventured into field assessment activity.

Methodology

The following methods were used;

- Reviewing site literature
- Site interviews
- Observations
- Taking measurement using a 50m tap measure
- Taking pictures

Areas of interest at the water source points

Environmental (Aquatic and Terrestrial)

- Clearing natural vegetation
- down stream flow interference
- Erosion and land slide
- Water catchment status (fire incidences)

Environmental conservation structures

- Soil and water conservation structures
- Source land fencing
- Tree planting

Environmental Health

- Risk of source eye contamination
- Site safety
- Excreta disposal facility
- Solid waste disposal at site
- Existence of the storm drainage channel

Socio-economic Environment

- Local people availed with job opportunities
- Working relations of the site workers with the community
- Community complaints

8.2 Key impacts and mitigation measures

This presents the key potential impacts of the proposed development and proposes mitigation measures against the adverse ones.

Table 15 *Water point environmental status and restoration plan matrix*

Water source point	Environmental	Environmental conservation structures	Environmental Health	Socio-economic Environment	Recommendation
Rwembogo	- Needs to acquire at least 5,000sqm of land around the source area. - source yield is 1.3 l/s and the design yield is 0.9 l/s there is enough water left for aquatic life, though there will be reduced flow down stream but no significant effect to the aquatic and terrestrial life.	- Fencing off the source catchment area would prevent human activity and animals.	- there are no settlements around the source - No pit Latrines in the vicinity of source area. Ecological Sanitation is required at the source for use during construction and post construction	- Local community availed to the community	- Desist from cutting natural vegetation with an aim of later planting trees - Fencing requirements by improving the size of the holes for fencing poles (60cm by 30cm) and using treated poles, and live fence like phobia, . - List of recommended tree species which include; Prunus Africana, Khaya red mahogany, Lovoa specie, measopsis should be provided to contractors and already existing trees and shrubs

Table 14 contn'd

Water source point	Environmental	Environmental conservation structures	Environmental Health	Socio-economic Environment	Recommendation
Nyakatare	- Needs to acquire at least 5,000sqm of land around the source area. - source yield is 0.9 l/s and the design yield is 0.6 l/s there is enough water left for aquatic life .	-	- there are no settlements around the source - No pit Latrines in the vicinity of source area. Ecological Sanitation is required at the source for use during construction and post construction	- Local community availed with jobs	- Any source protection excavation works should not be done during rainy season - 10 hedge rows to be planted along a distance of 48m upstream - Desist from any activity within 70 meters up stream
Kabalisa (1&2)	- Nearly all natural vegetation has been cut down only grass is left for animals	Though the springs are protected, the entire catchments are in somebody's, firm.	-	- One of the sources only benefits one person, the owner of the land.	- Tree planting is recommended And Surface run off retaining structures constructed.
Kiniogo	- Cultivation is intensive and very close to the spring. Children have made the source area a meeting and playing point. Sanitation around the spring is not good. Likelihood of contaminating the source. - no interference with stream	-no environmental conservation structure in place	- a lot of human activity, likely to lead to contamination of the sources.	Neighboring communities benefit from this source	- Desist from cutting natural vegetation were it is not necessary - More land should be should be secured and fenced off to avoid human activity.

Table 16 *Impact-Effect Mitigation Matrix*

sector activity	Potential impacts	Effects	Mitigation measures	Responsibility
	Negative Impacts			
Pre-construction Phase Land acquisition	• Land in disputes	• delays in project set off	• Land titles secured before any works	Sub county/ WSC DWO
Transportation of Materials	• Silently increased traffic	• Possibility of accidents • dust	• Low speed driving • Watering of the access road	Contractor
Construction Phase Land take	• Change in land use	• Some of Endangered sensitive species extincted • Loss of biodiversity	• Identification of endangered sensitive fauna and flora in the area before development and preserve it or relocate it	Contractor
Source protection	• Soil erosion • Land slides	• Contaminating the water source • Destroying the water source	• Minimising Agricultural and constructional activities around the catchment • Construction of the diversion channels • Contour trenching • Maintenance of the vegetation up stream	Contractor
Demarcation and fencing	• Loss of vegetation/farm crops	• Complaints from community	• Boundaries clearly demarcated before fencing	Sub county/ WSC

Table 15 Contn'd

sector activity	Potential impacts	Effects	Mitigation measures	Responsibility
Bush clearing of site	• Change in land use	• Vegetation destruction • Destruction of wildlife habitats • Soil erosion	• Tree planting • Restore some of the destroyed sites • Establishing procedures for reducing soil erosion around the reservoir and water source point e.g morden methods of farming	Contractor DWO
Excavations	• Quarries/Borrows pits	• Large quantities of materials removed • Vegetation destruction • Large gaping holes • Usual nuisance e.g mosiquitoe breeding sites	• Site restoration after construction • Use of the excavated soil • Tree planting • Soil filling and compacting all holes during and after construction	Contractor
Construction of reservoir tanks and pipe trenches	• Surface Runoff	• Soil Erosion	• Minimal site disturbance • Controlled/checked drainage in soft spots • Slope control • Re-forestation of exposed	Contractor
Occupational health , health and safety of workers	• Accidents • Poor sanitation	• Poor sanitation related diseases	• Projective wear and equipment should be provided • Safety guidelines • Latrine should be provided for the workers • Safe adequate water for drinking and bathing should be provided	Contractor

Table 15 Contn'd

sector activity	Potential impacts	Effects	Mitigation measures	Responsibility
Creation of employment during project construction	• Unexpected population influx to Katuna	• Pressure on meager resource • Altered social order due to population increase • Likely incidence of STIs with a focus on HIV infection	• Most employment opportunities should be given to the residents of the sub – county • Plan for them especially workers' infrastructure such as pit latrines, safe water, security measures etc • HIV/AIDS awareness campaigns	Sub county contractor
Post construction Phase Operation and maintenance	• Increased waste water	• Nuisances e.g mosquito breeding sites	• A drainage system should be put into place	Sub county/WSC
Scheme management	• Poor management	• Non functionality of water points	• Membership to SWUWS which trains water management committees	WSC/DWO/ Sub county

Table 17 *Summary of Environmental monitoring plan*

Issue/Component	**Environmental Indicator**	**Responsibility**
Noise, dust, vibration during construction	- Record of complaints from public	Sub county/DWO/ WSC/
Occupational health and safety of workers and public	- Record of accidents - Health and safety guidelines	Sub county/DWO/ WSC/
Land cover protection during construction	- Evidence of trees planted - Record of compensation for plantations	Sub county/DWO/ WSC/
Soil erosion	- Evidence of bare soils	Sub county/DWO/ WSC/
Streams drying	- Decreased levels of waters flowing in the streams	Sub county/DWO/ WSC/
Mismanagement of the scheme	- Records of complaints from the public - High rate of non-functionality of the water points	Sub county/DWO/ WSC/

8.3 Positive impacts of the Project

Socio-economic

Water supply: Safe water coverage in Katuna will increase to nearly 100%. This is because the scheme target is to cover all the population in the area.

Sanitation: The poor sanitation in terms of poor conditions and status of the existing structures will change for the better through sanitation awareness campaigns and ecological sanitation toilets construction and promotion.

Employment: A good number of people will be employed by the project to carry out different services or through sale of some of the locally available construction materials required.

Bio-physical Environment

Vegetation cover will increase as a result of the environmental protection programme. Under this programme trees will be planted to protect the soil and improve the authenticity of the area with in the protection area especially the source area.

9 OPERATION AND MAINTENANCE STRATEGY

Sustainability of water and sanitation systems through proper and effective Operation and Maintenance has been recognized by government as a priority activity in order to safeguard infrastructural investments. It is widely acknowledged that most projects fail due to inappropriate O & M. The root of this state of affairs varies from political to social, technical and economic considerations, among which problems of inadequate management have been identified as a constraint.

The O & M strategy must be laid in the planning phase to emphasize the need to sustain the investment for the economic and the social good of every stakeholder especially the beneficiaries. It was established that the existing water supply is not fully functional because there is no management structure in place. The two most feasible management options which have emerged are as outlined below:

Option 1: The Katuna local authority (sub county) as the provider and overseer of basic social services, delegate the management of the water supply and sanitation facilities to the proposed Katuna Water users Association (KAWU) through a Memorandum-of-Understanding that would require the KAWU to contract out the day – to -day operations of the facilities directly to a private sector utility operator which can be a legal entity or an individual.

Option 2: The Katuna local authority (Sub County) as the provider and overseer of the basic social services, directly enter into a management contract with a private sector utility operator which can be a legal entity or an individual for the operation and maintenance of the water supply and sanitation facilities. However, the town council delegates management and day-to-day operation oversight of service delivery activities to the KAWU through a Memorandum-of-Understanding.

To achieve the above stated, below are strategies which if implemented will result in a self sustaining Water supply system.

1) The community shall select a Water and Sanitation Implementation committee (WSC) comprising of eleven members of which at least six shall be women. This committee shall help in mobilization of community members during implementation of the scheme. They will work on behalf of the community to execute all community obligations on their behalf including supervision and monitoring. This committee shall be trained and sensitized about water and sanitation activities, and their roles as community representatives.

2) After implementation of the scheme, the sub county in which this scheme shall elect a Water and Sanitation Board from the water user association comprising of five members three of which are from the community, one a sub county chief and one member a councilor in water in charge of social services. To emphasize on Gender balance at least two members shall be Women.
3) The Water Supply and Sanitation Board (WSSB) shall open a bank account in the names of Katuna Water Supply and Sanitation Scheme, on which deposits can be made accruing form the water sales and any other income generating activities. The signatories to the account shall be three.
4) They shall employ a Scheme Operator/private operator who will be responsible for the day to day running of the scheme. In this proposal, a provision for training a scheme Operator (SO) has been considered under the soft ware component The Scheme Operator shall undergo training in management, accounting and budgeting and record/book keeping. The scheme operator/private operator shall be answerable to the Water and Sanitation Board.
5) The community as the end users should pay for the services provided, that is, pay for water services and sanitation services to meet the O & M costs. The fee shall be determined by the WSC together with implementing partner during test running. However, this option needs political intervention and rigorous sensitization of the communities.
6) It is highly recommended that in the short term plan the scheme should employ the Scheme Operator shall be paid an agreed percentage of the total collections, as a baseline 40% can be considered for the scheme to be able save some money for sustainability and in the long run services of a private operator can be procured.
7) It is also highly recommended that the scheme should apply to the South Western Umbrella of Water and Sanitation (SWUWS) funded by the Directorate of Water Development (DWD) and will benefit from pooling together resources with other schemes. SWUWS is an association of water users represented by their Water Supply and Sanitation Boards (WSSB).

The DWO will use the guidelines below to conduct O & M training for future user communities. The training will target leaders within the community; the Sub county leaders, Executive members of LC III council, heads of institutions within the water supply area, Opinion leaders, Representatives of persons with private connections, Extension staff and WSC members, WSSB members and SO applicants on he roles and responsibilities of each stake holder to avoid conflict.

O & M training will be conducted in four days and techniques applied include;
(*See annex for the training guide*)

- Brain storming
- Participatory lecture
- Group discussions

Evaluation of the training will be done at the end of each day and interviews for SO conducted at end of the training.

Goal

Equip essential actors in O & M with knowledge to manage the constructed systems sustainably.

Objectives

By the end of the training participants should be able to;

i) Understand the management of water and sanitation systems.
ii) Get an overview of O & M
iii) Identify actors in O & M and their respective roles and responsibilities in scheme management.
iv) Gain knowledge on daily operations of the scheme.
v) Know the basics of taking meter readings and making proper records.
vi) Describe the layout of the scheme with all hydraulic constructions, their use and maintenance schedule.
vii) Recognize the importance of keeping proper records and be able to keep proper records for water and sanitation scheme.
viii) Grasp basics in checking money records
ix) Know the importance of budgeting, and the budgeting process.

10 RECOMEDATIONS AND CONCLUSIONS

10.1 Conclusion

1) The springs from Nyakatare and Rwembogo should be combined to serve the main Katuna area up to the end point in Mukarangye. Both springs are currently used by communities around them.
2) From the feasibility study carried out, it was recommended that the Kabaliisa Scheme needs to be rehabilitated and extended to serve Rwakakobe and Nyamengo communities.
3) However, for some minimal impacts identified, mitigation measures have been recommended This general conclusion is therefore, that the project can be implemented provided that the stakeholders implements the mitigation measures recommended by this study.

10.2 Recommendations

1. The community should be involved from the start to avoid chickening out on their respective responsibilities and especially the local people should be given priority for skilled and semi – skilled jobs.
2. For sustainability, we propose the system should be metered except the community taps at the sources; this will reduce on the water wastages, misuse and for proper accountability of the user fees generated.
3. Land take should be adequately compensated and land titles processed
4. Eco-san toilets should be encouraged as an alternative sanitation system, since it attempts to address the shortcomings of the traditional systems preventing pollution rather than attempting to control it.

11 ANNEXES:

1) Demand Projections.
2) Water quality analysis report.
3) Survey results.
4) Hydraulic design.
5) Pressure vs. Time at Tap stands
6) O&M Training Guide
7) Detailed Cost estimate (Bills of quantities)
8) Drawings (schematic layout, profiles, hydraulic structures).

