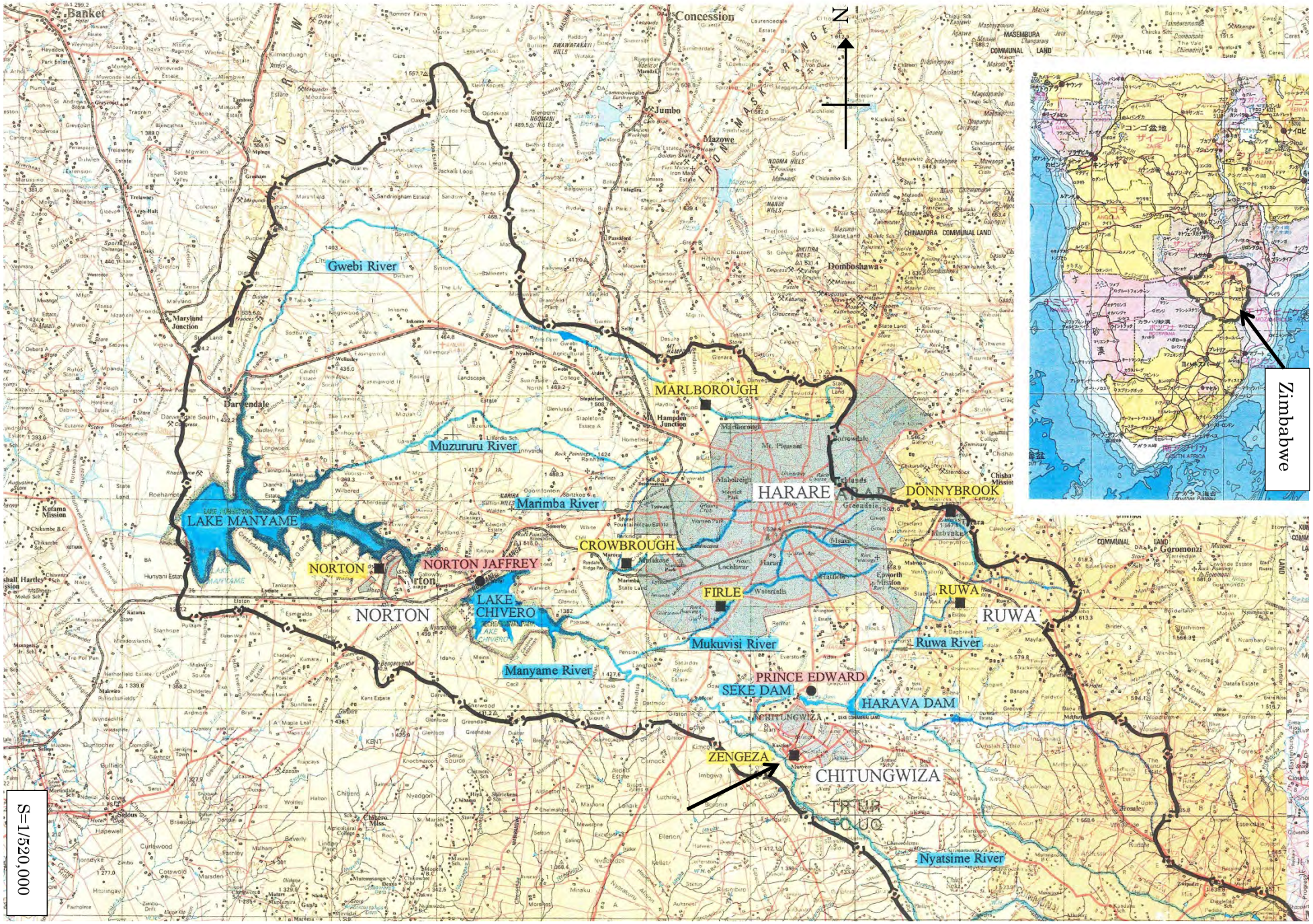
Exchange rate: 1 USD = 77.98 Yen, as of July 2012


N
Zimbabwe
S=1/520,000
Gwebi River
Muzururu River
Marimba River
Manyame River
Mukuvisi River
Ruwa River
Nyatsime River
LAKE MANYAME
LAKE CHIVERO
HARARE
CHITUNGWIZA
ZENGEZA
PRINCE EDWARD
SEKE DAM
HARAVA DAM
MARLBOROUGH
CROWBROUGH
DONNYBROOK
FIRLE
RUWA
NORTON
NORTON JAFFREY
Darwendale
Maryland Junction
Mazowe
Domboshawa
Concession
Banket
IRONMASK RANGE

THE PROJECT
FOR
THE IMPROVEMENT OF WATER SUPPLY, SEWAGE AND SOLID WASTE MANAGEMENT
IN
CHITUNGWIZA IN
THE REPUBLIC OF ZIMBABWE

FINAL REPORT

TABLE OF CONTENTS (APPENDIX)

Appendix

APPENDIX 1

Status of the Existing Sewerage Facilities and Evaluation for the Future Operation

1.1 Administration Building

The facility was commissioned in 2000, constructed by JICA project.

Table 1.1.1 Administration Building

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1998-2000, commissioned in 2000		
Quantity	One structure	1 lump sum	1 lump sum
Details/Specification	RC and Block	Building Service	Building Service
Current Status	Sound in structure	Maintenance needed	Need maintenance
Current Practical Performance/Function	Usable Ground sinking found near by the Building	Partly broken	Maintenance needed
Possibility of Future Use	Usable	Maintenance or rehabilitation needed	Maintenance needed
Expected Life Remaining	About 40 yrs		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for Future Use	Inspection and repair	Inspection and repair/change	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection.		

1.2 Sewage Treatment Process

There are 2 head works and one of them was commissioned in 2000, constructed by JICA project, the other was constructed in 1975.

Table 1.2.1 Head works constructed in 2000

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1998-2000, commissioned in 2000		
Unit or number	One structure	1 lump sum	1 lump sum
Details/Specification	RC	Screen, Grit Chamber	1 lump sum
Current Status	Not used, sound in structure	Rehabilitation, Maintenance needed	Rehabilitation, Maintenance needed
Current Practical Performance/Function	Usable	Partly broken	Rehabilitation, Maintenance needed
Possibility of Future Use	Usable	Maintenance or rehabilitation needed	Rehabilitation, Maintenance needed
Expected Life Remaining	About 40 yrs		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for Future Use	Inspection and repair	Inspection and repair/change	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection.		

Table 1.2.2 Head works constructed in 1975

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1975		
Unit or number	One structure	1 lump sum	1 lump sum
Details/Specification	RC	Screen, Grit Chamber	1 lump sum
Current Status	Used, decrepit, cracks and rebar exposures	Rehabilitation, Maintenance needed	Rehabilitation, Maintenance needed
Current Practical Performance/Function	Usable	Rehabilitation, Maintenance needed	Rehabilitation, Maintenance needed
Possibility of Future Use	Usable	Rehabilitation, Maintenance needed	Rehabilitation, Maintenance needed
Expected Life Remaining	About 10-20yrs after rehabilitation		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for Future Use	Inspection and repair	Inspection and repair/change	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection. **Subject to rehabilitation by AWF project under AfDB**		

Picture 1: 1975 Head Works

Picture 2: 1975 Head Works

Table 1.2.3 Anaerobic Ponds

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1975-2000		
Unit or number	Three structures	1 lump sum	1 lump sum
Details/Specification	RC, and Earth	Screen	1 lump sum
Current Status	Used but not cleaned, structure sound	Maintenance needed	Need maintenance
Current Practical Performance/Function	Usable	Partly broken	Maintenance needed
Possibility of Future Use	Usable	Maintenance or rehabilitation needed	Maintenance needed
Expected Life Remaining	About 40 yrs		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for Future Use	Inspection and repair	Inspection and repair/change	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection. **Subject to rehabilitation by AWF project under AfDB**		

Picture 3: 1975 Anaerobic Pond No. 3

Picture 4: 2000 Anaerobic Pond

Table 1.2.4 Trickling Filters

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1975-2000		
Unit or number	Five structures with distribution tank	1 lump sum	1 lump sum
Details/Specification	RC	Sprinklers and appurtenances	1 lump sum
Current Status	Not used, decrepit	Not used, decrepit	Not used, decrepit
Current Practical Performance/Function	Usable	Not used, decrepit	Maintenance or rehabilitation needed
Possibility of Future Use	Usable	Rehabilitation needed	Maintenance or rehabilitation needed
Expected Life Remaining	About 10-20 yrs after rehabilitation		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for Future Use	Inspection and repair	Inspection and repair/change	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection. **Subject to rehabilitation by AWF project under AfDB**		

Picture 5: 1975 Tricking Filters

Picture 7: 1975 Tricking Filter

Picture 6: Cracks on the 1975 Tricking Filter Wall

Picture 8: 1975 Tricking Filters

Table 1.2.5 Maturation Ponds

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	2000		
Unit or number	Three structures	-	1 lump sum
Details/Specification	Earth	-	1 lump sum
Current Status	Not used	-	Maintenance or rehabilitation needed
Current Practical Performance/Function	Usable	-	Maintenance or rehabilitation needed
Possibility of Future Use	Usable	-	Maintenance or rehabilitation needed
Expected Life Remaining	More than 10-20 yrs after rehabilitation	-	
Evaluation for Future Use	Possible	-	Possible
Required Measure for Future Use	Inspection and repair	-	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection. **Subject to rehabilitation by AWF project under AfDB**		

Table 1.2.6 Effluent Pump station

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1990, 2000		
Unit or number	Two structures	1 lump sum	1 lump sum
Details/Specification	Earth	Pumps and Electric Panels	1 lump sum
Current Status	Not used	Maintenance or rehabilitation needed	Maintenance or rehabilitation needed
Current Practical Performance/Function	Usable	Maintenance or rehabilitation needed	Maintenance or rehabilitation needed

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Possibility of Future Use	Usable	Maintenance or rehabilitation needed	Maintenance or rehabilitation needed
Expected Life Remaining	More than 10-20 yrs after rehabilitation		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for Future Use	Inspection and repair	Inspection and repair/change	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection. **Subject to rehabilitation by AWF project under AfDB**		

Table 1.2.7 Pipeline to the Farmland

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1995		
Unit or number	1 lump sum	-	1 lump sum
Details/Specification	RC	-	1 lump sum
Current Status	Not used	-	Need maintenance
Current Practical Performance/Function	Usable	-	Maintenance needed
Possibility of Future Use	Usable	-	Maintenance needed
Expected Life Remaining	Uncertain	-	Uncertain
Evaluation for Future Use	Possible	-	Possible
Required Measure for Future Use	Inspection and repair	-	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection.		

Picture 9: Channel from STP to Imbwa Farm

Table 1.2.8 Primary Sedimentation Tanks,

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1998-2000, commissioned in 2000		
Unit or number	Two structures	1 lump sum	1 lump sum
Details/Specification	RC	Sludge Scraper, Motor	1 lump sum
Current Status	Not used, sound in structure	Rehabilitation, Maintenance needed	Rehabilitation, Maintenance needed
Current Practical Performance/Function	Usable	Partly broken	Rehabilitation, Maintenance needed
Possibility of Future Use	Usable	Maintenance or rehabilitation needed	Rehabilitation, Maintenance needed
Expected Life Remaining	About 40 yrs		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for Future Use	Inspection and repair	Inspection and repair/change	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection.		

Picture 10: Primary Sedimentation Tank

Table 1.2.9 Flow Equalizing Tank

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1998-2000, commissioned in 2000		
Unit or number	One structure	1 lump sum	1 lump sum
Details/Specification	RC	Mixers, Motor,	1 lump sum
Current Status	Not used, sound in structure	Maintenance or rehabilitation needed	Need maintenance
Current Practical Performance/Function	Usable	Partly broken	Maintenance needed
Possibility of Future Use	Usable	Maintenance or rehabilitation needed	Maintenance needed
Expected Life Remaining	About 40 yrs		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for	Inspection and repair	Inspection and repair/change	Inspection and repair/change

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Future Use			
Judgement	Usable, maintenance and rehabilitation needed after inspection.		

Picture 11: Flow Equalizing Tank

Table 1.2.10 Biological Reactor

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1998-2000, commissioned in 2000		
Unit or number	One structure	1 lump sum	1 lump sum
Details/Specification	RC	Mixers, Motor,	1 lump sum
Current Status	Not used, sound in structure	Maintenance or rehabilitation needed	Need maintenance
Current Practical Performance/Function	Usable	Partly broken	Maintenance needed
Possibility of Future Use	Usable	Maintenance or rehabilitation needed	Maintenance needed
Expected Life Remaining	About 40 yrs		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for Future Use	Inspection and repair	Inspection and repair/change	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection.		

Picture 12 Biological Reactor

Table 1.2.11 Final Sedimentation Tank

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1998-2000, commissioned in 2000		
Unit or number	Four structures	1 lump sum	1 lump sum
Details/Specification	RC	Sludge Scraper, Motor	1 lump sum
Current Status	Not used, sound in structure	Rehabilitation, Maintenance needed	Rehabilitation, Maintenance needed
Current Practical Performance/Function	Usable	Partly broken	Rehabilitation, Maintenance needed
Possibility of Future Use	Usable	Maintenance or rehabilitation needed	Rehabilitation, Maintenance needed
Expected Life Remaining	About 40 yrs		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for Future Use	Inspection and repair	Inspection and repair/change	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection.		

Picture 13 Final Sedimentation Tank

1.3 Sludge Treatment Process

Table 1.3.1 Gravity Thickening Tank

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1998-2000, commissioned in 2000		
Unit or number	Two structures	1 lump sum	1 lump sum
Details/Specification	RC	Sludge scraper, motor	1 lump sum
Current Status	Not used, sound in structure	Maintenance needed	Need maintenance
Current Practical Performance/Function	Usable	Partly broken	Maintenance needed
Possibility of Future Use	Usable	Maintenance or rehabilitation needed	Maintenance needed
Expected Life Remaining	About 40 yrs		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for Future Use	Inspection and repair	Inspection and repair/change	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection.		

Table 1.3.2 Sludge Digester

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1998-2000, commissioned in 2000		
Unit or number	Two structures	1 lump sum	1 lump sum
Details/Specification	RC	Pumps	1 lump sum
Current Status	Not used, sound in structure	Maintenance or rehabilitation needed	Need maintenance
Current Practical Performance/Function	Usable	Partly broken	Maintenance needed
Possibility of Future Use	Usable	Maintenance or rehabilitation needed	Maintenance needed
Expected Life Remaining	About 40 yrs		
Evaluation for Future Use	Possible	Possible	Possible
Required Measure for Future Use	Inspection and repair	Inspection and repair/change	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection.		

Table 1.3.3 Sludge Drying Bed

	Structural Safety	Equipment Soundness	Pipelines/Plumbing
Construction	1998-2000, commissioned in 2000		
Unit or number	1 lump sum	-	1 lump sum
Details/Specification	RC	-	1 lump sum
Current Status	Not used, sound in structure	-	Need maintenance
Current Practical Performance/Function	Usable	-	Maintenance needed
Possibility of Future Use	Usable	-	Maintenance needed
Expected Life Remaining	About 40 yrs	-	
Evaluation for Future Use	Possible	-	Possible
Required Measure for Future Use	Inspection and repair	-	Inspection and repair/change
Judgement	Usable, maintenance and rehabilitation needed after inspection.		

1.4 Overall Evaluation of the existing facility in the Zengeza STP

Conclusion for the evaluation of the existing facility is as follows:

(1) All the mechanical/Electrical equipment will be needed to be rehabilitated for future reuse.

(2) Structures of the BNR facility are almost sound without visible wide cracks. Concrete surface is smooth and hard.

(3) Old Trickling Filters are decrepit with a lot of cracks with wide openings. Re-bars are exposed and corroded in some parts. However, rehabilitation of the structure will be possible and it will be available for the treatment work, since water tightness of the side wall is not perfectly required as the water flow direction is downwards from the top of the structure. Further water flow is not a pressured flow against the wall.

(4) AWF project under AfDB is going to rehabilitate the trickling filters for urgent rehabilitation work. Although its treatment capacity will not meet the discharging water quality, pump stations to transmit the effluent to the Imbwa Farm will also be made under the program. Imbwa Farm can accommodate the effluent for the pastures, by which discharge of the pollution load to the Lake Chivero will be avoided.

(5) BNR facility will be utilized for another purpose such as extended aeration or effluent reservoir, other than BNR use. Since the capacity of the facility is about 30,000 m^3, daily maximum inflow of 30,000 m^3/day can be accommodated with the rehabilitation of aerators without complicated sequential operation mode. Extended aeration process can flexibly be changed into the mode of Anoxic-Oxic-Anoxic-Oxic which enables biological nutrient removal in the future.

(6) There is a vacant lot in the yard out of six trains for the trickling filters by which effective alternatives can be possible to increase the limited capacity of the existing trickling filter process.

(7) Maturation ponds will be rehabilitated under AWF scheme as well and it will be usefull for not only the treatment but buffer facility before sending the effluent to the farm.

(8) Sludge treatment process is not included in the AWF scheme. Existing sludge digestion system is simple with no heating device. Structure is considered sound, then it is recommended to utilize the digestion tank for stabilization and volume reduction of the sludge.

Thus, reuse of the existing facility is promising for the future even it is not employing BNR process.

2. Confirmation of AfDB Project in Chitungwiza

2.1 Outline of the Project

a) Manyame Trunk sewer

There is a new Trunk sewer line under construction by The contractor which is being funded by African Development Bank. The project was awarded in September 2011 and it only started in February 2012 and is expected to be completed within 7 month. 250 mm diameter Asbestos Cement (AC) pipes is being used for the Trunk sewer which branch from the main sewer from manhole Ts27. The main Trunk sewer is being laid 375mm AC pipes, however the size of the pipes was changed to 400mm PVC pipes because the supplier had run out of stock of 375mm AC pipes. Prefabricated manhole rings with diameter of 1050mm and height of 600m are being used to construct manholes and cast iron lids have been substituted by pre-cast concrete rings due to vandalism. The depth of trenches depends on the terrain of the ground on this Trunk line it was up to 2,5m deep. The area has relatively high water table.

SUMMARY

i) Main Trunk sewer from Ts 21 –Ts 28

Overall length: 498 m

No. of pipes	Size	Type of pipe	No. of manholes
56	375mm	Asbestos Cement (AC)	
47	400mm	P V C	Total No. 7

6

Picture 14: New Sewer Pipes Installed by AWA Funds

Picture 15: New ACP Sewer Pipes by AWA Funds

Water Quality at the site

ii) 250 mm Trunk sewer

Overall length: 326.4 m

No. of pipes procured	Diameter	Pipe Material	No. of manholes
78	250 mm	Asbestos Cement (AC)	4

Picture 16: New Sewer Pipes Installed by AWA Funds

Picture 17: New Sewer MH Installed by AWA Funds

b) (i) **<u>Pump station 1</u>**

The pump was built in 70s.Pumps from the sump are corroded and they are now leaking. The contractor is currently working on building a tank to collect sand. They are going to construct a new vertical flow chamber on this pump station and a new mortar, new pump and new control panel is going to be installed. The ground has high water table and this has slowed down the progress since water constantly need to be pumped out of the trenches and ZESA load shading has also contributed the delay due to lack of electricity.

Picture 18: Inside Pump Station I

Picture 19: Outside Pump Station I

(ii) **Pump Station 2**

The station has not been working . On this station new pumps are needed.

Picture 20: Inside Pump Station II

Picture 21: Electrical Panel in Pump Station II

(iii) **Pump Station 3**

The pump station was built in 2003 and it only lasted for 2 years and up to now it is not working. The contractor is going to re habilitate the station. They are going to install a new vertical flow chamber. The pump station has 3 mortars and already the contractor collected 2 for servicing and one new one is going to be installed. Currently no work has started on this station

Picture 22: Vertical Chamber in Pump Station III

Picture 23: Pump in Pump Station III

Picture 24: Vertical Chamber in Pump Station III

APPENDIX 2
ILBM Report 2010

1. Introduction

Urbanization necessitates the provision of improved water and sanitation facilities. The most effective are high technology and often capital intensive to install and operate. The facilities are therefore very sensitive to economic factors. Since 2002, Zimbabwe had an economic crisis characterized by hyperinflation and negative economic growth which resulted in lack of expansion and inadequate maintenance of existing systems. Without water and sanitation facilities, the whole cycle of providing water and dealing with waste water broke down resulting in the environmental challenges such as eutrophication of Lake Chivero and the 2008 cholera outbreak.