Water demand projections

Population equivalent gives the calculated amount of consumers reduced to an average per capita consumption of 25 liters per day. It helps to establish the actual population served. This and sheet is for the line using Rwembogo and Nyakatare Sources, so it does not include communities and institutions of Kabaliisa, Rwakakobe and Nyamengo which will be supplied by the aliisa source

ent population in Katuna	2476	Average amount of family members per hh	6
of people supplied with tap stands	75	Population growth rate [%]	3
of people supplied with yard connections	20	Design Period [years]	20
of people supplied with inhouse connections	5	Multiplying factor	1.81

Item	Consumption [l / capita]	Current Population served	Current Demand [l/day]	Current Demand [l/s]	Projected Demand [l/s]	7:00 - 10:00 (30%) [l/s]	10:00 - 17:00 (40%) [l/s]	17:00 - 19:00 (30%) [l/s] PEAK DEMAND	PE Factor	Current Population Equivalent	Projected Population Equivalent
mestic											
ople served with Tapstands	25	1857	46425	0.537	0.970	2.329	1.331	3.494	1.00	1857	3354
ople served with Yard Connections	40	495.2	19808	0.229	0.414	0.994	0.568	1.491	1.60	792	1431
ople served with Indoor Connections	80	123.8	9904	0.115	0.207	0.497	0.284	0.745	3.20	396	716
titutions											
chools											
y School 1 - International Nursery School	6	110	660	0.008	0.014	0.033	0.019	0.050	0.24	26	48
y School 2 - Little angels	6	39	234	0.003	0.005	0.012	0.007	0.018	0.24	9	17
y School 3 - Katuna P/S	6	409	2454	0.028	0.051	0.123	0.070	0.185	0.24	98	177
y School 4 - Mayengo P/S	6	378	2268	0.026	0.047	0.114	0.065	0.171	0.24	91	164
arding School 1 - Mukarangye PS	25	362	9050	0.105	0.189	0.454	0.259	0.681	1.00	362	654
lealth institutions											
spensary - Name (No. of IDP)	100		0	0.000	0.000	0.000	0.000	0.000	4.00	0	0
spensary - Name	20		0	0.000	0.000	0.000	0.000	0.000	0.80	0	0
alth center - Name (No. of IPD)	100		0	0.000	0.000	0.000	0.000	0.000	4.00	0	0
alth center - Kamuganguzi health centre	20	150	3000	0.035	0.063	0.151	0.086	0.226	0.80	120	217
spital (ID patients)	100		0	0.000	0.000	0.000	0.000	0.000	4.00	0	0
spital (OD patients)	20		0	0.000	0.000	0.000	0.000	0.000	0.80	0	0
spital (staff and family)	25		0	0.000	0.000	0.000	0.000	0.000	1.00	0	0
Churches and Mosques											
urch 1 - Mukarange Romas Catholic	6	600	3600	0.042	0.075	0.181	0.103	0.271	0.24	144	260
urch - Mukarange COU	6	510	3060	0.035	0.064	0.154	0.088	0.230	0.24	122	221

Water demand projection continued

Item	Consumption [l / capita]	Current Population served	Current Demand [l/day]	Current Demand [l/s]	Projected Demand [l/s]	7:00 - 10:00 (30%) [l/s]	10:00 - 17:00 (40%) [l/s]	17:00 - 19:00 (30%) [l/s] PEAK DEMAND	PE Factor	Current Population Equivalent	Projected Population Equivalent
osque 2 - Katuna Mosque	6	3	18	0.000	0.000	0.001	0.001	0.001	0.24	1	1
urch 3 - Katuna Roman Catholic	6	5	30	0.000	0.001	0.002	0.001	0.002	0.24	1	2
urch 4 - (No. of residents)	6		0	0.000	0.000				0.24	0	0
urch 5 - St. Emmanuel's Mayengo COU	6	10	60	0.001	0.001	0.003	0.002	0.005	0.24	2	4
Hotels and Restaurants											
tel 1 - Name (No. of persons per night)	80		0	0.000	0.000	0.000	0.000	0.000	3.20	0	0
tel 2 - Name (No. of persons per night)	80		0	0.000	0.000	0.000	0.000	0.000	3.20	0	0
dge 1 - Name (No. of persons per night)	40		0	0.000	0.000	0.000	0.000	0.000	1.60	0	0
dge 2 - Name (No. of persons per night)	40		0	0.000	0.000	0.000	0.000	0.000	1.60	0	0
staurant 1 - Name (No. of guests per day)	6		0	0.000	0.000	0.000	0.000	0.000	0.24	0	0
staurant 2 - Name (No. of guests per day)	6		0	0.000	0.000	0.000	0.000	0.000	0.24	0	0
staurant 3 - Name (No. of guests per day)	6		0	0.000	0.000	0.000	0.000	0.000	0.24	0	0
staurant 4 - Name (No. of guests per day)	6		0	0.000	0.000	0.000	0.000	0.000	0.24	0	0
Government institution											
bcounty headquater (No. of residents)	25		0	0.000	0.000	0.000	0.000	0.000	1.00	0	0
bcounty headquater (No. of staff bers)	6		0	0.000	0.000	0.000	0.000	0.000	0.24	0	0
Other institutions									0.00	0	0
tuna Customs and Immigration	6	107	642	0.007	0.013	0.032	0.018	0.048	0.24	26	46
			101213	**1.171**	**2.116**	**5.078**	**2.902**	**7.617**		**4049**	**7312**

Water quality test results

Site/source	Appearance	Odour	pH	Turbidity (TU)	Electrical conductivity(µS/cm)	Temperature(0C)	Chlorides(mg/l)	Nitrite(mg/l) as N	Iron (mg/l)	Total Coliforms(cfu/100ml)	Faecal coliforms E-Coli cfu/100ml	Total Hardness(mg/l) as $CaCO_3$
Kinioga	Colourless	Odourless	4.99	0.8	220	23.5	6	0.13	1.2	0	0	80
Rwembogo	Colourless	Odourless	5	1	240	22.5	6	0.14	1.2	0	0	76
Nyakatare	Colourless	Odourless	5	0.7	250	23.5		0.14	1.1	0	0	82
Kabaliisa	Colourless	Odourless	5.5	0.8	230	20.6		0.12	1.1	0	0	100
Uganda National guideline Values for Rural Drinking H2O			6.5 -8.5	10	NG	Acceptable	250	1	1	NG	0	600
Maximum Allowable Concentration			5.5-9.5	30	NG	Acceptable	500	1	2	NG	50	800

Note:

NG-Not Given

Survey results

Transmission main from Rwembogo source to reservoir tank

Stn	Pt	Hm	Hu	Hl	Check	Angle	Ds	S Distance	dH	Sum dH	Remark
0								0.00		300.00	
2	1	**2**	2.079	1.921	**2**	**77.67**	**15.4**		-3.30		protected Spring Rwembogo source
	3	**2**	2.335	1.665	**2**	**96.53**	**66.6**	82.00	- 7.57	289.13	Open fields
4	3	**2**	2.181	1.82	**2.0005**	**92.03**	**36.1**		1.28		
	5	**2**	2.341	1.66	**2.0005**	**95.8**	**67.8**	185.83	- 6.85	283.57	"
6	5	**2**	2.154	1.847	**2.0005**	**80.9**	**30.3**		- 4.79		
	7	**2**	2.248	1.752	**2**	**90.6**	**49.6**	265.74	-0.52	278.25	"
8	7	**2**	2.258	1.743	**2.0005**	**80.51**	**50.8**		-8.37		
	9	**2**	2.51	1.489	**1.9995**	**98.47**	**101.0**	417.52	-4.87	255.00	"
10	9	**2**	2.435	1.564	**1.9995**	**82.06**	**86.3**		-11.92		
	11	**2**	2.511	1.489	**2**	**92.27**	**102.1**	605.91	- 4.04	239.04	"
12	11	**2**	2.171	1.828	**1.9995**	**90.2**	**34.3**		0.12		
	13	**2**	2.125	1.875	**2**	**93.16**	**25.0**	665.17	-1.38	237.78	Tap 1 at sabiti s home
14	13	**2**	2.074	1.916	**1.995**	**74.98**	**15.3**		-3.95		
	15	**2**	2.045	1.955	**2**	**111.9**	**8.4**	688.78	-3.11	230.72	Rocky area and pranted trees begins here
16	15	**2**	2.127	1.872	**1.9995**	**76.53**	**24.8**		-5.78		
	17	**2**	2.212	1.787	**1.9995**	**100.33**	**41.8**	755.39	-7.50	217.44	End of Rocky area
18	17	**2**	2.344	1.657	**2.0005**	**88.47**	**68.7**		-1.83		
	19	**2**	2.197	1.803	**2**	**103.96**	**38.2**	862.30	- 9.22	206.38	At Sahabina s home (Break pressure tank location)
20	19	**2**	2.169	1.83	**1.9995**	**82.96**	**33.6**		-4.12		
	21	**2**	2.11	1.889	**1.9995**	**77**	**21.5**	917.48	4.84	207.10	Planted trees
22	21	**2**	2.145	1.855	**2**	**87.75**	**29.0**		-1.14		
	23	**2**	2.159	1.84	**1.9995**	**94.75**	**31.8**	978.25	-2.63	203.33	"
24	23	**2**	2.285	1.715	**2**	**90.96**	**57.0**		0.95		
	25	**2**	2.151	1.849	**2**	**89.65**	**30.2**	1065.44	0.18	204.47	**"**
26	25	**2**	2.089	1.911	**2**	**68.59**	**16.6**		-6.05		
	27	**2**	2.109	1.891	**2**	**105.08**	**21.0**	1103.06	-5.48	192.95	"
28	27	**2**	2.119	1.88	**1.9995**	**65.57**	**21.8**		- 9.00		
	29	**2**	2.399	1.601	**2**	**92.38**	**79.7**	1204.55	-3.31	180.64	"
30	29	**2**	2.108	1.891	**1.9995**	**93.02**	**21.7**		1.14		
	31	**2**	2.121	1.88	**2.0005**	**102.9**	**23.5**	1249.71	-5.24	176.53	"
32	31	**2**	2.089	1.911	**2**	**78.06**	**17.4**		- 3.60		
	33	**2**	2.259	1.741	**2**	**105.43**	**49.9**	1317.06	- 3.29	159.65	Bihind Banshabire s house
34	33	**2**	2.039	1.961	**2**	**67.5**	**7.2**		- 2.76		
	35	**2**	2.137	1.864	**2.0005**	**88.53**	**27.3**	1351.56	0.70	157.59	Magara shouse
36	35	**2**	2.043	1.957	**2**	**72.75**	**8.2**		- 2.44		
	37	**2**	2.189	1.811	**2**	**110.22**	**35.5**	1395.24	-12.26	142.89	
38	37	**2**	2.139	1.86	**1.9995**	**71.12**	**26.4**		-8.54		
	39	**2**	2.158	1.842	**2**	**111.35**	**29.4**	1451.07	-10.71	123.64	
40	39	**2**	2.13	1.87	**2**	**70.84**	**24.6**		-8.06		
	41	**2**	2.31	1.69	**2**	**96.87**	**61.6**	1537.19	-7.36	108.21	PBM Bishops guest house
42	41	**2**	2.287	1.713	**2**	**88.01**	**57.4**		-1.99		
	43	**2**	2.224	1.775	**1.9995**	**90.74**	**44.9**	1639.45	- 0.58	105.64	kamuganguzi s.s
44	43	**2**	2.247	1.751	**1.999**	**86.06**	**49.5**		-3.40		
	45	**2**	2.326	1.675	**2.0005**	**90.19**	**65.1**	1754.03	-0.22	102.02	

Transmission main from Rwembogo source to reservoir tank continued

46	45	**2**	2.328	1.672	**2**	**87.64**	**65.5**		-2.70		
	47	**2**	2.465	1.535	**2**	**91.35**	**93.0**	1912.55	-2.19	97.13	
48	47	**2**	2.354	1.645	**1.9995**	**89.07**	**70.9**		-1.15		
	49	**2**	2.449	1.551	**2**	**89.24**	**89.8**	2073.23	.19	97.18	PBM at sign post of kamuganguzi s.s
50	49	**2**	2.528	1.473	**2.0005**	**90.31**	**105.5**		0.57		
	51	**2**	2.508	1.491	**1.9995**	**89.62**	**101.7**	2280.43	0.67	98.42	PBM Jn to Kabura / Nyakatare
52	51	**2**	2.519	1.481	**2**	**90.37**	**103.8**		-0.67		
	53	**2**	2.359	1.642	**2.0005**	**89.18**	**71.7**	2455.92	1.03	98.78	Along the main road to Katuna
54	53	**2**	2.57	1.43	**2**	**90.03**	**114.0**		- 0.06		
	55	**2**	2.742	1.259	**2.0005**	**90.19**	**148.3**	2718.22	-0.49	98.22	"
56	55	**2**	2.468	1.531	**1.9995**	**89.65**	**93.7**		0.57		
	57	**2**	2.714	1.288	**2.001**	**89.91**	**142.6**	2954.52	0.22	99.02	"
58	57	**2**	2.381	1.619	**2**	**91.09**	**76.2**		-1.45		
	59	**2**	2.663	1.336	**1.9995**	**88.34**	**132.6**	3163.35	3.84	101.41	Kamuganguzi health centre 111 about 300m off
60	59	**2**	2.511	1.489	**2**	**89.6**	**102.2**		0.71		
	61	**2**	2.535	1.466	**2.0005**	**91.38**	**106.9**	3372.41	- 2.57	99.55	Tap 2 at Baguma
62	61	**2**	2.577	1.424	**2.0005**	**88.99**	**115.3**		2.03		
	63	**2**	2.603	1.397	**2**	**89.6**	**120.6**	3608.29	0.84	102.43	kamuganguzi trading centre Tap 3
64	63	**2**	2.588	1.411	**1.9995**	**90.05**	**117.7**		- 0.10		
	65	**2**	2.587	1.411	**1.999**	**89.55**	**117.6**	3843.59	0.92	103.25	Along Katuna road
66	65	**2**	2.694	1.306	**2**	**91.11**	**138.8**		- 2.69		
	67	**2**	2.665	1.335	**2**	**88.59**	**133.0**	4115.32	3.27	103.83	"
68	67	**2**	2.546	1.456	**2.001**	**90.26**	**109.0**		- 0.49		
	69	**2**	2.699	1.3	**1.9995**	**90.68**	**139.9**	4364.21	- 1.66	101.68	"
70	69	**2**	2.505	1.495	**2**	**88.89**	**101.0**		1.96		
	71	**2**	2.579	1.422	**2.0005**	**90.64**	**115.7**	4580.88	- 1.29	102.34	"
72	71	**2**	2.435	1.566	**2.0005**	**88.92**	**86.9**		- 1.64		
	73	**2**	2.632	1.366	**1.999**	**90.48**	**126.6**	4794.36	- 1.06	99.64	Tap 4 in Nyamirima village
74	73	**2**	2.444	1.557	**2.0005**	**89.83**	**88.7**		-0.26		
	75	**2**	2.419	1.582	**2.0005**	**89.68**	**83.7**	4966.76	0.47	99.85	PBM at Existing R.Tank
76	75	**2**	2.382	1.619	**2.0005**	**90.82**	**76.3**		1.09		
	77	**2**	2.451	1.548	**1.9995**	**88.63**	**90.3**	5133.33	2.16	103.10	Along the road to Katuna
78	77	**2**	2.336	1.663	**1.9995**	**89.36**	**67.3**		-0.75		
	79	**2**	2.435	1.565	**2**	**89.06**	**87.0**	5287.61	1.43	103.77	"
80	79	**2**	2.434	1.566	**2**	**89.39**	**86.8**		-0.92		
	81	**2**	2.481	1.519	**2**	**89.85**	**96.2**	5470.61	0.25	103.10	Jn to Mayengo C.OU. Sign post
82	81	**2**	2.29	1.71	**2**	**100.46**	**57.0**		0.35		
	83	**2**	2.314	1.688	**2.001**	**77.32**	**61.1**	5588.72	3.41	126.86	End point at Proposed R. Tank

Nyakatare source to line from Rwembogo source

Stn	Pnt	Hm	Hu	Hl	Check	Angle	Ds	S Distance	dH	Sum dH	Remark
0								0.00		100.00	
2	1	**2**	2.32	1.68	**2**	**79.15**	**62.9**		-11.83		Nyakatare source
	3	**2**	2.522	1.477	**1.9995**	**99.19**	**103.2**	166.01	-16.48	71.69	Kiregyeya s farm
4	3	**2**	2.268	1.732	**2**	**81.62**	**53.0**		- 7.73		
	5	**2**	2.123	1.875	**1.999**	**97.22**	**24.6**	243.65	- 3.09	60.87	
6	5	**2**	2.23	1.77	**2**	**93.98**	**45.9**		3.19		
	7	**2**	2.092	1.907	**1.9995**	**87.06**	**18.5**	308.01	0.95	65.01	
8	7	**2**	2.24	1.76	**2**	**89.63**	**48.0**		- 0.31		
	9	**2**	2.151	1.849	**2**	**84.36**	**30.1**	386.06	2.95	67.65	At Bamwanga s Residance
10	9	**2**	2.298	1.703	**2.0005**	**82.67**	**59.0**		-7.53		
	11	**2**	2.148	1.851	**1.9995**	**96.14**	**29.5**	474.61	- 3.16	56.96	
12	11	**2**	2.33	1.669	**1.9995**	**87**	**66.0**		- 3.45		
	13	**2**	2.422	1.579	**2.0005**	**91.34**	**84.3**	624.89	-1.97	51.54	
14	13	**2**	2.262	1.738	**2**	**93.5**	**52.3**		3.19		
	15	**2**	2.139	1.862	**2.0005**	**82.47**	**27.5**	704.66	3.60	58.33	
16	15	**2**	2.314	1.687	**2.0005**	**84.23**	**62.4**		- 6.27		
	17	**2**	2.4	1.6	**2**	**95.84**	**79.6**	846.62	- 8.10	43.96	Kabura trading centre.
18	17	**2**	2.291	1.708	**1.9995**	**85.43**	**58.1**		- 4.63		
	19	**2**	2.308	1.691	**1.9995**	**90.25**	**61.7**	966.44	- 0.27	39.06	
20	19	**2**	2.273	1.727	**2**	**88.16**	**54.6**		- 1.75		
	21	**2**	2.265	1.735	**2**	**90.32**	**53.0**	1074.01	- 0.30	37.01	
22	21	**2**	2.291	1.709	**2**	**86.74**	**58.1**		-3.30		
	23	**2**	2.34	1.66	**2**	**91.17**	**68.0**	1200.10	- 1.39	32.32	
24	23	**2**	2.42	1.582	**2.001**	**88.55**	**83.8**		- 2.12		
	25	**2**	2.335	1.665	**2**	**88.54**	**67.0**	1350.85	1.71	31.90	At PBM Jn to Nyakatare

Katuna town Distribution main

Stn	Pnt	Hm	Hu	Hl	Check	Angle	Ds	S Distance	dH	Sum dH	Remark
0								0.00		100.00	
2	1	**2**	2.31	1.691	**2.0005**	**77.32**	**60.4**		- 3.26		Proposed R.Tank
	3	**2**	2.291	1.709	**2**	**100.54**	**57.2**	117.61	-10.47	76.28	PBM Jn to Mayengo C.O.U-katuna road
4	3	**2**	2.3	1.7	**2**	**89.16**	**60.0**		- 0.88		
	5	**2**	2.459	1.542	**2.0005**	**89.9**	**91.7**	269.30	0.16	75.56	Tinka s house TAP.5 katuna town
6	5	**2**	2.349	1.65	**1.9995**	**89.43**	**69.9**		-0.70		
	7	**2**	2.499	1.501	**2**	**89.84**	**99.8**	439.00	0.28	75.14	Twesime s house TAP.6 katuna town
8	7	**2**	2.487	1.514	**2.0005**	**89.74**	**97.3**		- 0.44		
	9	**2**	2.535	1.465	**2**	**89.88**	**107.0**	643.30	0.22	74.92	Bajara s Steven TAP.7
10	9	**2**	2.251	1.748	**1.9995**	**90.05**	**50.3**		0.04		
	11	**2**	2.258	1.742	**2**	**89.56**	**51.6**	745.20	0.40	75.36	Byekwaso Yusufu TAP. 8
12	11	**2**	2.198	1.802	**2**	**90.34**	**39.6**		0.23		
	13	**2**	2.451	1.549	**2**	**91.48**	**90.2**	874.96	- 2.33	73.27	Just across first gate. Katuna customs bldg TAP.9
14	13	**2**	2.155	1.845	**2**	**91.09**	**31.0**		0.59		
	15	**2**	2.32	1.681	**2.0005**	**89.78**	**63.9**	969.86	0.25	74.11	Byenaku s house. Along Rubaya road. TAP.10
16	15	**2**	2.236	1.764	**2**	**90.33**	**47.2**		0.27		
	17	**2**	2.47	1.529	**1.9995**	**89.49**	**94.1**	1111.15	0.84	75.21	Musinga s house TAP.11
18	17	**2**	2	1.728	**1.9995**	**90.01**	**54.3**		0.01		
	19	**2**	2.575	1.426	**2.0005**	**90.78**	**114.9**	1280.34	- 1.56	73.66	Richard s house TAP.12
20	19	**2**	2.461	1.539	**2**	**91.26**	**92.2**		2.03		
	21	**2**	2.62	1.379	**1.9995**	**91.05**	**124.1**	1496.60	- 2.27	73.41	Katuna p/s 200m off TAP.13 And TAP.14 at Musime
22	21	**2**	2.36	1.64	**2**	**90.74**	**72.0**		0.93		
	23	**2**	2.381	1.62	**2.0005**	**88.22**	**76.1**	1644.66	2.36	76.71	TAP.15 at katabagwa s house. Rubaya Road
24	23	**2**	2.263	1.738	**2.0005**	**87.88**	**52.5**		- 1.94		
	25	**2**	2.369	1.632	**2.0005**	**90.36**	**73.7**	1770.82	- 0.46	74.30	TAP. 16 at Hajji Nzirwe s house.
26	25	**2**	2.36	1.641	**2.0005**	**90.55**	**71.9**		0.69		
	27	**2**	2.313	1.688	**2.0005**	**90.34**	**62.5**	1905.22	- 0.37	74.62	End of katuna town TAP.17 at Kyenkobe s
28	27	**2**	2.321	1.679	**2**	**89.99**	**64.2**		- 0.01		
	29	**2**	2.56	1.44	**2**	**89**	**112.0**	2081.40	1.95	76.56	Along Rubaya road
30	29	**2**	2.427	1.572	**1.9995**	**91.19**	**85.5**		1.78		
	31	**2**	2.461	1.539	**2**	**89.17**	**92.2**	2259.07	1.34	79.68	"
32	31	**2**	2.529	1.47	**1.9995**	**90.04**	**105.9**		0.07		
	33	**2**	2.429	1.57	**1.9995**	**89.99**	**85.9**	2450.87	0.01	79.76	TAP.18 at Ketti s residance
34	33	**2**	2.57	1.429	**1.9995**	**89.01**	**114.1**		- 1.97		
	35	**2**	2.405	1.594	**1.9995**	**88.94**	**81.1**	2646.04	1.50	79.29	Protected spring existing 10m off
36	35	**2**	2.369	1.63	**1.9995**	**89.59**	**73.9**		- 0.53		
	37	**2**	2.589	1.411	**2**	**91.07**	**117.8**	2837.72	- 2.20	76.56	
38	37	**2**	2.443	1.559	**2.001**	**90.01**	**88.4**		0.02		

Katuna town Distribution main continued

	39	**2**	2.39	1.61	**2**	**89.96**	**78.0**	**3004.12**	0.05	76.63	TAP.19 at Julius Maney changer s house
40	39	**2**	2.49	1.51	**2**	**89.64**	**98.0**		- 0.62		
	41	**2**	2.646	1.355	**2.0005**	**89.61**	**129.1**	**3231.21**	0.88	76.90	Jn to Mukarangye P/S. Its on a high hill
42	41	**2**	2.396	1.603	**1.9995**	**90.43**	**79.3**		0.60		
	43	**2**	2.41	1.591	**2.0005**	**88.42**	**81.9**	**3392.38**	2.26	79.75	Along katuna road
44	43	**2**	2.671	1.329	**2**	**90.14**	**134.2**		0.33		
	45	**2**	2.461	1.54	**2.0005**	**89.49**	**92.1**	**3618.67**	0.82	80.90	TAP. 20 at sana s house
46	45	**2**	2.521	1.48	**2.0005**	**90.01**	**104.1**		0.02		
	47	**2**	2.61	1.389	**1.9995**	**89.05**	**122.1**	**3844.86**	2.02	82.94	TAP. 21 at Twebaze s residance
48	47	**2**	2.383	1.618	**2.0005**	**89.14**	**76.5**		- 1.15		
	49	**2**	2.299	1.702	**2.0005**	**90.14**	**59.7**	**3981.05**	- 0.15	81.65	TBM Jn to Ryaruhinda village
50	49	**2**	2.321	1.68	**2.0005**	**87.8**	**64.1**		- 2.46		
	51	**2**	2.49	1.509	**1.9995**	**89.61**	**98.1**	**4143.20**	0.67	79.85	End point Mukarangye trading centre Tap.22 At late bantu Residence

Branch to Ryaruhindi Village

Stn	**Pnt**	**Hm**	**Hu**	**Hl**	**Check**	**Angle**	**Ds**	**S Distance**	**dH**	**Sum dH**	**Remark**
2	1	**2**	2.295	1.706	**2.0005**	**90.67**	**58.9**		- 0.69	81.65	TBM Jn to Ryaruhinda village
	3	**2**	2.388	1.612	**2**	**87.41**	**77.5**	136.42	3.50	85.15	Protected spring 6m off this point
4	3	**2**	2.078	1.923	**2.0005**	**91.13**	**15.5**		-0.31		
	5	**2**	2.28	1.72	**2**	**92.66**	**55.9**	207.85	- 2.60	82.25	Along the road to Ryaruhinda area
6	5	**2**	2.202	1.798	**2**	**88.72**	**40.4**		0.90		
	7	**2**	2.271	1.729	**2**	**87.55**	**54.2**	302.39	2.31	85.46	"
8	7	**2**	2.125	1.874	**1.9995**	**92.29**	**25.1**		- 1.00		
	9	**2**	2.112	1.888	**2**	**88.33**	**22.4**	349.86	0.65	85.11	At Katabazi Residance
10	9	**2**	2.237	1.763	**2**	**90.46**	**47.4**		- 0.38		
	11	**2**	2.208	1.791	**1.9995**	**84.6**	**41.5**	438.78	3.91	88.64	Two Protected springs 3m off this point
12	11	**2**	2.119	1.881	**2**	**92.45**	**23.8**		- 1.02		
	13	**2**	2.22	1.78	**2**	**82.63**	**43.6**	506.19	5.60	93.22	Rwamafa Residance
14	13	**2**	2.138	1.863	**2.0005**	**95.9**	**27.4**		-2.81		
	15	**2**	2.163	1.836	**1.9995**	**82.36**	**32.4**	565.96	4.31	94.72	End point at Mbarara s Residance. TAP 23

Kabaliisa Distribution network

Stn	Pnt	Hm	Hu	Hl	Check	Angle	Ds	S Distance	dH	Sum dH	Remark
	1001							0.00		100.00	
1002	1001	**2**	2.076	1.925	**2.0005**	**83.66**	**15.0**		- 1.66		Reservoir Tank Position
	1003	**2**	2.393	1.607	**2**	**92.3**	**78.5**	93.54	- 3.15	95.19	At Bamwanga/Along Rd.
1004	1003	**2**	2.355	1.646	**2.0005**	**89.7**	**70.9**		0.37		
	1005	**2**	2.258	1.742	**2**	**92.1**	**51.6**	216.01	- 1.89	92.93	Tap 1 Jack
1006	1005	**2**	2.188	1.812	**2**	**88.29**	**37.6**		- 1.12		
	1007	**2**	2.094	1.905	**1.9995**	**93.4**	**18.9**	272.46	- 1.12	90.69	Along Line
1008	1007	**2**	2.145	1.854	**1.9995**	**83.12**	**28.9**		- 3.46		
	1009	**2**	2.152	1.848	**2**	**98.42**	**30.1**	331.42	- 4.40	82.83	Tap 2 Makosa Henry
1010	1009	**2**	2.358	1.64	**1.999**	**84.58**	**71.5**		- 6.75		
	1011	**2**	2.283	1.715	**1.999**	**90.8**	**56.8**	459.69	- 0.79	75.28	Tap 3 Mburaburirwe
1012	1011	**2**	2.268	1.731	**1.9995**	**88.2**	**53.7**		- 1.69		
	1013	**2**	2.289	1.712	**2.0005**	**88**	**57.7**	571.03	2.01	75.61	
1014	1013	**2**	2.168	1.832	**2**	**84.37**	**33.4**		- 3.28		
	1015	**2**	2.145	1.855	**2**	**97.15**	**28.8**	633.25	- 3.58	68.75	Tap 4 Fred Mwerinde
1016	1015	**2**	2.118	1.883	**2.0005**	**83.1**	**23.3**		- 2.80		
	1017	**2**	2.05	1.95	**2**	**85.43**	**10.0**	666.54	0.79	66.74	Tap 5 at PBM Jn to the main road
1018	1017	**2**	2.105	1.895	**2**	**85.87**	**20.9**		- 1.51		
	1019	**2**	2.815	1.185	**2**	**89.63**	**163.0**	850.49	1.05	66.28	Tap 6 Rukara Grace

Branch to Kamuganguzi C.O.U, PS & SS

Stn	Pnt	Hm	Hu	Hl	Check	Angle	Ds	S Distance	dH	Sum dH	Remark
								666.54		66.74	PBM Jn to the main road
2		**2**	2.129	1.87	**1.9995**	**85.72**	**25.8**		-1.93		
		2	2.632	1.388	**2.01**	**90.57**	**124.4**	816.77	- 1.24	63.57	Tap 7 at kabatereine.
4		**2**	2.181	1.821	**2.001**	**88.8**	**36.0**		- 0.75		
	5	**2**	2.13	1.87	**2**	**91.32**	**26.0**	878.75	- 0.60	62.22	PBM at kamuganguzi s.s sign post
6	5	**2**	2.439	1.561	**2**	**89.17**	**87.8**		- 1.27		
	7	**2**	2.821	1.179	**2**	**88.73**	**164.2**	1130.70	3.64	64.59	Along the road to kamuganguzi s.s and a tap 8 for s.s
8	7	**2**	2.376	1.625	**2.0005**	**91.68**	**75.1**		2.20		
	9	**2**	2.367	1.633	**2**	**88.4**	**73.4**	1279.14	2.05	68.84	
10	9	**2**	2.175	1.825	**2**	**92.37**	**35.0**		1.45		
	11	**2**	2.429	1.57	**1.9995**	**88.27**	**85.9**	1399.97	2.59	72.87	Tap 9 for kamuganguzi C.O.U
12	11	**2**	2.112	1.888	**2**	**88.03**	**22.4**		-0.77		
	13	**2**	2.31	1.689	**1.9995**	**88.7**	**62.1**	1484.44	1.41	73.51	Tap10 at kamuganguzi P/s
14	13	**2**	2.185	1.815	**2**	**89.98**	**37.0**		- 0.01		
	15	**2**	2.185	1.816	**2.0005**	**88.83**	**36.9**	1558.33	0.75	74.25	Tap 11 at Agaba s residance
16	43	**2**	2.047	1.952	**1.9995**	**93.57**	**9.5**		0.59		
	45	**2**	2.224	1.775	**1.9995**	**85.7**	**44.8**	1612.59	3.36	78.20	End Point at Tiberaba Tap 12