Competence of sewage and wastewater treatment in the urban areas upstream of Lake Chivero has driven the marked historical changes in the water quality of this lake (Magadza 1997, 2008; Nhapi& Tirivarombo 2004). In the early 1970s, when Lake Chivero became hyper eutrophic, improvement of quality sewage effluent was achieved by the installation of Biological Nutrient Removal plants. For the best part of the last decade, inadequately treated and raw sewage has been discharged into the rivers that drain into Lake Chivero, resulting in the current poor quality of water.

The poor quality of raw water has also resulted in increased cost of water treatment as well as wastage of water. More than a decade ago, the wastage at Water Treatment Works was 12% for Prince Edward and 26% for Morton Jaffray (JICA, 1996). These high values were due to frequent backwashing and the high dosage of coagulant necessitated by the poor water quality and increased algae in the raw water.

Eutrophication resulted in undesirable ecosystem changes in Lake Chivero. The primary production levels Lake Chivero increased by over 10 orders of magnitude from 1.64 gCm2/h to 6.03 gCm2/h in 1979 to 18.5 gCm2/h to 140 gCm2/h around 2003 (Mhlanga *et al.* 2006; Ndebele 2003). Oxygen depletion and release of toxins caused by algal bloom die-off may lead to massive fish mortalities, as reported in Lake Chivero (Mhlanga 2006; Moyo 1997). The dissolved oxygen concentrations following an algal bloom die-off, ranged from 2 mg/l at a depth of 5 m to 3.9 mg/l at the lake surface. A mean of 2 mg/l and below 4 mg/l was measured in January 2010 (Muisa 2010).

A pollutant mass balance based on flow and nutrient revealed that sewage effluent was the major source of nutrients in the rivers. (Nhapi *et al.* 2001, 2006). The reason for this situation was that the major plants in Harare were overloaded. The total design capacity of the plants was 233 300 m^3/d compared to total current flows of about 279 300 (Nhapi *et al. 2001).* A more recent assessment was required on phosphates and nitrogen loading for the whole catchment hence the study in Chitungwiza.

Lake Chivero receives water from the Manyame, Mukuvisi and Marimba rivers. Chitungwiza and Ruwa are drained by the Manyame River. Sewage effluent from the Zengeza Sewage Treatment Plant (ZSTP) is discharged into the Nyatsime River and sewage from Sewage Pumps directly into the Manyame River. The Manyame contributed the highest in terms on nitrogen (2.645 kg/day) and phosphorus (506 kg/d) loads to Lake Chivero compared to the Marimba, Mukuvisi and direct runoff (Nhapi *et al.* 2006). At the time of that study, the Manyame River had higher concentrations than previously reported by JICA (1996). The increase was attributed to sewer overflows in Chitungwiza and the release of waste stabilisation pond effluent into rivers at Donnybrook and Ruwa plants. The situation worsened in the intervening years and new data on loading was required.

Industrial activities are a source of heavy metals contamination. Though results obtained by Zaranyika in 1997 and Mathuthu *et al*., 1997, reveal that copper and zinc levels fell within WHO recommended upper limits, Utete (2009) found that the levels of some metals in both flowing water and river bed sediments exceeded the WHO limits. Because of the potential health risk they posed these metals need to be monitored.

The objective of this study was to acquire current information to aid in the selecting of appropriate sewage management strategies in Chitungwiza that would minimize pollution of Lake Chivero. The quantity and quality of sewage was measured at the ZSTP and the quantities of sewage discharged from 3 pumping station discharging directly into the Manyame River were estimated. Our goal was to estimate the phosphorus and nitrogen loading into the Lake Chivero in order to assess the impact of sewage emanating from Chitungwiza.

2 Materials and Methods

2.1 Sampling site description

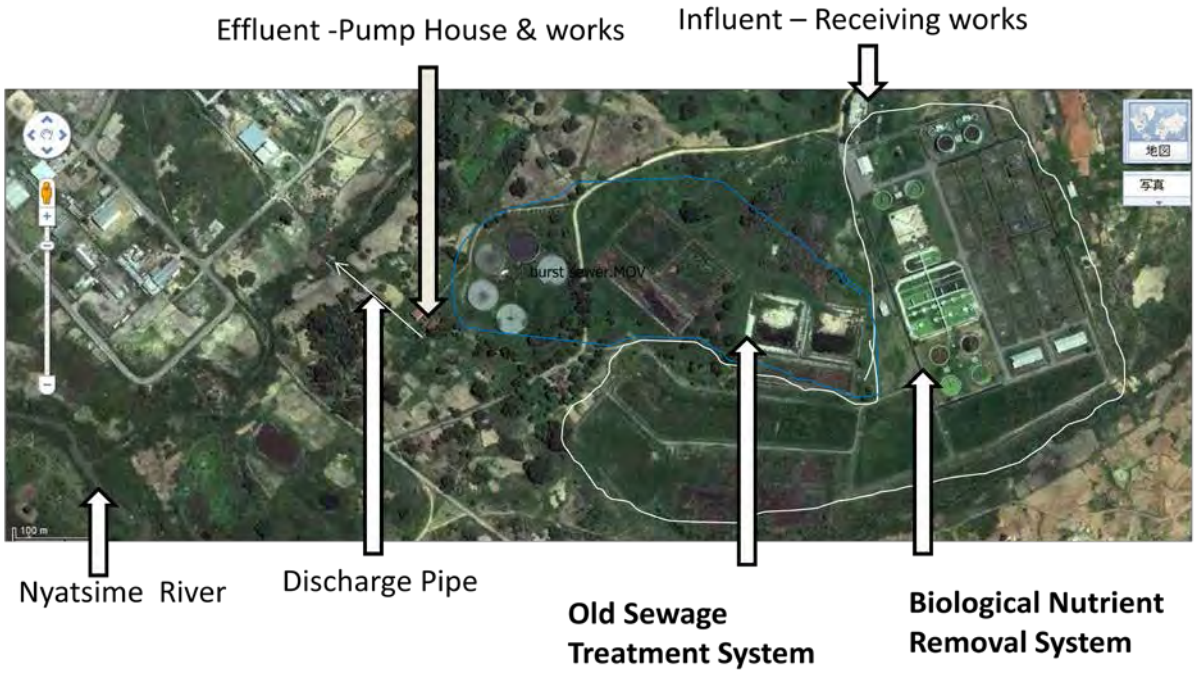


Figure A2-1 Map shows the layout of Zengeza Sewage Treatment Plant and the position of Sampling Points

The Zengeza Sewage Treatment Plant (ZSTP) comprise of two sewage treatment systems (Fig A2.1). The first to be constructed was the conventional system (Trickling filter) followed, in 2001, by the Biological Nutrient Removal (BNR). Each has a capacity of 20 mega l/day though the former can handle up to 35 mega l/day. The upper limit is inclusive of a 1.5 safety factor. The BNR system was meant to replace the older system but was not large enough to do so therefore both systems were operated concurrently.

Following several years of frequent breakdowns and disrepair, the BNR stopped functioning in 2003. Routine maintenance of the pump to keep the remaining equipment such as motors was undertaken. The conventional system was also maintained and all the sewage was diverted to it thus causing overloading. As a result, the residence time of sewage was shortened, resulting in loss of effectiveness in sewage treatment. Consequently, the discharge from the ZSTP was of unacceptable standard and contributed to the pollution of Lake Chivero.

The ZSTP plant received wholly domestic sewage with industrial sewage discharged into the river separately. Under normal operation the industrial effluent is pumped to the ZSTP. Metal concentration was measured to assess whether there were any other sources of heavy metal pollution. According to the sewage collection plan, the sewage from some parts of Chitungwiza was pumped to the ZSTP

from three pumping station but these had been broken down. The effluent from these pumps was consequently discharged directly into the Manyame River.

The original treatment system produced effluent that did not meet the standard for discharging into the river as reported by Zaranyika *at al.* 1999). Sewage effluent was therefore pumped out of the Lake Chivero basin to the Mupfure catchment and used for Imbwa Farm irrigation. The BNR system was supposed to produce effluent compliant to regulation for discharge into the river. When the pumps broke down all sewage was discharged directly into the Manyame River system. It is the quality of this sewage that was of concern and stimulated this study.

Flow measurements and sewage samples were collected at ZSTP at points indicated in Fig A2.1 and at one of the Sewage Pump Stations (SP). The weather data logger recording rainfall, temperature and relative humidity was placed close to the sewage intake.

2.2 Measurement of Flow at ZSTP

Flow rate was measured for 7 day from 18 to 24 December 2010. Measurements were taken hourly at the sewage intake (Influent) and 2 hourly in the Discharge pipe (Effluent) marked in Fig A2.1.

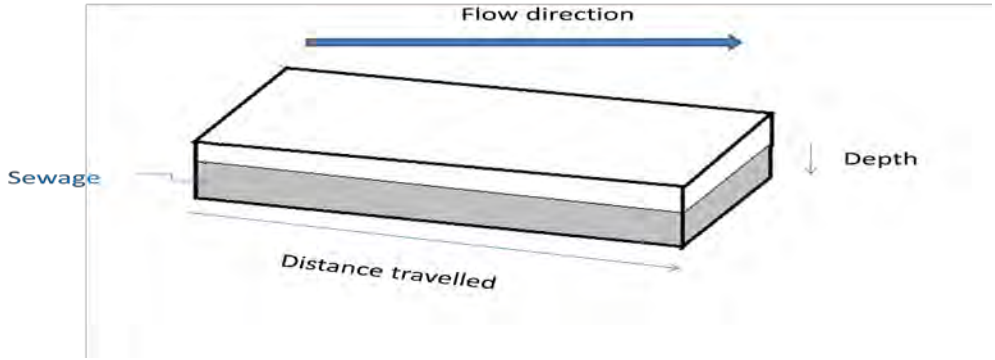
The sewage flow to the ZSTP was estimated from velocity in a section of the channel or pipe. The velocity was taken as the detention time of a float for the length of that section (Fig A2.2). In the Influent channel, a ping pong ball attached to a string was used as the float. A free floating, 5x5x5 cm block of white Styrofoam, was used in the effluent pipe.