Branch to Kabura Trading Centre

St	Pnt	Hm	Hu	Hl	Check	Angle	Ds	S Distance	dH	Sum dH	Remark
								878.75		62.22	PBM- Kamuganguzi s.s. Sign post
2	1	2	2.528	1.473	2.0005	90.3	105.49		0.55		
	3	**2**	2.508	1.491	**1.9995**	**89.62**	**101.7**	1085.95	0.67	63.45	PBM Jn to kabura
4	3	**2**	2.371	1.629	**2**	**88.7**	**74.2**		1.68		
	5	**2**	2.379	1.622	**2.0005**	**88.43**	**75.7**	1235.80	2.07	67.20	Tap 13 at Mbare s home
6	5	**2**	2.362	1.639	**2.0005**	**91.18**	**72.3**		-1.49		
	7	**2**	2.342	1.659	**2.0005**	**86.32**	**68.2**	1376.24	4.37	70.09	
8	7	**2**	2.279	1.722	**2.0005**	**89.67**	**55.7**		0.32		
	9	**2**	2.501	1.499	**2**	**90.1**	**100.2**	1532.14	-0.17	70.23	Tap 14End point Kabura trading centre -

Hydraulic design:

Kabaliisa Hydraulic calculations

Pipe section	Chainage	Section length	Altitude	Pipe flow	Pipe		Velocity	Frictional loss (m)	Cum frictional loss (m)	Residual head (m)	HGL elevation (m)
	(m)	(m)	(m)	(L/s)	Class	Dia (mm)	(m/s)				
Reservoir	0		1845.7							0	1845.7
Tap 1	216	216.0	1838.6	2.8	6	90	0.6	1.0	1.0	6.1	1,844.7
Tap 2	331	115.4	1828.5	2.6	6	90	0.5	0.5	1.5	15.7	1,844.2
Tap 3	460	128.3	1820.9	2.4	6	90	0.5	0.4	1.9	22.8	1,843.8
PT	571	111.3	1821.3	2.2	6	90	0.4	0.3	2.2	22.2	1,843.5
Tap 4	633	62.2	1814.4	2.0	6	90	0.4	0.2	2.4	28.8	1,843.3
Tap 5	665	31.3	1812.4	2.0	6	90	0.4	0.1	2.5	30.8	1,843.2
Jn to Tap 12	667	2.0	1812.4	2.0	6	90	0.4	0.0	2.5	30.8	1,843.2
Tap 6	851	184.0	1811.9	1.8	6	90	0.0	0.0	2.5	31.3	1,843.2

Pipe section	Chainage	Section length	Altitude	Pipe flow	Pipe		Velocity	Frictional loss (m)	Cum frictional loss (m)	Residual head (m)	HGL elevation (m)
	(m)	(m)	(m)	(L/s)	Class	Dia (mm)	(m/s)				
Reservoir	0		1845.7							0	1845.7
Tap 1	216	216.0	1838.6	2.8	6	90	0.6	1.0	1.0	6.1	1,844.7
Tap 2	331	115.4	1828.5	2.6	6	90	0.5	0.5	1.5	15.7	1,844.2
Tap 3	460	128.3	1820.9	2.4	6	90	0.5	0.4	1.9	22.8	1,843.8
PT	571	111.3	1821.3	2.2	6	90	0.4	0.3	2.2	22.2	1,843.5
Tap 4	633	62.2	1814.4	2.0	6	90	0.4	0.2	2.4	28.8	1,843.3
Tap 5	665	31.3	1812.4	2.0	6	90	0.4	0.1	2.5	30.8	1,843.2
Jn to Tap 6	667	2.0	1812.4	2.0	6	90	0.4	0.0	2.5	30.8	1,843.2
Tap 7	817	150.2	1809.2	1.6	6	50	1.0	4.3	6.8	29.7	1,838.9
Jn to Tap 13 &14	879	62.0	1807.9	1.4	6	50	0.9	1.4	8.2	29.6	1,837.5
Tap 8	1,131	252.0	1810.2	1.0	6	50	0.6	3.1	11.3	24.2	1,834.4
Tap 9	1,400	269.3	1818.5	0.8	6	50	0.5	2.2	13.5	13.7	1,832.2
Tap 10	1,485	84.5	1819.2	0.6	6	50	0.4	0.4	13.9	12.6	1,831.8
Tap 11	1,558	73.9	1819.9	0.4	6	50	0.3	0.2	14.1	11.7	1,831.6
Tap 12	1,613	54.3	1823.9	0.2	6	50	0.1	0.0	14.1	7.7	1,831.6

Kabaliisa Hydraulic calculations continued

Pipe section	Chainage	Section length	Altitude	Pipe flow	Pipe		Velocity	Frictional loss (m)	Cum frictional loss (m)	Residual head (m)	HGL elevation (m)
	(m)	(m)	(m)	(L/s)	Class	Dia (mm)	(m/s)				
Reservoir	0		1845.7							0	1845.7
Tap 1	216	216.0	1838.6	2.8	6	90	0.6	1.0	1.0	6.1	1,844.7
Tap 2	331	115.4	1828.5	2.6	6	90	0.5	0.5	1.5	15.7	1,844.2
Tap 3	460	128.3	1820.9	2.4	6	90	0.5	0.4	1.9	22.8	1,843.8
PT	571	111.3	1821.3	2.2	6	90	0.4	0.3	2.2	22.2	1,843.5
Tap 4	633	62.2	1814.4	2.0	6	90	0.4	0.2	2.4	28.8	1,843.3
Tap 5	665	31.3	1812.4	2.0	6	90	0.4	0.1	2.5	30.8	1,843.2
Jn to Tap 6	667	2.0	1812.4	2.0	6	90	0.4	0.0	2.5	30.8	1,843.2
Tap 7	817	150.2	1809.2	1.6	6	50	1.0	4.3	6.8	29.7	1,838.9
Jn to Tap 12	879	62.0	1807.9	1.4	6	50	0.9	1.4	8.2	29.6	1,837.5
PT	1,086	207.2	1810.2	1.0	6	32	0.6	4.5	12.7	22.8	1,833.0
Tap 13	1,236	149.9	1812.9	0.2	6	32	0.6	3.2	15.9	16.8	1,829.8
Tap 14	1,532	296.3	1815.9	0.2	6	32	0.3	1.8	17.7	12.1	1,828.0

Katuna Hydraulic calculations

Pipe section	Chainage	Section length	Altitude	Pipe flow	Pipe		Velocity	Frictional loss (m)	Cum frictional loss (m)	Residual head (m)	HGL elevation (m)
	(m)	(m)	(m)	(L/s)	Class	Dia (mm)	(m/s)				
Reservoir	0		1845.7							0	1845.7
Tap 5	269	269.3	1821.2	3.8	6	110	0.5	0.7	0.7	23.8	1,845.0
Tap 6	439	169.7	1820.8	3.6	6	110	0.5	0.4	1.1	23.8	1,844.6
Tap 7	643	204.3	1821.0	3.4	6	90	0.7	1.3	2.4	22.3	1,843.3
Tap 8	745	101.9	1821.0	3.2	6	90	0.6	0.6	3.0	21.7	1,842.7
Tap 9	875	129.8	1818.0	3	6	90	0.6	0.7	3.7	24.0	1,842.0
Tap 10	970	94.9	1819.0	2.8	6	90	0.6	0.4	4.1	22.6	1,841.6
Tap 11	1,111	141.3	1820.0	2.6	6	90	0.5	0.6	4.7	21.0	1,841.0
Tap 12	1,280	169.2	1819.3	2.4	6	90	0.5	0.6	5.3	21.1	1,840.4
Jn to Tap 13 &14	1,497	216.3	1819.1	2.2	6	50	0.4	0.6	5.9	20.7	1,839.8
Tap 15	1,645	148.1	1822.4	1.8	6	50	0.4	0.3	6.2	17.1	1,839.5
Tap 16	1,771	126.2	1820.0	1.6	6	50	0.3	0.2	6.4	19.3	1,839.3
Tap 17	1,905	134.4	1820.3	1.4	6	50	0.3	0.2	6.6	18.8	1,839.1
Tap 18	2,451	545.7	1825.4	1.2	6	50	0.2	0.5	7.1	13.2	1,838.6
PT	2,838	386.9	1822.2	1.0	6	50	0.2	0.3	7.4	16.1	1,838.3
Tap 19	3,004	166.4	1822.3	1.0	6	50	0.2	0.1	7.5	15.9	1,838.2
PT	3,232	227.1	1822.6	0.8	6	50	0.2	0.1	7.6	15.5	1,838.1
Tap 20	3,619	387.5	1826.6	0.8	6	50	0.2	0.2	7.8	11.3	1,837.9
Tap 21	3,846	226.5	1828.6	0.6	6	50	0.1	0.1	7.9	9.2	1,837.8
Jn to Tap 23	3,982	136.2	1827.3	0.4	6	50	0.1	0.0	7.9	10.5	1,837.8
Tap 22	4,144	162.2	1825.5	0.2	6	50	0.0	0.0	7.9	12.3	1,837.8

Katuna Hydraulic calculations continued

Pipe section	Chainage	Section length	Altitude	Pipe flow	Pipe		Velocity	Frictional loss (m)	Cum frictional loss (m)	Residual head (m)	HGL elevation (m)
	(m)	(m)	(m)	(L/s)	Class	Dia (mm)	(m/s)				
Reservoir	0		1845.7							0	1845.7
Tap 5	269	269.3	1821.2	3.8	6	110	0.5	0.7	0.7	23.8	1,845.0
Tap 6	439	169.7	1820.8	3.6	6	110	0.5	0.4	1.1	23.8	1,844.6
Tap 7	643	204.3	1821.0	3.4	6	90	0.7	1.3	2.4	22.3	1,843.3
Tap 8	745	101.9	1821.0	3.2	6	90	0.6	0.6	3.0	21.7	1,842.7
Tap 9	875	129.8	1818.0	3	6	90	0.6	0.7	3.7	24.0	1,842.0
Tap 10	970	94.9	1819.0	2.8	6	90	0.6	0.4	4.1	22.6	1,841.6
Tap 11	1,111	141.3	1820.0	2.6	6	90	0.5	0.6	4.7	21.0	1,841.0
Tap 12	1,280	169.2	1819.3	2.4	6	90	0.5	0.6	5.3	21.1	1,840.4
Jn to Tap 13 &14	1,497	216.3	1819.1	2.2	6	50	0.4	0.6	5.9	20.7	1,839.8
Tap 15	1,645	148.1	1822.4	1.8	6	50	0.4	0.3	6.2	17.1	1,839.5
Tap 16	1,771	126.2	1820.0	1.6	6	50	0.3	0.2	6.4	19.3	1,839.3
Tap 17	1,905	134.4	1820.3	1.4	6	50	0.3	0.2	6.6	18.8	1,839.1
Tap 18	2,451	545.7	1825.4	1.2	6	50	0.2	0.5	7.1	13.2	1,838.6
PT	2,838	386.9	1822.2	1.0	6	50	0.2	0.3	7.4	16.1	1,838.3
Tap 19	3,004	166.4	1822.3	1.0	6	50	0.2	0.1	7.5	15.9	1,838.2
PT	3,232	227.1	1822.6	0.8	6	50	0.2	0.1	7.6	15.5	1,838.1
Tap 20	3,619	387.5	1822.6	0.8	6	50	0.2	0.2	7.8	15.3	1,837.9
Tap 21	3,845	226.2	1828.6	0.6	6	50	0.1	0.1	7.9	9.2	1,837.8
Jn to Tap 22	3,981	136.2	1827.3	0.4	6	50	0.1	0.0	7.9	10.5	1,837.8
PT	4,118	136.4	1830.1	0.2	6	50	0.0	0.0	7.9	7.7	1,837.8
PT	4,189	71.4	1827.1	0.2	6	50	0.0	0.0	7.9	10.7	1,837.8
PT	4,284	94.5	1830.4	0.2	6	50	0.0	0.0	7.9	7.3	1,837.8
PT	4,420	136.4	1833.6	0.2	6	50	0.0	0.0	7.9	4.2	1,837.8
Tap 24	4,547	127.2	1839.7	0.2	6	50	0.0	0.0	7.9	-2.0	1,837.8

Note: The last two points on the above table would require that while implementing;

- Pipeline to be located at an elevation lower than the indicated.
- Dig deeper while excavating trenches for pipes.

10m^3 Detailed Report for Break-Pressure Tank

Scenario Summary	
Scenario	design20
Active Topology Alternative	Base-Active Topology
Physical Alternative	Base-Physical
Demand Alternative	Base-Demand
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow
Capital Cost Alternative	Base-Capital Cost
Energy Cost Alternative	Base-Energy Cost
User Data Alternative	Base-User Data

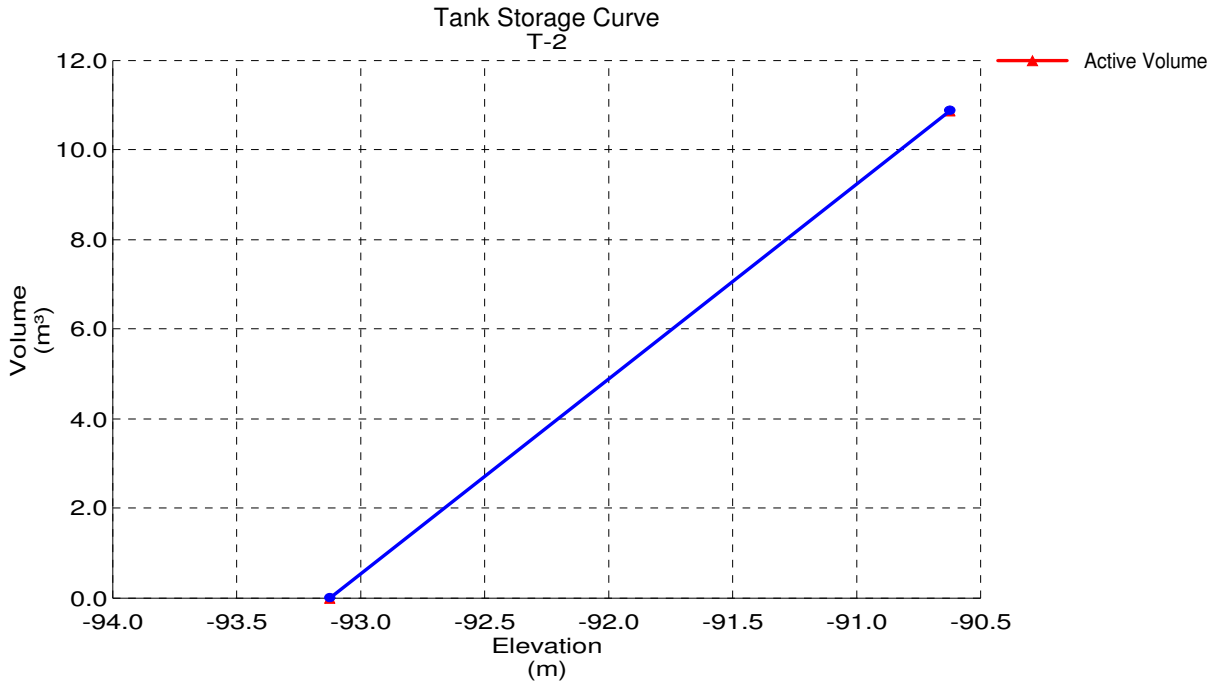
Global Adjustments Summary			
Demands Collection	<None>	Roughness	<None>

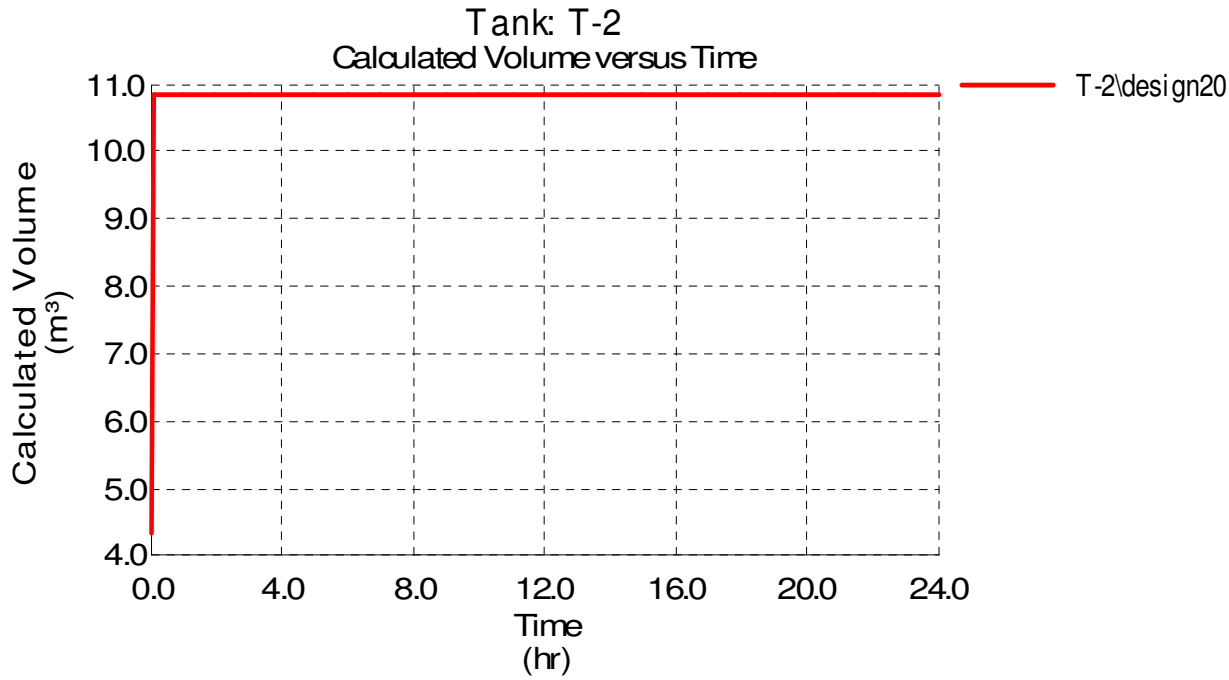
Geometric Summary					
X	862.30	m	Elevation	-93.62	m
Y	0.00	m	Zone	Zone	

Operating Range Summary					
Maximum Elevation	-90.62	m	Maximum Level	3.00	m
Initial HGL	-92.12	m	Initial Level	1.50	m
Minimum Elevation	-93.12	m	Minimum Level	0.50	m
Base Elevation	-93.62	m			

Storage					
Section Type	Constant Area		Circular Tank Shape	true	
Diameter	2.35	m	Average Area	4.3	m²
Inactive Volume	0.00	m³	Total Active Volume	10.84	m³

Calculated Results Summary								
Time (hr)	Calculated Hydraulic Grade (m)	Calculated Level (m)	Pressure (m H2O)	Calculated Percent Full (%)	Calculated Volume (m^3)	Inflow (l/s)	Outflow (l/s)	Current Status
0.00	-92.12	1.50	1.497	40.0	4.34	14.311	-14.311	Filling
0.13	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
1.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
2.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
3.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
4.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
5.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
6.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
7.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
8.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
9.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
10.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
11.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
12.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
13.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
14.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
15.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
16.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
17.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
18.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
19.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
20.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
21.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
22.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
23.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full
24.00	-90.62	3.00	2.994	100.0	10.84	0.000	-0.000	Full


Tank Storage Curve
T-2
Active Volume
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Volume
(m³)
-94.0
-93.5
-93.0
-92.5
-92.0
-91.5
-91.0
-90.5
Elevation
(m)


Tank: T-2
Calculated Volume versus Time
T-2\design20
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
Calculated Volume
(m³)
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time
(hr)

Detailed Report for Reservoir Tank (90m^3)

Scenario Summary			
Scenario	design20		
Active Topology Alternative	Base-Active Topology		
Physical Alternative	Base-Physical		
Demand Alternative	Base-Demand		
Initial Settings Alternative	Base-Initial Settings		
Operational Alternative	Base-Operational		
Age Alternative	Base-Age Alternative		
Constituent Alternative	Base-Constituent		
Trace Alternative	Base-Trace Alternative		
Fire Flow Alternative	Base-Fire Flow		
Capital Cost Alternative	Base-Capital Cost		
Energy Cost Alternative	Base-Energy Cost		
User Data Alternative	Base-User Data		

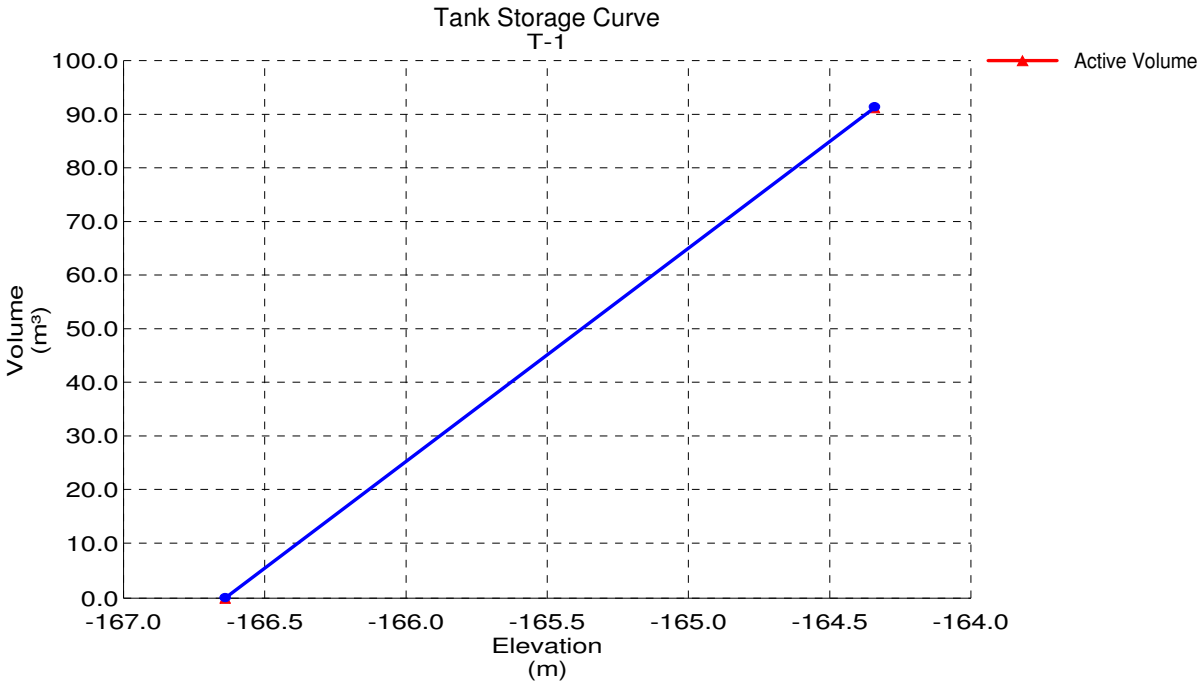
Geometric Summary					
X	5,588.72	m	Elevation	-164.14	m
Y	0.00	m	Zone	Zone	

Demand Summary		
Type	Base Flow (l/s)	Pattern
Demand	0.000	Rural Growth Centre

Operating Range Summary					
Maximum Elevation	-164.34	m	Maximum Level	2.80	m
Initial HGL	-166.34	m	Initial Level	0.80	m
Minimum Elevation	-166.64	m	Minimum Level	0.50	m
Base Elevation	-167.14	m			

Storage					
Section Type	Constant Area		Circular Tank Shape	true	
Diameter	7.10	m	Average Area	39.6	m²
Inactive Volume	0.00	m³	Total Active Volume	91.06	m³

Calculated Results Summary								
Time (hr)	Calculated Hydraulic Grade (m)	Calculated Level (m)	Pressure (m H2O)	Calculated Percent Full (%)	Calculated Volume (m^3)	Inflow (l/s)	Outflow (l/s)	Current Status
0.00	-166.34	0.80	0.798	13.0	11.88	2.600	-2.600	Filling
0.13	-166.31	0.83	0.828	14.3	13.06	2.732	-2.732	Filling
1.00	-166.09	1.05	1.045	23.8	21.65	2.729	-2.729	Filling
2.00	-165.84	1.30	1.292	34.6	31.48	2.726	-2.726	Filling
3.00	-165.60	1.54	1.540	45.3	41.29	2.722	-2.722	Filling
4.00	-165.35	1.79	1.787	56.1	51.09	2.718	-2.718	Filling
5.00	-165.10	2.04	2.033	66.9	60.87	2.714	-2.714	Filling
6.00	-164.86	2.28	2.280	77.6	70.65	2.711	-2.711	Filling
7.00	-164.61	2.53	2.526	88.3	80.40	-1.800	1.800	Draining
8.00	-164.77	2.37	2.362	81.2	73.92	-1.798	1.798	Draining
9.00	-164.94	2.20	2.199	74.1	67.45	-1.795	1.795	Draining
10.00	-165.10	2.04	2.036	67.0	60.99	0.142	-0.142	Filling
11.00	-165.09	2.05	2.049	67.5	61.50	0.142	-0.142	Filling
12.00	-165.07	2.07	2.062	68.1	62.01	0.142	-0.142	Filling
13.00	-165.06	2.08	2.075	68.7	62.52	0.141	-0.141	Filling
14.00	-165.05	2.09	2.088	69.2	63.03	0.141	-0.141	Filling
15.00	-165.04	2.10	2.101	69.8	63.54	0.141	-0.141	Filling
16.00	-165.02	2.12	2.113	70.3	64.04	0.141	-0.141	Filling
17.00	-165.01	2.13	2.126	70.9	64.55	-4.049	4.049	Draining
18.00	-165.38	1.76	1.759	54.9	49.97	-4.043	4.043	Draining
19.00	-165.75	1.39	1.392	38.9	35.42	2.724	-2.724	Filling
20.00	-165.50	1.64	1.639	49.7	45.22	2.720	-2.720	Filling
21.00	-165.25	1.89	1.886	60.4	55.02	2.717	-2.717	Filling
22.00	-165.00	2.14	2.132	71.2	64.80	2.713	-2.713	Filling
23.00	-164.76	2.38	2.378	81.9	74.56	2.709	-2.709	Filling
24.00	-164.51	2.63	2.624	92.6	84.31	2.705	-2.705	Filling

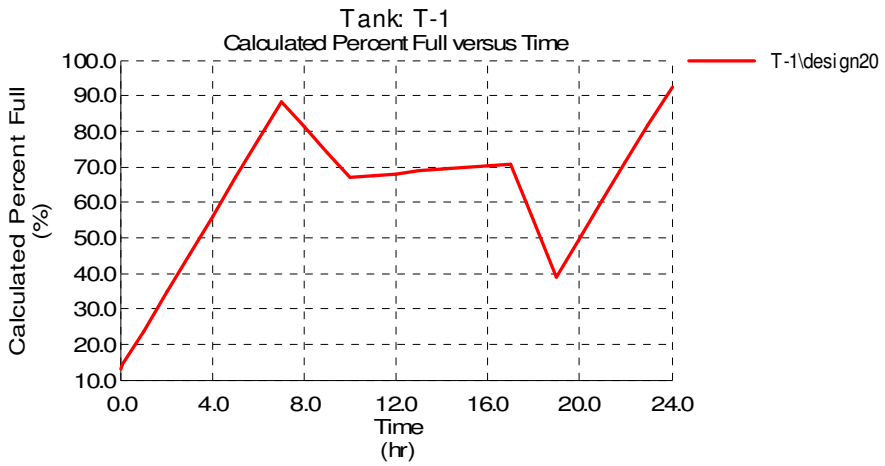

Tank Storage Curve
T-1
Active Volume
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Volume
(m³)
-167.0
-166.5
-166.0
-165.5
-165.0
-164.5
-164.0
Elevation
(m)

Scenario: design20

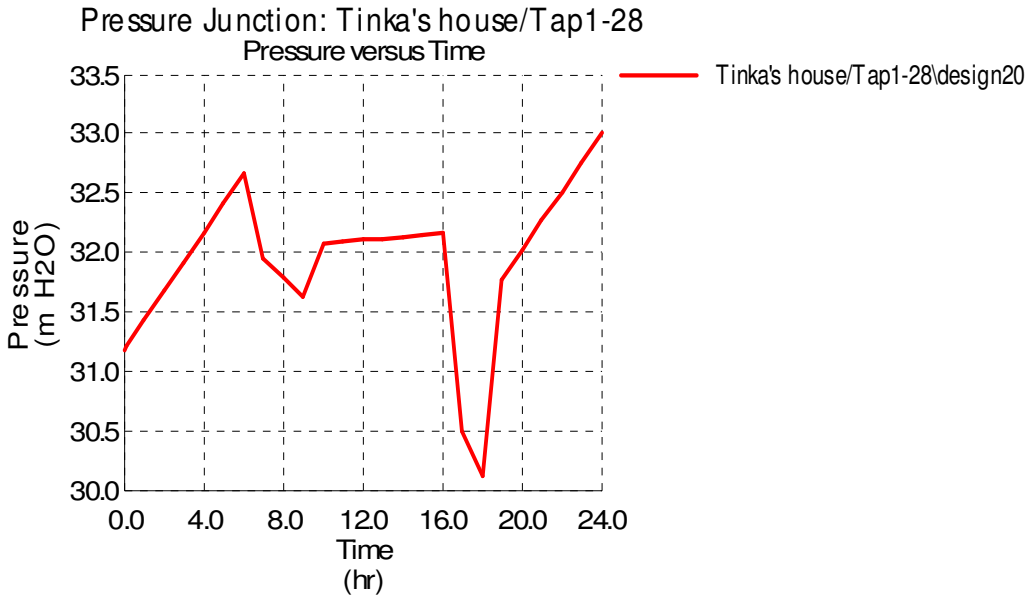
Extended Period analysis: 18.00 hr / 24.00