The formula for estimating the volume of a rectangular solid was used to calculate the influent volume of the sewage. The volume contained in the measured section of the channel and the time taken by the ping pong ball to travel the length of that section was used to estimate sewage flow rate as below.

Flow rate = L x W x depth/time

Where L is the length of the section of weir and the length travelled by the ping pong ball, W is width of the channel and time is the time taken for the pig pong ball to flow down the length of the section of the channel (L). The length and width of the section were 669 cm and 89 cm respectively. Measures were taken to ensure accuracy of readings. Fifteen minutes prior to taking water samples and flow measurements grids used to remove large solids were cleared to prevent water damming. Sand deposits were cleared during low water in the early morning.

a) Influent channel measurement



b) Effluent pipe measurement

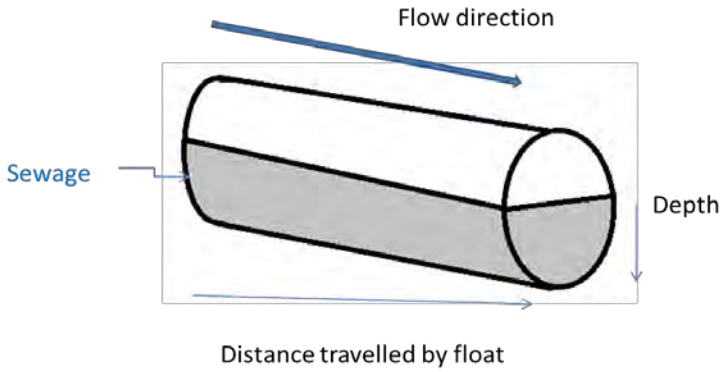


Figure A2.2. Measured dimensions at the intake (influent) weir and at the effluent outflow pipe.

The effluent volume was using the formula of a sector below;

$$R^2 \cos^{-1}(R-h/R)-((R-h)(2Rh-h^2)^{0.5})$$

Where R = radius of pipe and h is the height of the water in the pipe. The velocity of the float through the pipe was used to estimate flow rate.

The diameter of the effluent discharge pipe was 55 cm. The length of the section of the pipe used for estimating flow was measured using a GPS as well as a 500cm tape. The GPS reading gave a reading of 1000 cm that was used in the calculations.

2.3 Estimation of Sewage flow rates at Pump Stations

Sewage effluent from the three sewage pumps servicing Zengeza and St Marys were estimated from the resident population size. The calculations were based on the capita use of water and the non-consumptive use proportion that drains to the sewage works. Water consumption for the high density residential area was reported to be 80l/day (JICA 1996) and this value was used in the calculations. Of the water delivered to household, about 87% is discharged as sewage (Eng. Tinofa pers. communication). The exact number of people in each household was unknown hence sewage estimates were made using varying number of people per household of 10, 15 and 20. The median

value of 15 people per household was used to estimate the quantity of sewage discharged at the Pump Stations.

2.4 Sewage physical and chemical characteristics

Sewage samples for laboratory analysis were collected at the Influent and at the Effluent Pump House. Samples were taken every hour at the Influent and every 2 hours at the Effluent. On each sampling occasion, 200 ml of sewage was taken from the channel using the grab sampling technique. These samples were collected over a 24 hour period and mixed to make a composite sample. A subsample of 200ml was taken for analysis. Subsidiary samples were taken for further tests on 28 January, 8 February and 8 March 2011. Two grab samples were collected at these sampling occasions. A composite sample of these two was analyzed.

The physical and chemical parameters measured were chemical oxygen demand (COD), biological oxygen demand (BOD) total suspended solids (TSS), total dissolved solids (TDS) turbidity, conductivity, pH, nitrates (NO_3), nitrites (NO_2), ammonia (NH_3), phosphates (PO_4), total phosphorus (TP) chlorine (Cl), cadmium(Cd) , chrome (Cr), lead (Pb) and zinc (Zn). The sum of the Kjeldahl N, nitrite and nitrates was taken as the total nitrogen (TN).

Metals were analyzed using and Atomic Absorption Spectophotometry. Fore suspended solids the non-filterable residue method was used. Physical parameters were measured using meters.

The various methods used for chemical analysis are presented in Table A2.1.

Table A2.1. Methods used for the analysis of sewage.

Parameter	Method
Nitrates	Cadmium reduction column method
Nitrite	Diatomization method
Ammonia	High level indophenol method
Nitrogen	Persulphate digestion and cadmium reduction column method
Phosphate (PO_4-P)	Ascorbic acid/Muphy-Riley method
Total Phosphates	Persulphate digestion and ascorbic acid method
Chloride	Mercuric Nitrate Titrimetric method

3. Findings

3.1 Sewage flow Rates at Sewage works

Sampling each day started at 06.00 hours every day. Daily inflow of sewage had two typical peaks one at between 10.00 hours and 11.00 hours and the other between 18.00 and 20.00 hours (Fig A2.3). This pattern was not clear on Day 3, Day 6 and Day 7. These daily peaks had attenuated at the outlet.

The average daily inflow was between 193.7 and 244.8 l/s (16 735 and 21 151 m^3/day) with the highest recorded on 20 December (Fig A2.4). This high inflow coincided with the highest recorded daily rainfall of 22 mm (Table A2.2). Over the recording period, the average inflow was 224.6 l/s or 19 408 m^3/day. The average outflow was 255.7 l/sec/day or 22 090 m^3/day. The difference between the influent and the effluent is larger than expected and the source discrepancy may be due to infiltration of water into the system.

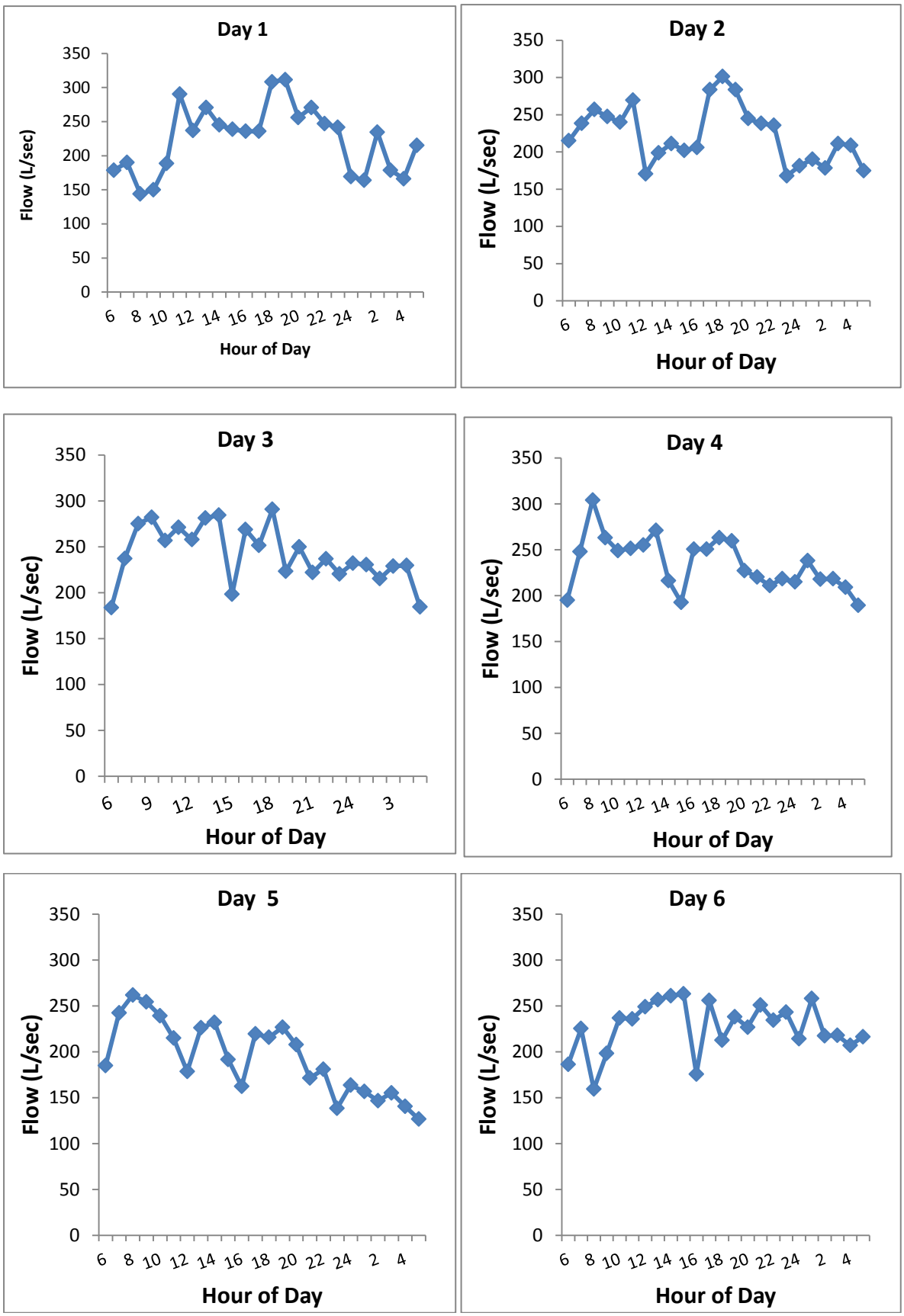


Figure A2.3. Pattern of sewage inflows throughout the day from Day 1 (18 Dec 2010 to Day 6 (24 Dec 2010).