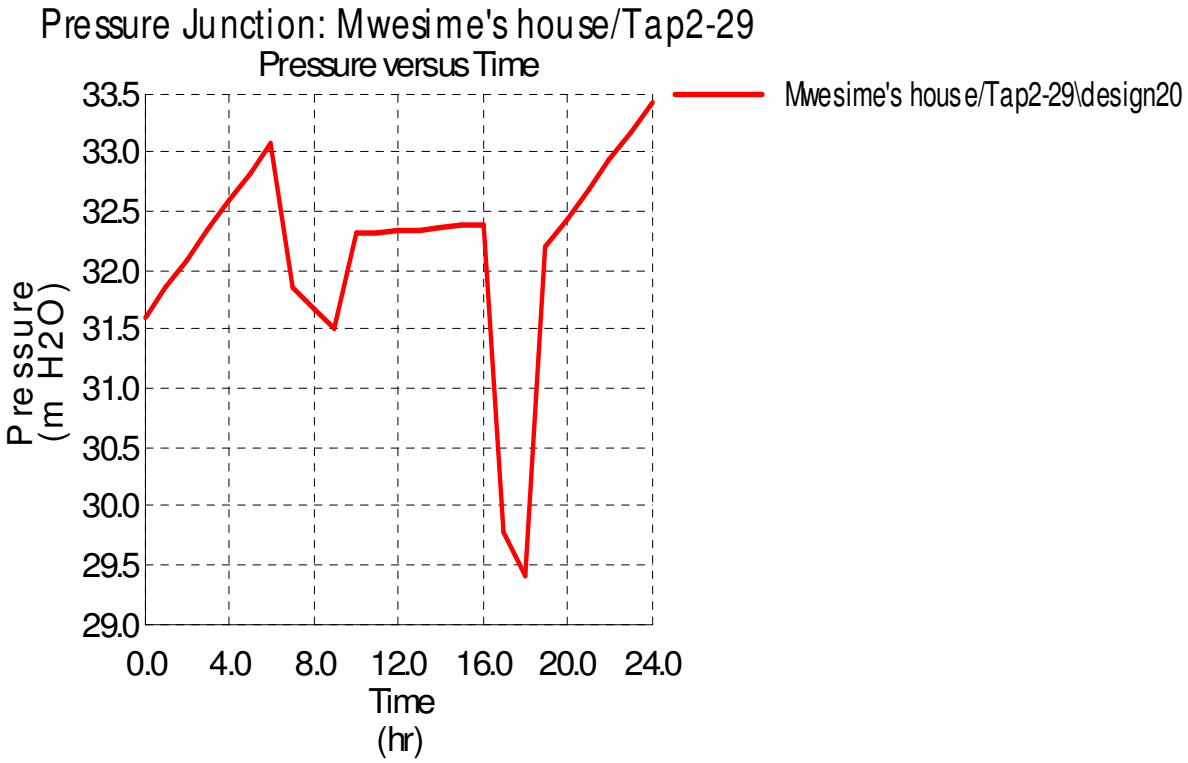
Calculated Results: Reservoir Tank

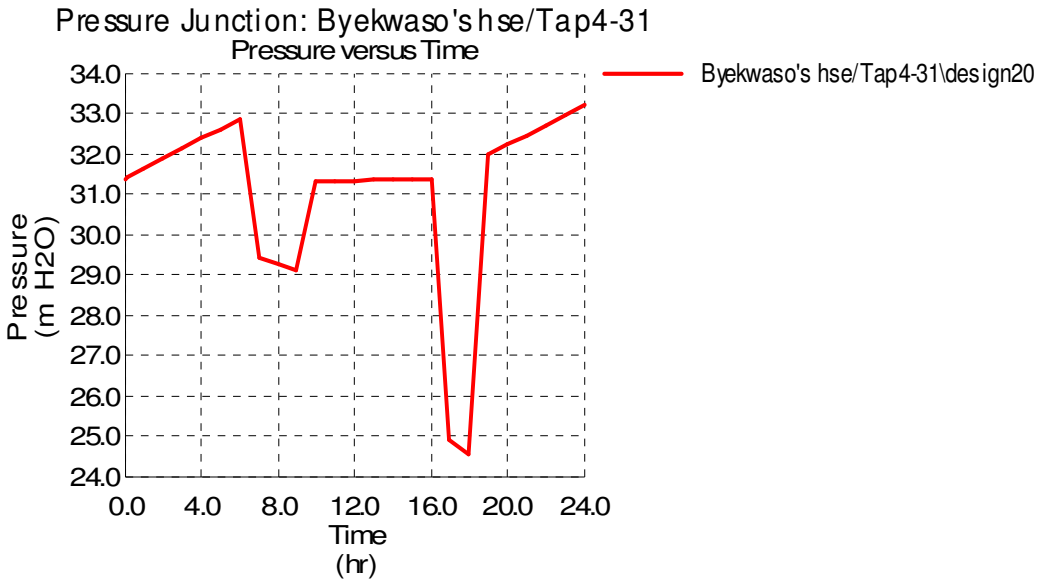
Time (hr)	Calculated Hydraulic Grade (m)	Calculated Level (m)	Pressure (m H2O)	Calculated Percent Full (%)	Calculated Volume (m^3)	Inflow (l/s)	Outflow (l/s)	Current Status
0	-166.34	0.8	0.798	13	11.88	2.6	-2.6	Filling
0.13	-166.31	0.83	0.828	14.3	13.06	2.732	-2.732	Filling
1	-166.09	1.05	1.045	23.8	21.65	2.729	-2.729	Filling
2	-165.84	1.3	1.292	34.6	31.48	2.726	-2.726	Filling
3	-165.6	1.54	1.54	45.3	41.29	2.722	-2.722	Filling
4	-165.35	1.79	1.787	56.1	51.09	2.718	-2.718	Filling
5	-165.1	2.04	2.033	66.9	60.87	2.714	-2.714	Filling
6	-164.86	2.28	2.28	77.6	70.65	2.711	-2.711	Filling
7	-164.61	2.53	2.526	88.3	80.4	-1.8	1.8	Draining
8	-164.77	2.37	2.362	81.2	73.92	-1.798	1.798	Draining
9	-164.94	2.2	2.199	74.1	67.45	-1.795	1.795	Draining
10	-165.1	2.04	2.036	67	60.99	0.142	-0.142	Filling
11	-165.09	2.05	2.049	67.5	61.5	0.142	-0.142	Filling
12	-165.07	2.07	2.062	68.1	62.01	0.142	-0.142	Filling
13	-165.06	2.08	2.075	68.7	62.52	0.141	-0.141	Filling
14	-165.05	2.09	2.088	69.2	63.03	0.141	-0.141	Filling
15	-165.04	2.1	2.101	69.8	63.54	0.141	-0.141	Filling
16	-165.02	2.12	2.113	70.3	64.04	0.141	-0.141	Filling
17	-165.01	2.13	2.126	70.9	64.55	-4.049	4.049	Draining
18	-165.38	1.76	1.759	54.9	49.97	-4.043	4.043	Draining
19	-165.75	1.39	1.392	38.9	35.42	2.724	-2.724	Filling
20	-165.5	1.64	1.639	49.7	45.22	2.72	-2.72	Filling
21	-165.25	1.89	1.886	60.4	55.02	2.717	-2.717	Filling
22	-165	2.14	2.132	71.2	64.8	2.713	-2.713	Filling
23	-164.76	2.38	2.378	81.9	74.56	2.709	-2.709	Filling
24	-164.51	2.63	2.624	92.6	84.31	2.705	-2.705	Filling

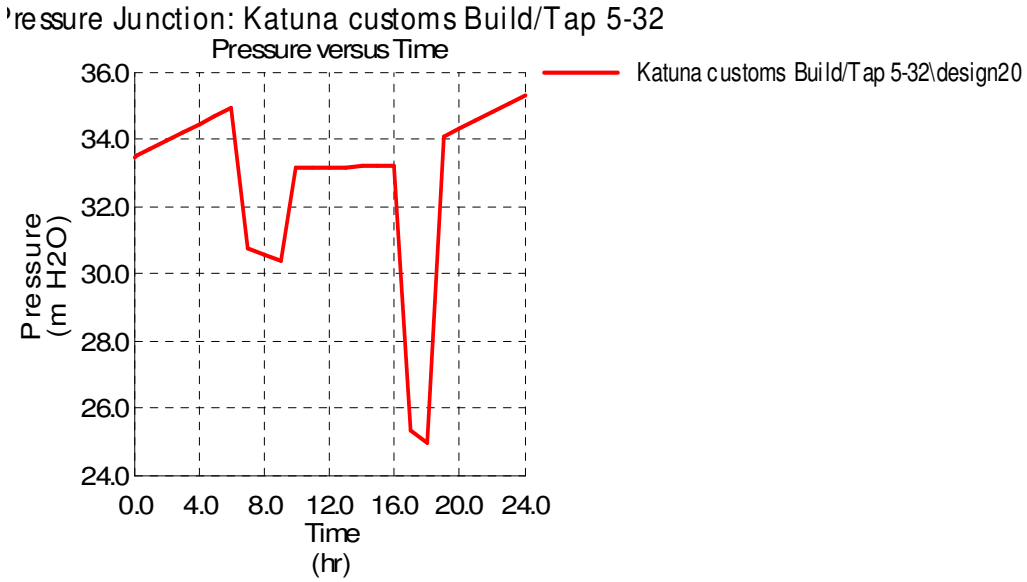


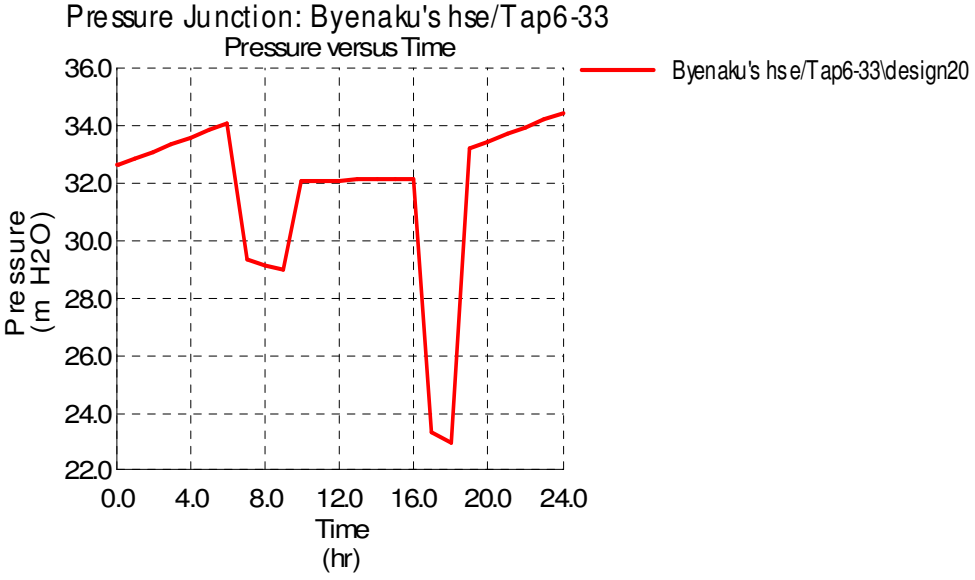
Pressure VS Time at Tap Stands

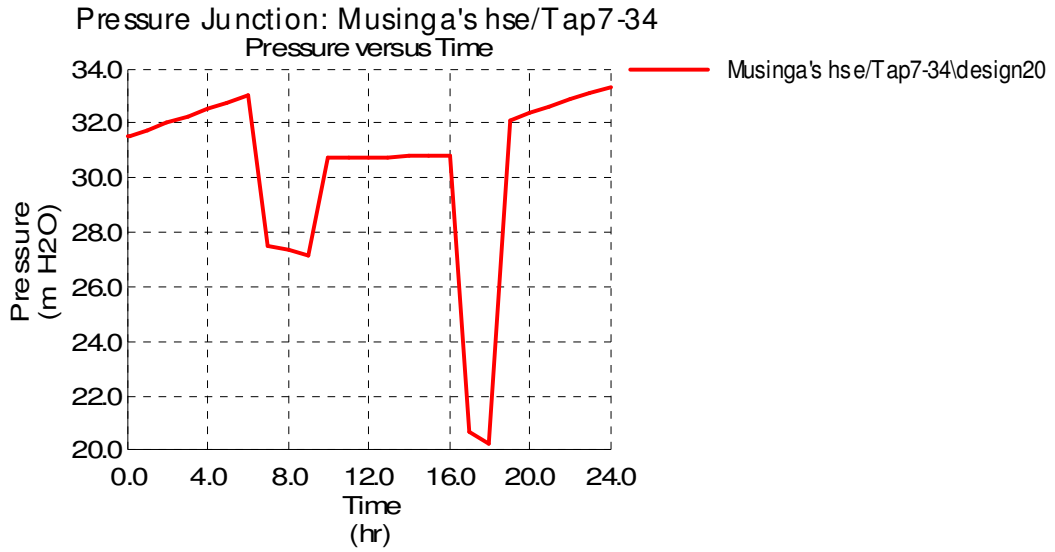


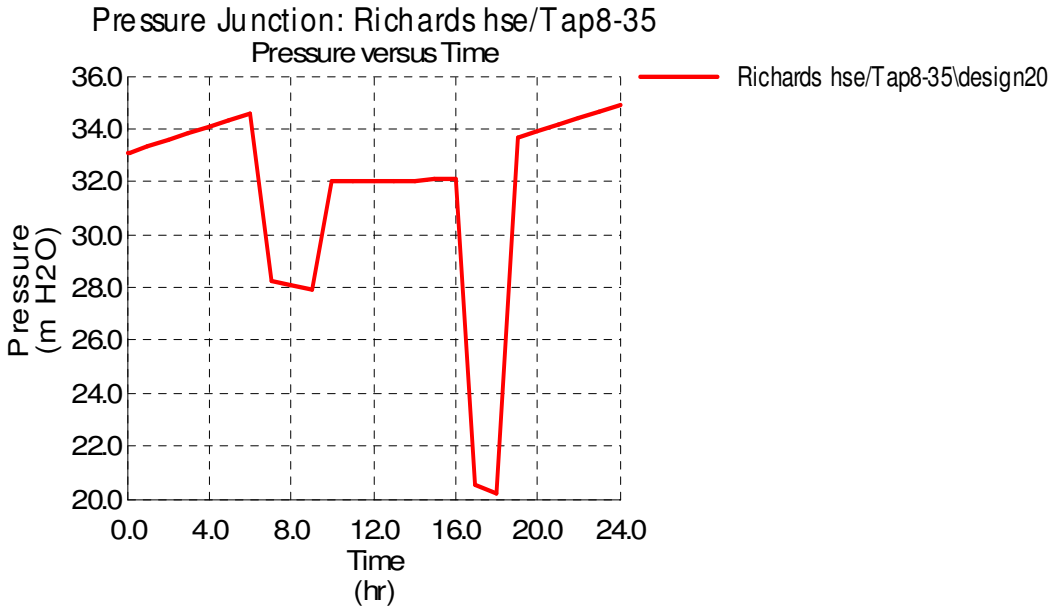


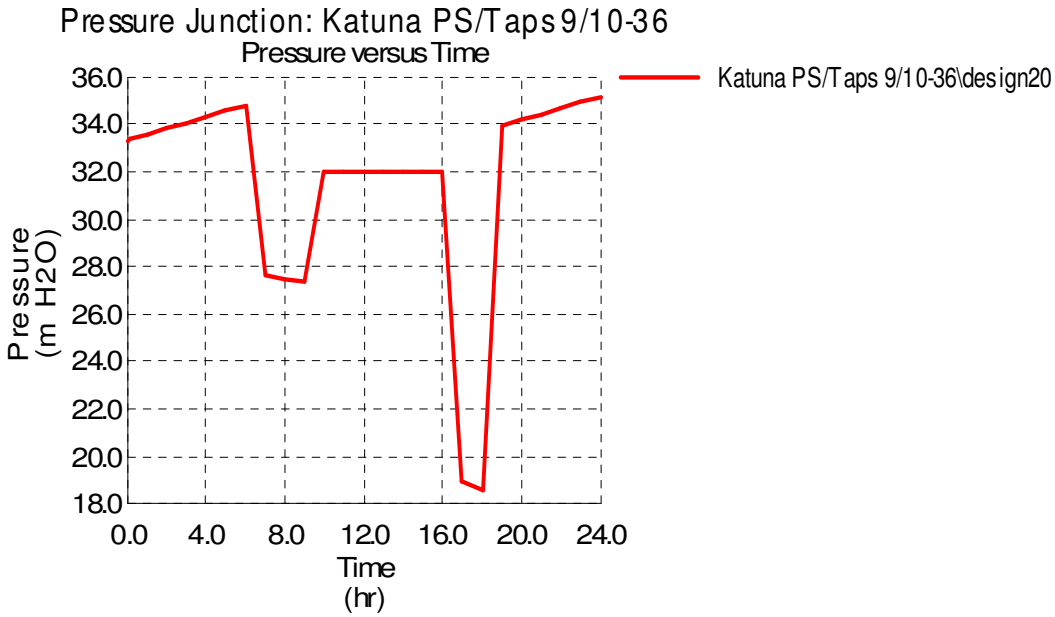

Pressure Junction: Byekwaso's hse/Tap4-31
Pressure versus Time
Byekwaso's hse/Tap4-31\design20
Pressure (m H2O)
34.0
33.0
32.0
31.0
30.0
29.0
28.0
27.0
26.0
25.0
24.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)