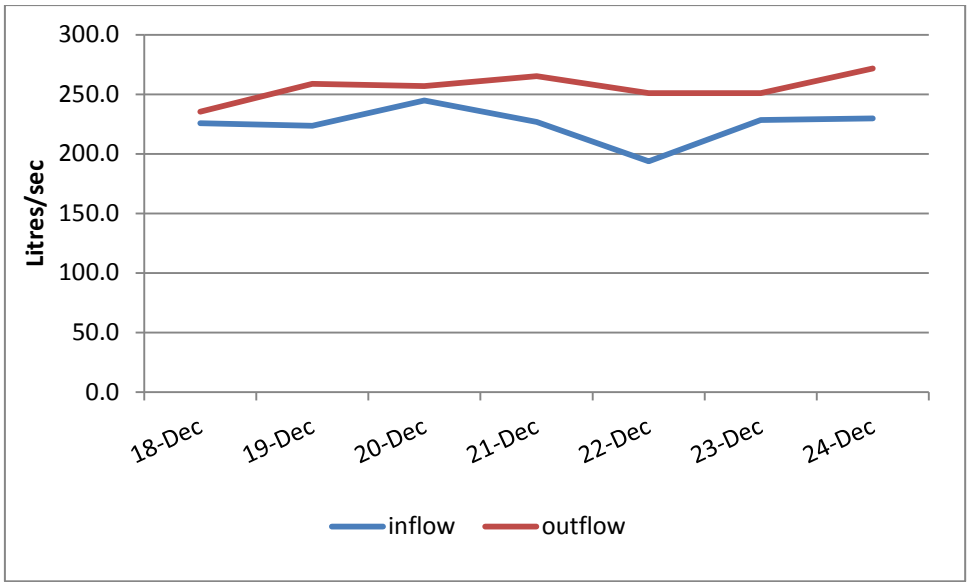


Figure A2.4. Average daily sewage flow rate through the ZSTP between 18 December and 24 December 2010.

Table A2.2. Mean daily temperature, relative humidity and total rainfall from 15 to 24 December, 2010.

Day	Temperature (^{0}C)	Relative humidity	Rainfall (mm)
15	21	76	1
16	22	71	2
17	21	76	18
18	22	75	8
19	21	78	1
20	20	84	22
21	20	78	0
22	22	69	0
23	23	69	0
24	22	77	1

3.2. Sewage flow at Pumps

The number of households supplied by the Sewage Pumps was highest for Pump 1 (Table A2.3). Pump 3 serves a new residential area which is still expanding and the number of households indicated here were those occupied. Since there was no information on the number of people in each household, 15 was guessed to be a reasonable figure. Using the value of 15 people per household the estimated amount of sewage produced was 12,240 ml/day. The amount would vary as shown in Table A2.3 for different household sizes.

Considering that the average inflow at ZSTP was 19 408 m^{3}l/day and the Sewage pumps produced 12,240 m^3/day the total discharge of sewage discharge from Chitungwiza was 31,648 m^3/day. Using

the average ZSTP effluent of 22,091 m^3/day the estimate total discharged effluent was 34,331 m^3/day. These estimates of sewage can be considered reasonable as the value is below the expected sewage flow of 39,150 m^3/day based on last year's estimated Chitungwiza water need of about 45 mega litres per day.
(http://www.parlzim.gov.zw/cms%5CHouse_Of_Assembly_Hansards/28_October_2010_37-09.pdf).
The sewage discharge estimates obtained here were used to calculate the phosphorus and nitrogen loading.

Table A2.3. Estimates of the volumes of water used and sewage discharged by households of 10, 15 and 20 persons, served by Sewage Pump stations in Zengeza and St Marys.

Pump Station	Households	Volume of water (m^3/day)		
		10 person	15 person	20 person
Pump 1	5,000	4,000	6,000	8,000
Pump 2	3,000	2,400	3,600	4,800
Pump 3	4,000	3,200	4,800	6,400
TOTAL	12,000	9,600	14,400	19,200
Sewage Estimate (85% water used)		**8,160**	**12,240**	**16,320**

3.3 Sewage Physical and Chemical characteristics

The results indicated discharge of raw sewage with high TDS, conductivity, nitrogen and phosphorus and chloride (Table A2.4). The mean influent TP, Kjeldahl N and TN in the December samples were 9.4 mg/l, 188.5 mg/l and 248.5 mg/l respectively. Effluent had slightly less values of 7.1 mg/l, 178.3 mg/l and 236.9 mg/l TP, Kjeldahl N and TN respectively showing an effect of passage through the ponds and filters.

The single grab samples collected in January, February and March at the ZSTP and the Sewage Pump in February also confirmed the discharge of raw sewage with high levels of ammonium, and suspended solids BOD and COD (Table A2.5). The mean values of TP, Kjeldahl N and TN in the influent of January and February were 12.8 mg/l, 278.4 mg/l and 429.6 mg/l. Again, compared to the influent, the effluent values were lower for nitrogen. The mean effluent values were 18.0 mg/L, 223.5 mg/L and 407 mg/L for TP, Kjeldahl N and TN respectively. The values recorded in this period had higher values of phosphorus and nitrogen compared to the December samples. This may be an effect of changes in water supply resulting in differences in dilution. Because water was not supplied to the section that is served by the Sewage Pump Station there was virtually no inflow of sewage when we sampled on 8 February 2011. Even so, the results were indicative of sewage quality.

The results obtained were comparable to those collected at the ZSTP in 2000, 2001and 2003 (Table A2.6). The values in the influent were between 8.8 and 11.8 mg/l TP and 81.2 to 110.6 Kjeldahl N. The effluent had low levels of both nitrogen and phosphorus until in October 2003 when values similar to those in the influent were recorded (Fig A2.5).

The metal concentration in the sewage was very low, a characteristic of domestic sewage (Table A2.7).

Table A2.4. Characteristics of the sewage collected at the ZSTP in December 2010.

Parameter	Site	18-Dec	19-Dec	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec
TDS (mg/l)	influent	811	664	709	771	790	824	705
	effluent	701	400	660	699	811	779	807
COND (µs/cm)	influent	893	731	779	848	868	905	774
	effluent	766	439	722	767	888	855	886
Total P (mg/l)	influent	8.4	5.2	10.5	11.2	8.7	12.4	9.6
	effluent	3.3	3.9	7.2	6.4	8.2	10.2	10.4
Cl (mg/l)	influent	142	142	177.5	197.4	169	183	205.2
	effluent	177.5	106.5	213	183.6	128.4	171.8	190.5
Nitrites (mg/l)	influent	0.02	0.04	0.03	0.04	0.04	0.06	0.06
	effluent	0.12	0.05	0.04	0.05	0.05	0.04	0.05
Nitrates(mg/l)	influent	80	70	60	70	40	60	40
	effluent	100	60	60	50	30	40	70
Kjeldahl N (mg/l)	influent	155	190	230	95	225.2	175.3	249
	effluent	100	205	240.5	110	198	228.7	165.6

Table A2.5. Physical and chemical characteristics of sewage collected in 2011 from the ZSTP and the Pump Station in St Marys.

	31/1/11		08/2/11		08/3/11		08/2/11
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Pump Station
SS (mg/l)	208	56	420	106	640	124	248
TDS (mg/l)	704	725	931	901	950	876	760
BOD (mg/l)	150	116	123	61	600	590	65
COD (mg/l)	626	528	540	225	1,128	1,067	485
COND (µs/cm)	773	798	1028	994	4,020	6,950	838
TURB (ntu)	305	102	375	189	680	279	379
pH	6.6	6.8	5.2	6.2	7.8	7.3	6.8
NO_2 (mg/l)	12.5	16	5	7.5	2	2	6.5
NO_3 (mg/l)	105	225	180	120	33.4	28.6	180
NH_3 (mg/l)	60	80	140	70	38.0	31.5	42
Kjeldahl N (mg/L)	116.3	122.0	440.5	325.0	201.7	184.8	397.0
PO_4 (mg/l)	4.8	4.5	7.8	5.2	47.4	43.8	6.5
Total P (mg/l)	14.1	12.8	11.4	23.3	87.5	64.7	18.4
Cl (mg/l)	106.8	78.3	37.0	178	177.5	142	34.2

Table A2.6. Sewage quality data from the BNR system from 2000 to 2003 (Raw sewage measured in equalization basin)

	21-Sep-00		5 Oct-00		12-Oct-00		4-Sep-01		28-Sep-01		9-Oct-01		1 Jan-03		1 Oct-03	
	Raw	Effluent	Raw	Effluent	Raw	Effluent	Raw	Effluent	Raw	Effluent	Raw	Effluent	Raw	Effluent	Raw	Effluent
SS (mg/l)	261	6.7	377	Trace	400	22.9	150	17.5	113	21.4	132	25.7	550	7.6	561	455
BOD (mg/l)	220	5.5	360	4.5	300	3			350	10.5						
COD (mg/l)	365	24.1	472	17.1	400.7	26.6	507.7	83.1	471.3	81.3	368.4	68.9	1005	75.9	1474.6	699.9
Ammonia (mg/l)	53	trace	41	Trace	38	trace	36	nil	43	6.6	52	2.76	61	12.6	59	59
Nitrites (mg/l)		0.12		0.06		0.46		0.03		trace		0.44		t		0.56
Nitrates (mg/l)		3.3		2.4		3.1		0.8		nil		Nil		nil		nil
Kjeldahl N (mg/l)	110.6	5.6	85.4	5.6	74	11.2		7.7	81.2	16.8		15.4		25.2	100.8	95.2
Total P (mg/l)	10.2	Trace	11.8	Trace	5.2	trace		1.01	8.8	1.92		0.18		0.32	9.4	12.2
Chloride (mg/l)		72					80	76	88	64	68	68	80	68	100	68