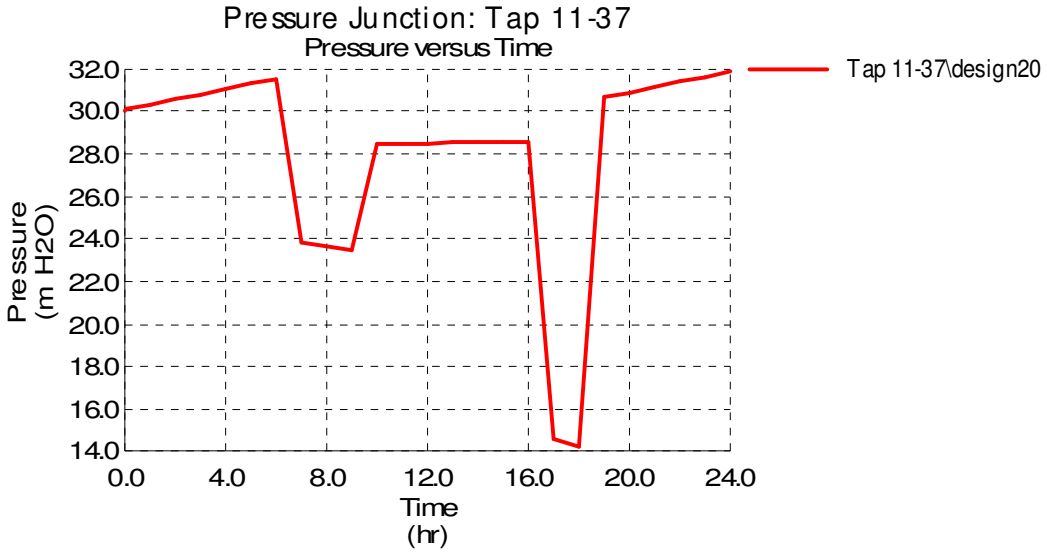

Pressure Junction: Katuna customs Build/Tap 5-32
Pressure versus Time
Katuna customs Build/Tap 5-32\design20
Pressure (m H2O)
36.0
34.0
32.0
30.0
28.0
26.0
24.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)

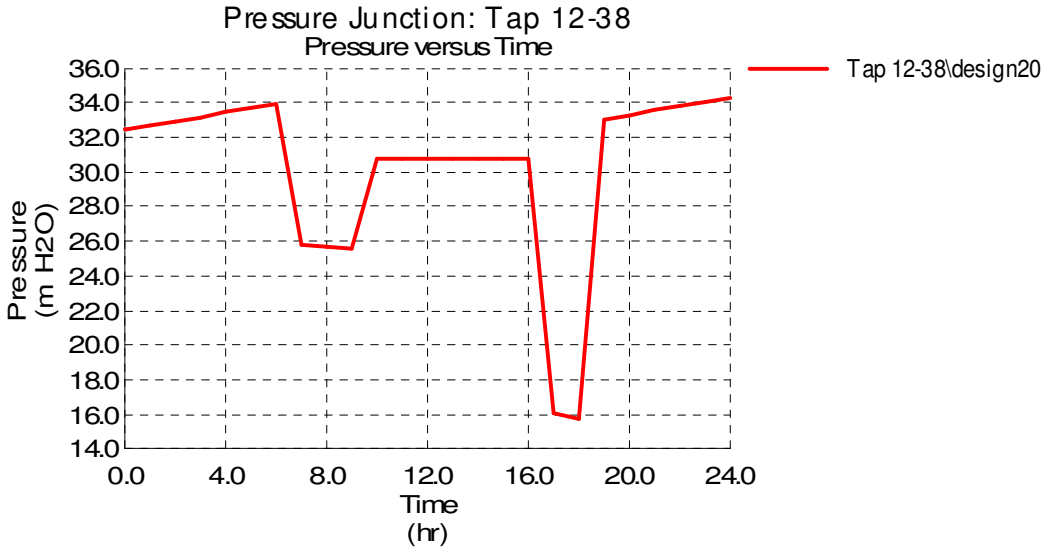

Pressure Junction: Byenaku's hse/Tap6-33
Pressure versus Time
Byenaku's hse/Tap6-33\design20
Pressure (m H2O)
36.0
34.0
32.0
30.0
28.0
26.0
24.0
22.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)

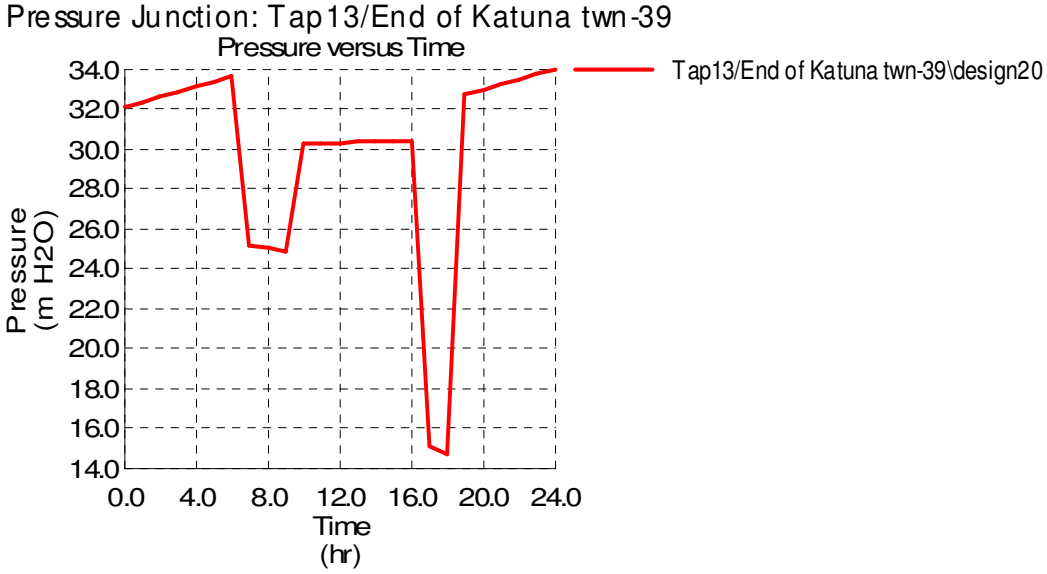

Pressure Junction: Musinga's hse/Tap7-34
Pressure versus Time
Musinga's hse/Tap7-34\design20
Pressure (m H2O)
34.0
32.0
30.0
28.0
26.0
24.0
22.0
20.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)

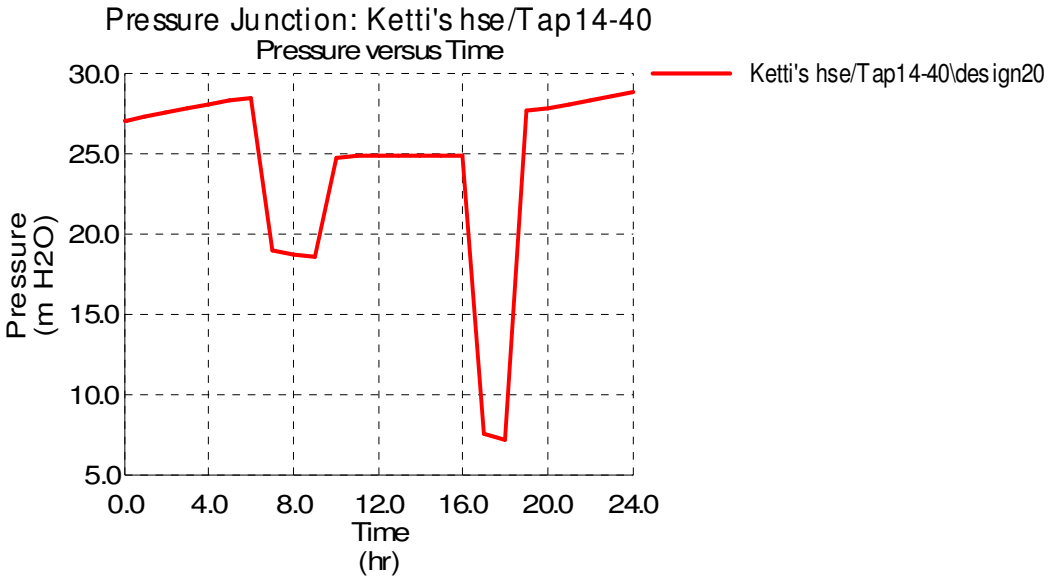

Pressure Junction: Richards hse/Tap8-35
Pressure versus Time
Richards hse/Tap8-35\design20
Pressure (m H2O)
36.0
34.0
32.0
30.0
28.0
26.0
24.0
22.0
20.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)

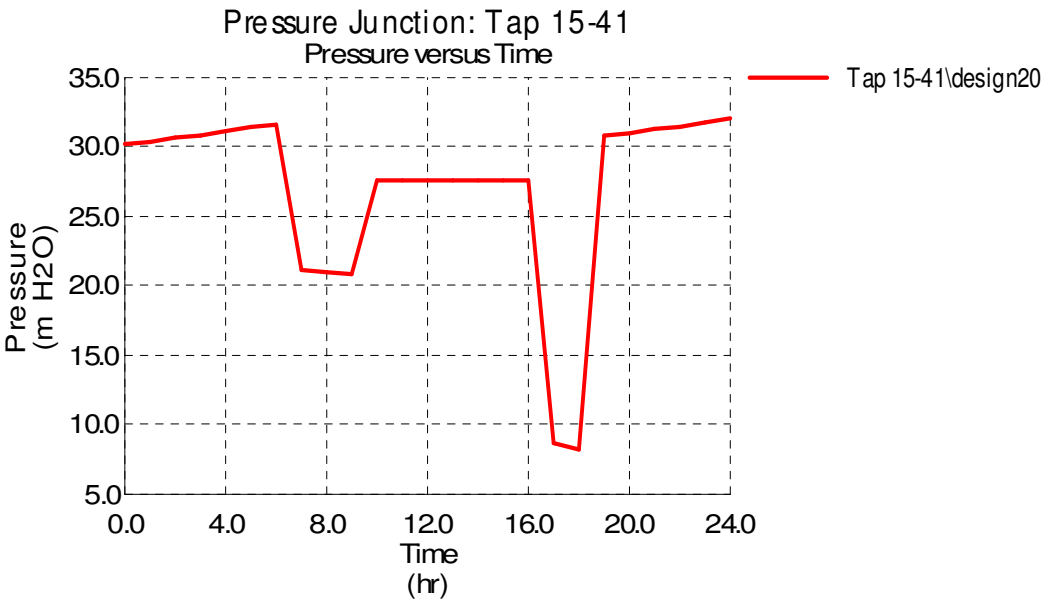

Pressure Junction: Katuna PS/Taps 9/10-36
Pressure versus Time
Katuna PS/Taps 9/10-36\design20
Pressure (m H2O)
36.0
34.0
32.0
30.0
28.0
26.0
24.0
22.0
20.0
18.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)

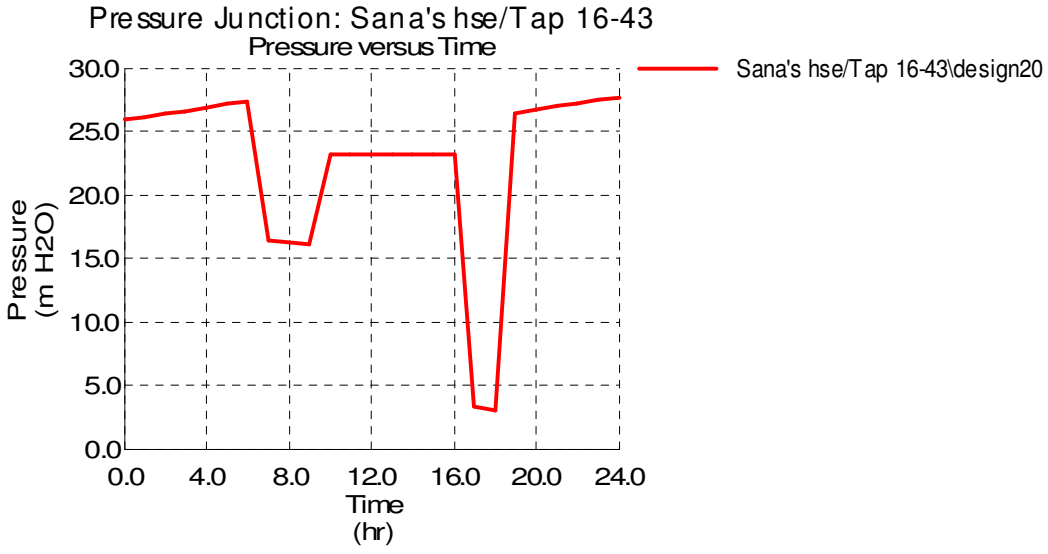

Pressure Junction: Tap 11-37
Pressure versus Time
Tap 11-37\design20
Pressure (m H2O)
32.0
30.0
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)

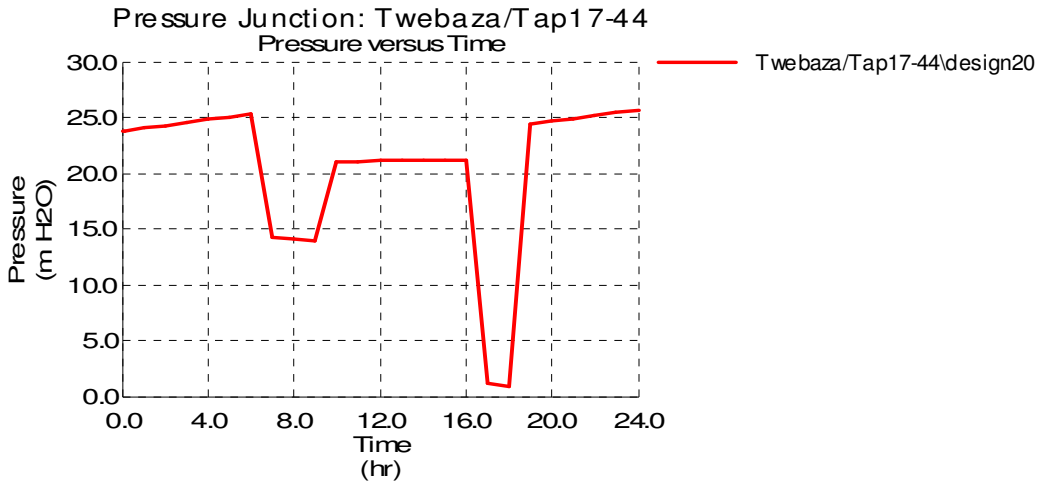

Pressure Junction: Tap 12-38
Pressure versus Time
Tap 12-38\design20
Pressure (m H2O)
36.0
34.0
32.0
30.0
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)

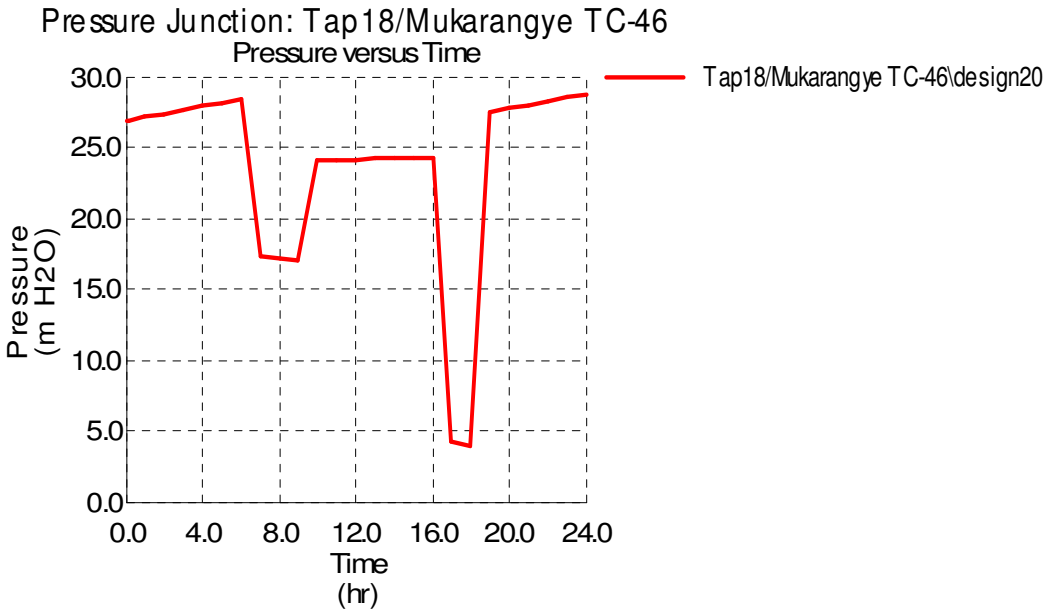

Pressure Junction: Tap13/End of Katuna twn-39
Pressure versus Time
Tap13/End of Katuna twn-39\design20
Pressure (m H2O)
34.0
32.0
30.0
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)


Pressure Junction: Ketti's hse/Tap14-40
Pressure versus Time
Ketti's hse/Tap14-40\design20
Pressure (m H2O)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)


Pressure Junction: Tap 15-41
Pressure versus Time
Tap 15-41\design20
Pressure (m H2O)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)


Pressure Junction: Sana's hse/Tap 16-43
Pressure versus Time
Sana's hse/Tap 16-43\design20
Pressure (m H2O)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)


Pressure Junction: Twebaza/Tap17-44
Pressure versus Time
Twebaza/Tap17-44\design20
Pressure (m H2O)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)


Pressure Junction: Tap18/Mukarangye TC-46
Pressure versus Time
Tap18/Mukarangye TC-46\design20
Pressure (m H2O)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Time (hr)

SESSION: REVIEW OF PROJECT PHASES

Background:

The project undergoes different phases in the target towns. The different phases have got major actors with different roles and responsibilities. Initial phases involve the community in planning and implementation, although the project has got a lot of input. However, the O & M phase is solely a responsibility of the benefiting community and there's need to reaffirm this stature to avoid the community over depending on the project in O & M.

Time: 30 minutes

Session Objectives:

- To emphasize the role of the user community in O & M of the constructed system.
- To assess participants knowledge of community obligation under O & M.

Session Content:

- Design phase: Consultant
- Construction phase Consultant/Contractor and community
- O & M: Community

Conclusion:

It is important for the future water user community to note that they are fully responsible for O & M of the system. Sustainability of the system depends on the management of the scheme by the community. If they manage the system poorly, it will lead to the collapse of the scheme.

SESSION: OPERATION AND MAINTENANCE

Background:

Sustainability of water and sanitation systems through proper and effective Operation and Maintenance has been recognized by government as a priority activity in order to safeguard infrastructure investments. The crucial role of good O&M practices in sustainability of water supplies and improved sanitation has been acknowledged. Most projects fail due to inappropriate O & M of schemes. This session aims at strengthening future user community's knowledge about good O & M practices to safeguard the sustainability of the constructions.

Time: 1 Hour 30 Minutes

Session Objectives:

- Understand the meaning of O & M.
- Identify common problems in O & M and means to guard against them.
- Know the importance of pooling funds for O & M.

Session Content:

What is Operation?

Operation is the actual or smooth running of a service or system. For example provision of fuel, starting the pump, control of water collection points, general mechanics, water treatment and hygienic handling.

What is Maintenance?

Maintenance deals with the activities that keep the system in proper working condition. It includes maintenance of all activities necessary to keep scheme in good condition as at the time of handover. It includes;

Preventive maintenance (Management, cost recovery and maintenance activities undertaken in response to pre-scheduled systematic inspection, repair, replacement, leading to continuity in service level, O & M spread overtime, extension of life span of equipment, users' satisfaction and willingness to pay.)

And

Crisis maintenance (Maintenance undertaken only in response to breakdowns and incase of public complaints, leading to poor service level, high O & M costs, faster wear and tear of equipments, and users' dissatisfaction.)

Problems associated with O & M

- Lack of skilled personnel to operate the scheme effectively
- Leakage along the pipeline, at the tanks, valves, etc
- Un-serviced meters and non-functional taps
- Poor willngness to contribute user fees for O & M.
- Accessibility and availability of spare parts.
- Vandalism of assets

- Sustainability of good sanitation levels and water contamination.
- Lack of coordination between water users and water committees / Boards
- Lack of political will
- No distinction regarding different tasks and actors involved.
- Poor knowledge of financial principles and no bookkeeping.
- Identification of O&M activities
- Poor awareness of future needs
- No links between cost estimation and cost recovery
- Poor system of collection, unrealistic / inappropriate tariff structure

Improving performance requires;

- Proper management of water supply facilities
- Adequate data on O&M
- Sufficient and efficient use of funds
- Appropriate system design
- High profile of O&M
- Adequate policies, legal framework and overlapping responsibilities
- Political support
- Identification of O&M responsibility bearers
- Emphasis on cost recovery

Importance of cost recovery

- Available public funds are inadequate to meet O & M thus community contribution in form of users fees.
- State intervention and control may be ineffective and inefficient.
- Communities are not given chance to choose say appropriate technology due to subsidized services.
- Payments increase sense of ownership
- User payments increase quality and standards of service.

Conclusion:

In order to have sustainable and functional schemes, emphasis has to be put on the important aspects that are deemed necessary in O & M. Efficiency and effectiveness of O&M lead to sustainability of Water supply and sanitation services. The type of mode applied for water and sanitation schemes management determines the efficiency and effectiveness of Operation and Maintenance.

SESSION: MANAGEMENT OF THE SCHEME

Background:

Community management aims at empowering and equipping communities with skills to own and control their own systems. As owners they have the responsibilities and decision-making power and hold the future sustainability of the scheme. Sustainability of the constructed system depends on the quality of O & M. Failure of most constructed systems has been attributed to inappropriate O & M of schemes. The root of this state of affairs varies from political to social, technical and economic considerations, among which problems of inadequate management have been identified as a constraint. This session is meant to enlighten community about the management system of the scheme to be handed over.

Time: 1 Hour 30 Minutes

Session Objectives:

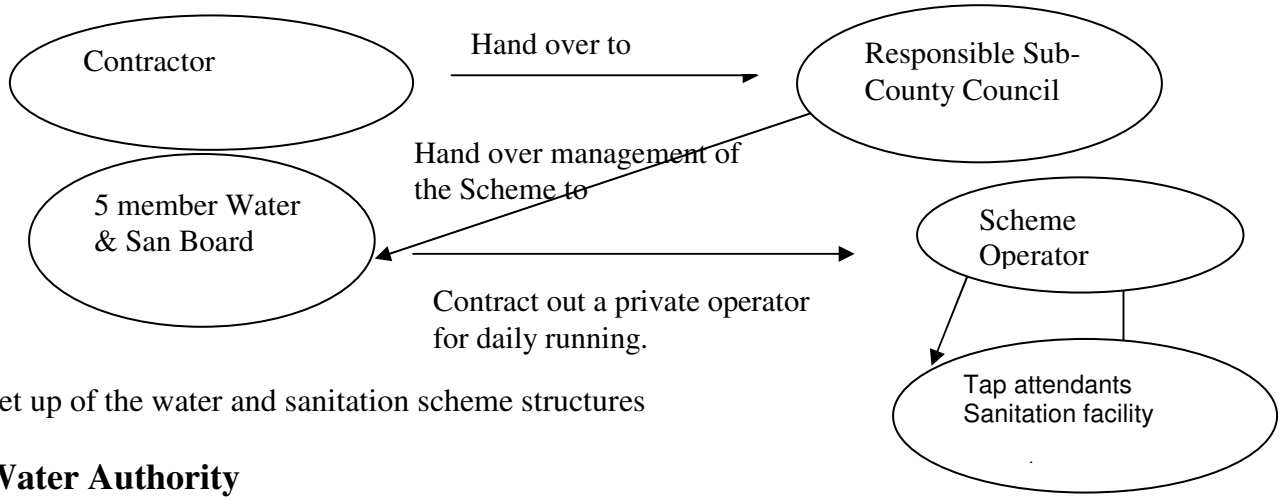
By the end of the session participants will be able to;

- Know the management model, actors and reporting structure of the scheme.
- Gain knowledge about the selection of WSSB and SO.

Session Content:

Hand Over and Management of System

The completed Scheme is handed over to the Sub County council as the relevant authority. The Sub County council is required to hand over the management of the scheme to a five-member committee (the Water Supply and Sanitation Board). The WSSB contracts out the day-to-day running of the scheme to a private person; the Scheme Operator. The SO will need to employ people to assist in the delivery of services (e.g. tap attendants at the tap stands) but these persons are solely under him and not under the WSSB.



Set up of the water and sanitation scheme structures

Water Authority

- The minister appoints a water authority.
- Authority responsible for management of assets, water and sanitation services.
- Authority does not own assets.

Water Supply and Sanitation Board (WSSB)

The board is composed of five persons;

i) Three persons drawn from the water users
ii) The Sub county chief
iii) LC III Councilor responsible for water and sanitation

Formation of the WSSB:

The Sub county Chief and the councilor on the WSSB represent their positions, and not individuals. The LC III council appoints the three persons on the WSSB, with the following observations;

- The selected person must be a person from within the water area (water user).
- The WSSB must have at least 1 woman.
- The selected person must be hardworking, honest and trust worthy

Scheme Operator (SO)

Selecting the Scheme Operator:

The WSSB holds the responsibility of selecting a Scheme Operator. The selection process must be transparent and should accommodate competition. The following should be considered while selecting a SO;

- Ability to read and write English.
- Knowledge about the management system of the scheme (Attended this training).
- Ability to keep proper records
- Preferably from the water area.
- Innovative, hardworking and presentable.

Conclusion:

It is vital to select and appoint competent persons in the management of the scheme if sustainability is to be achieved.

SESSION: RESPONSIBILITIES OF ACTORS IN SCHEME MANAGEMENT.

Background:

Role differentiation is an essential factor for successful O & M of systems. The actors identified in the previous session need to understand clearly their contribution towards management of the constructed system thus contributing to the sustainability of the systems.

Time: 2 Hours

Session Objectives:

- To create awareness on actors roles and responsibilities.

Session Content:

Responsibilities of the Council / Sub County

- Maintain assets of the scheme
- Appoint a Water Supply and Sanitation Board
- Supervise the WSSB in the management of the scheme.
- Carry out internal audits of the scheme.
- Assist the WSSB to deal with persons that vandalize the scheme and to resolve any conflicts pertaining to the scheme.
- Ensure smooth running of the scheme.
- Ensure sanitation standards are maintained in the community.
- Mobilise extension staff for continued sensitization of the community on water and sanitation.

Responsibilities of the WSSB

- Plan for water and sanitation scheme activities.
- Selecting, supervising and paying the Scheme Operator.
- Approve private connection applications before they are submitted to SWUWS for technical approval.
- Approve budgets and all expenditure of the scheme.
- Supervise sanitation activities.
- Sensitizing water users on water and sanitation.

Responsibilities of the Scheme Operator

1. Ensure smooth running of the scheme and constant supply of water to user community.
2. Maintain all assets of the scheme and keep inventory.
3. Maintain proper records of the scheme.
4. Smooth collection of funds for O & M of the scheme.
5. Supervision of sanitation activities and safe water chain sensitization.
6. Keep and maintain office for the scheme.
7. Responsible for procurements of scheme.
8. Make scheme projections about income and expenditure.

Scheme Operator Tasks

1. Regularly monitor scheme constructions to detect faults.
2. Carry out repairs timely.
3. Select scheme attendants and supervise them.
4. Update inventory of scheme.
5. Make entries in books of accounts regularly.
6. Prepare accounts documents for the scheme.
7. Take meter readings of the scheme regularly and collect money from Attendants.
8. Collect revenue from water sales (public tap stands & private connections).
9. Sensitize Tap Attendants about safe water chain.
10. Wash tanks, clean office, and sanitation facilities.
11. Procure spares, tools, and equipment of scheme.
12. Attend to impromptu visitors of the scheme.
13. Receive, complaints, suggestions from the users and forward them to WSSB for decision-making.
14. Carry out preventive maintenance of scheme.
15. Source fenced, grass trimmed, tap stands fenced.
16. Prepare business plan and budgets of the scheme.

Responsibilities of a tap attendant

- Collect money from the water users at the taps and hand it over to the SO.
- Ensure tap environment is clean and water collection containers are clean.
- Record meter readings at the beginning and end of each day.
- Sensitize users about proper water handling.

Conclusion:

All scheme actors in O & M must carry out their obligations diligently to ensure sustainability of the constructed systems.

Construction cost estimates

Drawings (schematic layout, profiles, hydraulic structures).