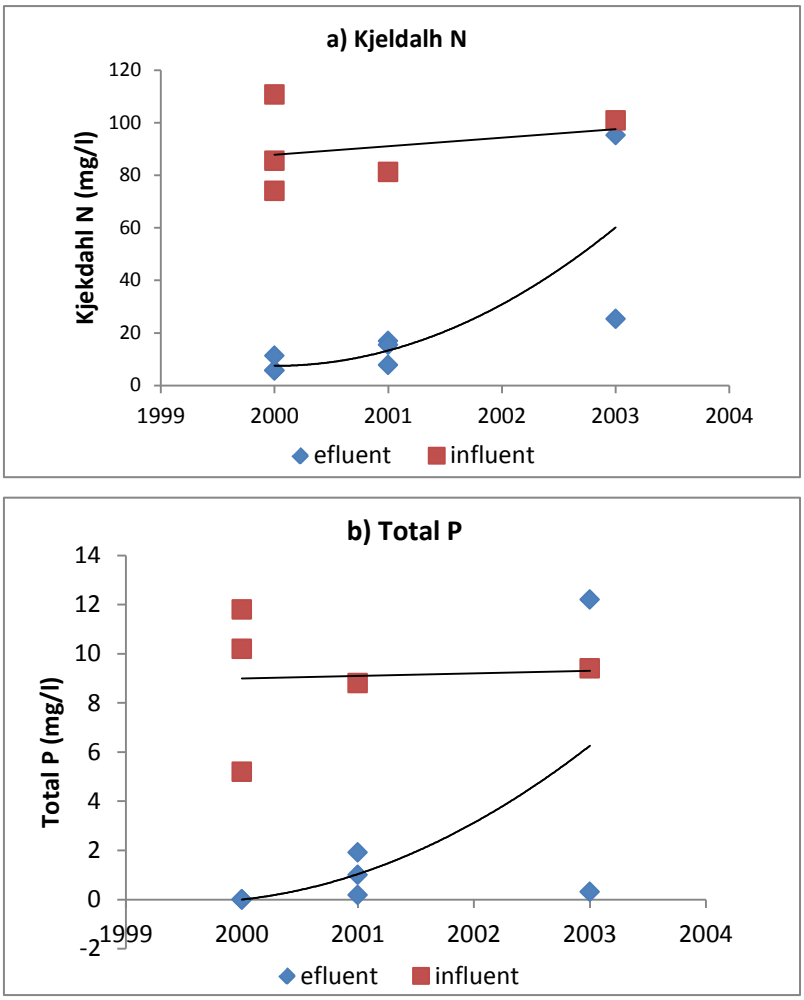


Figure A2.5. Changes in the concentration of Kjeldahl N and Total P in the influent and effluent from the ZSTP BNR from 2000 to 2003.

Table A2.7. Metal concentration in the sewage collected in December 2010 at the ZSTP

Date	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	Pb (mg/l)	Zn (mg/l)
Influent/Inflow					
18/12/10	ND	ND	ND	ND	ND
19/12/10	ND	0.07	ND	0.01	ND
20/12/10	0.01	0.03	ND	ND	ND
21/12/10	ND	0.09	ND	0.01	ND
22/12/10	ND	0.01	ND	ND	0.01
23/12/10	ND	0.10	ND	ND	ND
24/12/10	ND	0.08	ND	ND	0.02
Effluent/Outflow					
18/12/10	0.01	ND	ND	ND	ND
19/12/10	ND	0.10	ND	ND	0.01
20/12/10	ND	ND	ND	ND	ND
21/12/10	ND	0.07	ND	ND	ND
22/12/10	0.01	0.05	ND	ND	ND
23/12/10	ND	0.03	ND	ND	ND
24/12/10	ND	0.10	ND	0.01	ND

ND = not detected

3.4 Nutrients loading

The total sewage flow from Chitungwiza was taken as the sum of the Sewage Pumping Stations 1, 2, and 3 plus flow measured at ZSTP. The total sewage effluent flow used for the estimate was 34,331 M^3/day. At the time of sampling, since very little sewage flowed at the Sewage Pump Station hence the nitrogen and phosphorus from that sample was not used in the loading calculations. We took the composition of the sewage at the pump to be similar to that of the ZSTP. Flow measurements at the ZSTP were used for calculation loading for both the December samples and the later samples. Using the estimated Chitungwiza total effluent flow, the loading in December was 8,132 kg/day and 243 kg/day nitrogen and phosphorus respectively. The mean estimates of TN and TP from January and February 2011 samples gave loadings of 13,998 kg/day nitrogen and 619 kg/day phosphorus.

The nitrogen loading obtained from the December results is far higher than the 2,807 kg/day reported by Nhapi *et al.* (2006) for the Manyame River. In the same study the phosphorus loading was 655 kg/day which is higher than we found.

4. Management Implication of finding

The study highlighted major problems of sewage management in Chitungwiza. One major problem is the discharge of untreated sewage with high nutrient contents and other qualities that affect human health and the ecology of the receiving waters. The data we obtained showed the inadequacy of sewage handling and treatment capacity. We also encountered problems in data availability, retrieval and access. There is nevertheless much strength such as the current infrastructure and human resources that can be utilized to improve the management of waste water. In this section we shall consider these issues in respect to pollution of Lake Chivero and sewage management in Chitungwiza.

4.1 Chitungwiza ia a source of large amount of phosphorus and nitrogen

Sewage from Chitungwiza is a source of large amounts of phosphorus and nitrogen entering the Manyame River. Even though the contributions of other sources were not measured we know that sewage is major source of nutrients.

Nhapi & Tirivarombo (2004) reported that overflow from a sewage treatment plant accounted for 47% of TN and 42% of TP in the Mukuvisi River. Nhapi *et al.* (2006) reported that the Manyame River brought into Lake Chivero the largest amount of TN and TP compared to Mukuvisi River, Marimba River and Direct runoff. Our results showed that heavy loading of the Manyame River still occurred. We conclude that loading from this river has a large impact of the total loading of Lake Chivero.

Considering the long duration, of at least 5 years, when the ZSTP was not operating at all, a large amount of nutrients have been transported in the river system. The high loading and the duration of the problem must accounts for the current severity of eutrophication in Lake Chivero.

4.2 Effective Treatment of sewage Essential

The study highlighted the need to treat sewage in order to reduce nutrient loading. When functional, the ZSTP reduced the nutrient load substantially (Fig A2.5). Also, the history of Lake Chivero testified the effectiveness of the use of the BNR in the removed of nitrogen and phosphorus (Thornton 1982). Because the effluent did not meet the standard for discharging into rivers, the effluent was pumped into the adjacent Mufure River catchment. The pump to transfer the effluent was not working at the time of the study, and yet it is critical to effect a reduction of nutrient loading. A sewage treatment system will only have a positive impact if it removes nutrients from the sewage to an acceptable level.

4.3 Inadequate Effective Sewage Treatment

The amount of sewage generated by the Chitungwiza is much more than the capacity of the existing BNR plant. At the time of study, an unknown amount of sewage may have been lost through broken and blocked pipes. In addition, waste water from industry was not assessed in this study. The BNR plant capacity is 20,000 m^3/day yet the amount of sewage inflow was more than 30,000 m^3/day. (The current influent at ZSTP is between 19,000 and 22,000 m^3/day and the three non-functional Sewage Pumps may together bring in about 12,000 m^3/day).

The conventional system (Trickling filter) that is unable to remove P and N but will continue to be needed for sewage treatment. The conventional system will continue to produce effluent that has to be removed from the Lake Chivero basin. A BNR or a similarly effective system is needed to produce effluent that meets the discharge standard. The BNR system may not be the only available technology. Methods for treatment of sewage that do not rely on capital intensive and heavy maintenance need to be explored. Magadza 2008 advocated the use of ecological methods for treatment of runoff. The use of specifically constructed and managed wetlands may be beneficial and need to be considered and tested.

4.4 Industrial sewage handling

The study showed very low levels of metals in the sewage entering the ZSTP. However, heavy metals have been recorded in the Manyame River (Utete 2009) indication a need to deal with this type of pollutant. The industrial sewage will have high metal content and other pollutant that may harm the other systems hence should be dealt with separately. The characteristic and quantity of the industrial sewage need to be assesses and its processing evaluated. The collection of sewage need to be resuscitation and maintained such that all sewage is treated to required standard before discharge.

4.5 Excessive sand in system

There was constant need for removal of sand in the section where flow measurements were taken. The sand reduces the lifespan of pumps and therefore should be prevented from entering into the works.

4.6 Data collection and access

The data needed to make the assessments in this study was not handy yet such data is needed for effective management. Simple data such as the number of residence, water supplied to the city and water usage by metered household, could have been useful in the estimation of sewage outflow. A computerized system is essential.

4.7 Monitoring for anticipated changes

Changes taking place such as the repair of sewage collection pipes, the ZSTP will affect the parameters measured in this study. The process to rehabilitate the ZSTP (African Development Bank 2009) and the sewage treatment plants in Harare are underway. A monitoring system ought to be in place to document changes in effluent, loading and the impacts of these changes to the Lake Chivero basin.

4.8 Sustainable financing of Chitungwiza Sewage Treatment

Chitungwiza is a major urban area situated upstream of Lake Chivero and contributing to the eutrophication of this lake. Poor planning that favoured location of the dormitory town of Chitungwiza upstream of the water source contributed to the woes of discharge of waste water (Magadza 2008). This situation necessitates exploring and setting up financing measures to ensuring proper and sustainable sewage treatment.

Acknowledgements

The sewage flow and water samples were collected by Chitungwiza municipality. Metal analysis was performed by the Institute of Mining Research, University of Zimbabwe. We are grateful to the use of the weather data logger loaned by the Department of Physics. The project was funded by ILEC.

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APPENDIX 3

Logs of Sewerage and Zengeza STP for 2001 and 2012

Outline of Operation

<February, 2001>

(1) ZSTP Old: Operational for Trains 2 and 5
Q1= 17,339 m^3/day

(2) ZSTP BNR: Operational, discharging to the River
Q2= 21,357 m^3/day

(3) Influent SS: SS= 392 mg/l

(4) Effluent PS Old: Operational

(5) Effluent PS New: Operational

(6) St Mary's PS 1: Operational

(7) St Mary's PS 2: Operational

(8) Tilcor PS: Operational

(9) Anaerobic Ponds: Operational

(10) Trunk line Blockage at 633 locations

(11)

<March, 2012>

(1) ZSTP Old: Non Operational, discharging raw sewage
Q1= Approx. 400,000 m^3/day

(2) ZSTP BNR: Non Operational, most equipment broken down
Q2= 0 m^3/day

(3) Influent SS: SS= unknown

(4) Effluent PS Old: Non Operational

(5) Effluent PS New: Non Operational

(6) St Mary's PS 1: Non Operational

(7) St Mary's PS 2: Non Operational

(8) St Mary's PS 3: Non Operational

(9) Tilcor PS: Non Operational

(10) Anaerobic Ponds: Non Operational

Remarks: ZSTP, Zengeza Sewage Treatment Plant

CHITUNGWIZA MUNICIPALITY

ENGINEERING SERVICES DEPARTMENT

MONTHLY REPORT FOR THE MONTH OF JANUARY 2001 TO BE PRESENTED TO THE PUBLIC WORKS, TOWNLANDS AND ENVIRONMENTAL MANAGEMENT COMMITTEE MEETING TO BE HELD ON 12 FEBRUARY 2001

1. BUILDING SECTION

Projects

(a) **Vocational Training Centres**

(i) Makoni Vocational Training Centre

Only the additional toilets required for ladies are not yet completed due to none supply of the additional materials. The school had proposed to supply the materials but to no avail.

(ii) St Mary's Vocational Training Centre

The renovations at this centre are being delayed by none supply of the following material:-

(a) IBR sheets for the garage
(b) All requested plumbing materials

The whole job is 86% done.

(iii) Zengeza 3 Bottlestore – Conversion to Minibar

- Progress on the ceiling is being hampered by the existing cold room which has not yet been removed by the Liquor Section
- Material for repositioning the main entrance door has not been supplied.
- Painting of the whole complex will only start after all internal work has been complete.

(iv) Industrial Incubators

The brickwork cladding of this four (4) compartment steel framed block started on 3 January 2001. Overall progress is 80% complete:-

General Maintenance

(e) CM – Other Departments/Sections

i. HQ Housing

Repaired two broken chairs.

(f) **Council Schools**

i. Ndangariro Primary School

Replaced all broken louvres supplied by the school.

ii. Tasimukira Primary School

Attended to plumbing repairs.

iii. Zengeza Main Primary School

Attended to plumbing repairs.

2. **ROADS SECTION**

(a) Drain Cleaning

The above work was carried out at:-

- Unit 'O' area along the road at Nzungu,
- Chaminuka School in St Mary's,
- Chikomo
- Vavarirai Roads
- Makoni Shopping Centre using the 428 'B' Excavator.

(b) Stabilizing

Stabilized gravel to fill potholes along the following roads:-

- Mutsau
- Zvidozvevanhu
- Chiratidzo
- Musarurwa
- Chaminuka
- Mukamba
- Nehanda
- Tilcor
- Chitewe
- Ingwe
- Munaiwa
- Chirambahuyo
- Chimurenga
- Batanai
- Shambare
- All shopping centres

(c) Humps

Constructed three (3) humps as follows:-

- 1 along Ingwe Drive in St Mary's
- 1 along Dumukwa in Zengeza 1
- 1 along Waterland Road in Zengeza 4

(d) Catch Pits Cleaning

Cleaned Makoni Shopping Centre and still an ongoing exercise.

(e) Bulldozer

The machine bush cleared a new road in Unit C Extension, at Refuse Dumping Pit and stock piled gravel near cemetery.

(f) Patching of Potholes

Patching of potholes is an ongoing exercise and listed hereunder are the roads patched during the month:-

- Jenje Road at Makoni Shopping Centre
- Mangwende Road in Unit 'G'
- Mharapara Road in Seke
- Marufurira in Unit A
- Gura in Unit K
- Manyara Road link between Units J and K
- Hondo Road in Unit J
- Tumba Road in Unit J
- Hombarume Drive in Zengeza 1 and 2
- Mukomberwa Drive in Zengeza 3,
- Ingwe Drive in Zengeza
- Hadzinanhanga
- Industrial Drive

(f) Premixing

Mixed aggregate stone and emulsion tar at the Depot and used 29 drums of catmix for patching of potholes.

(g) Gravelling

Carting of gravel to the following roads was carried out:-

- Town Centre in Unit D
- Chimurenga Road in Zengeza 4
- Hadzinanhanga Road
- Unit C Extension
- Mukamba Road in Unit F
- Karimatsenga Road in Unit K
- Zengeza 2 Open Spaced
- Zengeza 5 along Mbizi Close
- Chiratidzo Drive in St Mary's
- Chaminuka Primary School
- Dumukwa Road
- Ingwe Drive
- Waterland Road

(h) Motor Grader

The machine levelled the roads and open spaces that were gravelled.

(i) Frontend Loader

The machine loaded gravel into Tipper Trucks.

(j) Roller

The machine compacted all patched roads during the month.

3. **AMENITIES SECTION**

(a) Nursery

- Pot filling
- Prick-outs and watering
- Weeding
- General cleaning
- Root pruning

(b) Plant and Timber Firewood Sales

(i) Revenue collected - $3 565.00

(c) Cemeteries

	Type of Burial	No. of Burials	Revenue Collected
1.	Resident Infants	48	22 257.92
2.	Non Residents Infants	53	35 640.52
3.	Resident Adults	90	59 362.63
4.	Non-Resident Adults	61	64 517.70
5.	Pauper Adults	-	-
6.	Pauper Infants	-	-
7.	Free Adults	2	-
8.	Free Infants	-	-
	Totals	**254**	**181 778.77**

(d) Tractor Grass Cutting

The following areas had grass cut:-

- Zengeza Dental Clinic
- St Mary's Clinic
- St Mary Administration Office
- Katanga Beer Garden
- Unit F Library
- Chitungwiza General Hospital
- Seke North Clinic
- Seke Tavern
- Sewerage Treatment Plant area
- Tilcor Road
- Part of New Chitungwiza Road
- Tumba Road
- Tilcor Industrial Roads
- Chibuku Stadium

(e) Lawn Mower Grass Cutting

The above operations were done on the following places:-

- Head Office
- Zengeza Clinic
- Zengeza Administration Office
- Zengeza Library
- St Mary's Clinic
- St Mary's Administration Office
- Seke North Clinic
- Seke North Administration Office

4. MECHANICAL WORKSHOP SECTION

84 vehicles came for repair, 47 were repaired and taken away and 37 are still in workshop awaiting spares. Below is their breakdown:-

Trucks Taken Away after Repairs

	Fleet No.	Type	Department	Work Done
1.	250	Isuzu Truck	Sewerage	Engine overhaul, 1 x new battery terminal
2.	347	Mitsubishi Tipper	Roads	Clutch adjusted
3.	188	Mazda B1600	Security	B. service Removed, repaired and fitted starter Removed and fitted pump
4.	348	Mitsubishi Tipper	Roads	Air lock priming
5.	291	Nissan CK450	Refuse	Broken hydraulic steering pump Repaired seat Removed and fitted brake chamber Adjusted brakes Repaired and fitted hydraulic ram
6.	255	Nissan Hardbody	Liquor	Brakes adjusted Handbrake adjusted 1 x 12 bulb fitted
7.	257	Nissan Hardbody	Sewerage	Set rebonded and brake pads fitted 4 x rear wheel cylinder kits fitted
8.	314	Mitsubishi Lancer GLX	Engineering Services	1 x 12 double contact bulb fitted
9.	326	Nissan Hardbody Bankrun	Treasury	Set rebonded brake pads fitted
10.	187	Mazda B1600	Amenities	Removed and fitted worn out timing gear Tightened cross member bolts
11.	362	Hyundai	Audit	Repaired boot catch Clutch adjusted
12.	219	Mazda B1600	Refuse	Repaired clutch master cylinder Engine tune-up

				1 x set points fitted
13.	346	Mitsubishi Tipper	Roads	Air lock priming
14.	247	International Tractor	Refuse	Repaired and fitted clutch plate and p/plate
15.	304	Nissan CK450	Refuse	Removed gearbox clutch plate and p/plate 1 x new clutch plate and p/plate fitted
16.	273	Furukawa 325	Roads	2 x new batteries, air lock priming
17.	221	Suzuki A100	Building Inspectorate	1 x new clutch cable
18.	271	Nissan Hardbody	Ambulance	Set rebonded brake pads fitted
19.	325	Nissan Hardbody	Sewerage	B. service
20.	259	Nissan Hardbody	St Mary's Administration	Checked brake pads, rear brakes and adjusted them 1 x set rebonded brake pads fitted
21.	320	Nissan Hardbody	Water	1 x set rebonded brake pads fitted 4 x new ball joint bolts 2 x machined brake drums 4 x relined brake shoes fitted.
22.	299	Nissan CK450	Refuse	Air lock priming
23.	343	John Deere 2400	Amenities	Air lock priming
24.	321	Nissan Hardbody	Engineering Services	1 x battery fitted
25.	185	Mazda F1300	Main Council	Towed to supplier for electrical repairs claim
26.	243	Nissan D/C P/U	Health	2 x 5 amps indicator bulbs
27.	334	Nissan Champ	Engineering Services	1 x 15 amp fuse
28.	345	Isuzu KB280D	Housing	Repairs canopy door catch
29.	317	Mitsubishi L200	Treasury	Removed clutch plate and p/plate 1 x new clutch plate and p/plate fitted B. service
30.	294	Nissan CK450	Refuse	Fitted hub studs and nuts
31.	272	Nissan Hardbody	Ambulance	Set rebonded brake pads fitted 2 x 5 amp indicator bulbs fitted

8

				2 x 15 amps fuses 4 x rear wheel cylinder kits fitted Rear brakes adjusted
32.	258	Nissan Hardbody	Seke North Administration	Tightened earth wire 1 x set rebonded brake pads fitted
33.	2324	Nissan Hardbody	Security	2 x machined brake drums 4 x relined brake shoes fitted
34.	276	CAT Frontend Loader	Roads	Lost boom pad 1 x pad fitted 5 x new bucket tips fitted
35.	330	Nissan Hardbody	Ambulance	Repaired petrol pipe Removed thermostat
36.	282	Mitsubishi grader	Roads	1 x repaired drive chain fitted removed drive chain broken returned chain
37.	281	CAT Frontend Loader 928F	Refuse	2 x single contact bulbs 24 v air lock priming
38.	260	Isuzu KB260	Health	Check gearbox oil fitted
39.	322	Nissan Hardbody	Electricity	Removed starter for repair 1 x repaired starter fitted
40.	340	John Deere	Roads	Removed worn out hydraulic pipe, fitted one Clutch priming
41.	353	Suzuki 100	Health	Cleaned plug
42.	241	John Deere 2400	Refuse	Clutch priming
43.	234	Ford Tractor 6640	Refuse	Fitted repaired clutch plate and p/plate
44.	350	Mitsubishi Canter	Security	4 x machined brake drums 8 x relined brake shoes
45.	211	Landrover V8	Fire Brigade	4 x machined brake drums 8 x relined brake shoes B. Service
46.	249	MF 375 Tractor	Sewerage	Repaired Hydraulic
47.	363	CAT SD6D	Roads	Ram seals fitting and ram fitting
Vehicles in Workshop Awaiting Spares				
1.	328	Nissan Hardbody	Ambulance	Engine overhaul in progress some spares not yet delivered (chain guides and timing chain)
2.	329	Nissan Hardbody	Ambulance	Cylinder head for repair indent

				raised not yet approved
3.	186	Mazda B1600	Liquor	Engine needs new rings Cylinder head for repair head gasket, indent not yet raised awaiting ring size
4.	235	Ford Tractor 6640	Refuse	Pilot bearing and clutch plate and p/plate fore repair indent raised not yet approved
5.	342	John Deere	Amenities	Engine not starting – requisition raised
6.	247	International Tractor	Refuse	Clutch plate and p/plate needs repair – requisition raised also, front hub needs repair, indent not yet raised.
7.	254	Nissan HB12	Audit	Removed cylinder head and radiator for repair – indent raised but not yet approved.
8.	302	Nissan CK450	Refuse	Need tyres and seals hydraulic (jumbo leg)
9.	237	Nissan CP12	Roads	Clutch plate and p/plate for repair 2 x new batteries –indent not yet approved
10.	282	Mitsubishi Grader	Roads	Broken drive chain send to supplier claim
11.	2809	Nissan CK450	Refuse	Ignition needs repair waiting for auto electrical
12.	283	Nissan CK450	Roads	Needs tyres – no starter (starter stolen)
13.	288	D7R Bulldozer	Road	Repair transmission – indent not yet approved
14.	241	Fiat Tractor	Amenities	2 x gearbox sycromesh – indent not yet approved
15.	198	Toyota Dyna	Building	Old alternator beyond repair New alternator ordered – vehicle under VID
16.	225	Mazda B1600	Sewerage	Engine overhaul indent not yet approved
17.	224	Mazda B1600	Sewerage	Engine overhaul - indent not approved
18.	220	Mazda B1600	Sewerage	Engine overhaul done,

				distributor engine mountings battery condensor points fuel pump – indent not yet approved
19.	333	Nissan Champ	Health	1 x new coil spring – indent not approved
20.	344	John Deere 2400	Refuse	Diff for repair
21.	337	John Deere 2400	Amenities	Engine noise (alternator) – stolen starter
22.	338	John Deere 2400	Refuse	Brakes
23.	340	John Deere 2400	Refuse	Draw bar bolts and pin
24.	218	Dumper	Refuse	Engine overhaul
25.	216	Peugeot 504	Fire Brigade	Gearbox for repair
26.	215	Peugeot 504	Fire Brigade	Gearbox for repair
27.	331	Mazda E2000	Ambulance	No spares
28.	332	Mazda E2000	Ambulance	No spares
29.	330	Mazda E2000	Ambulance	No spares
30.	130	Wright Grader 130G	Roads	Cutting blades indent raised
31.	208	Peugeot 505	Ambulance	Engine overhaul – send to Puzey and Payne – returned as there were no funds, starters and alternators were stolen when returned
32.	214	Peugeot 505	Ambulance	Engine overhaul – send to Puzey and Payne – returned as there were no funds, starters and alternators were stolen when returned
33.	217	Peugeot 505	Ambulance	Engine overhaul – send to Puzey and Payne – returned as there were no funds, starters and alternators were stolen when returned
34.	204	CAT Compactor	Roads	Exhaust manfold and gasket - indent not yet approved
35.	183	D4H Bulldozer	Roads	Strip and quote hydraulic pump and repair – indent not yet approved
36.	226	CAT 916	Roads	Strip and quote engine indent not yet approved
37.	331	Nissan Hardbody	Ambulance	Repair cylinder head

				Overhaul gasket supplied Service filters delivered Stub, axle indent raised , not yet approved Wheel bearings delivered Rear springs - indent raised but not yet approved.

Vehicles sent out for Repairs

	Fleet No.	Type	Section/ Department	Garage Vehicle taken to/Work to be done
1.	298	Nissan CK450	Refuse	Vaals Panel Beaters for Accident damages ready but excess not paid SI 58475, 5 October 2000
2.	290	Nissan CK450	Refuse	Vaals Panel Beaters awaiting headlamps
3.	327	Nissan Hardbody	Administration and Secretarial Services	Ready but cheque dishonoured Engine overhal after knock
4.	235	Ford Tractor 6640	Refuse	Supreme Panel Beaters work in progress

N.B A mistake was made in the previous meeting. It was reported that fleet number 298 is back instead of fleet number 301. The omission is regretted.

5. **WATER SECTION**

The following works were attended to in January 2001

36No Underground water pipes were repaired
19No New water connections were given
19No Low water pressure pipes were attended by removing sand in the pipe/water meter
23No Constant water meters were repaired
22No Minor leakages were repaired
18No Meter for water reconnections were attended to
20No Meter disconnections were carried out during the month
6No New brass stop cork were fitted
4No Re-routing was done

We also completed servicing of new stands at Zengeza 3, Units C and J infills and work is in progress at Unit N infill.

6. **ELECTRICITY SECTION**

General Maintenance

1st Week

Zengeza Clinic

Installed 3 x 100 watts BC lamps bought by petty cash and 1 x BC lamp holder also bought by petty cash. Invoice number 60.

Kushinga Beerhall

Installed 2 x 100 watts BC lamps and 1 x BC lamp holder.

Unit 'O' Beerhall

Installed 1 x backlight lamp holder and 1 x 100 watts BC lamp.

2nd Week

Dungwiza Primary School

Installed 1 x cable joint, tape 20m x 1 core armored cable and 20m x earth wire.

Hunyani Beerhall

Installed 5m x armored cable in the beerhall's canteen.

Zengeza 4 Butchery

Repaired the cutting machine.

3rd Week

Katanga Beerhall

Installed 6 x fix shot six points lights and 6 x 2ft security lights.

Seke Tavern

Installed 9 x 100 watts BC lamps and 9 x BC lamp holders. All bought by petty cash. Invoice number 0001973.

St Mary's Mini Bar

Installed 1 x plug top bought by petty cash. Invoice number 9.

7. SEWERAGE/SEWAGE SECTION

Effluent into Old Works	520 160m^3
Effluent into BNR Works	640 710m^3
Total Inflow into works	1 160 870m^3
Total grit removed	175m^3
Total screenings removed	94m^3

Intake Works

Compressor 3 is running. Compressor number 1 still out at Compu Air for repair. New intake (BNR) grit pumps running well.

Effluent Pumpstations

Old Pumphouse

Pumps 1, 2 and 4 running. Pump No. 3 is broken down.

New Pumphouse

Pumps 1, 3 and 4 running well. Starter valve and motor for pump number 2 all still out for repairs. ABB Kent came and repaired faulty recorders.

St Mary's Pump 1

All pumps running.

St Mary's Pump II

Both pumps running.

Biological Filters

Filters number 2 and 5 are operational. Filters 3 and 4 were stripped and bearings taken out for quotations. Indent written out for replacement bearings.

Tilcor Pumpstation

All pumps running well.

Anaerobic Ponds

All sets of ponds operational. Desludging of ponds sets hampered by full drying bed (sets one and 2) and breached bed embankment (sets 3 and 4)

B.N.R. Plant

Generally the plant is running well. Our final effluent continually spilling to the river. The Electrician replaced flat battery and drive bolt for flow control actuator now working well. Instruments in control room (flow control) also reading well.

Blockages

Mainline	633
Toilet Blockages	48
Excavations	24
Sewer Connections	3
Reblocked toilets attended to	14
Council Properties	26

8. INSPECTORATE SECTION

Area	Total No of Stands	Total Plans Approved So Far	Estimated Cost	Total No. of Houses Commenced	Progress in 01/2001 Approved Plans	Total Houses Completed
Residential						
Seke Unit A	1 882	774	78 135 833	533	0	54
Seke Unit B	713	510	43 608 799	260	1	210
Seke Unit C	782	405	27 365 826	101	1	22
Seke Unit D	1 477	161	27 016 972	138	2	54
Seke Unit E	155	74	8 824 332	54	0	10
Seke Unit F	83	60	19 462 299	45	1	38
Seke Unit G	596	336	39 588 934	127	6	58
Seke Unit H	857	529	45 976 344	122	2	34
Seke Unit J	1 635	180	62 873 172	529	2	475
Seke Unit K	2 351	1 075	126 497 972	196	4	24
Seke Unit L	1 025	721	58 994 011	152	1	49
Seke Unit M	2 066	1 035	696 320 957	243	4	90
Seke Unit N	1 702	959	37 892 748	158	1	82
Seke Unit O	1 896	465	36 510 757	173	2	62
Seke Unit P	520	321	29 291 529	109	3	29
Zengeza 1	855	735	56 289 977	221	1	158
Zengeza 2	3 990	1 154	28 428 963	234	1	45
Zengeza 3	1 932	1 482	155 991 441	293	15	341
Zengeza 4	2 630	1 180	87 642 613	295	1	211
Zengeza 5	1 196	1 452	180 073 272	541	2	103
Chaminuka	29815	947	89 798 764	223	1	113
Total	**58 158**	**14 555**	**1 936 585 485**	**4 747**	**51**	**2 262**

Total number of new building plans approved (residential) 54No
Total number of building plans re-approved 43No
Total **97No**

Area	Total No of Stands	Total Plans Approved So Far	Estimated Cost	Total No. of Buildings Commenced	Progress in 01/2000 Approved Plans	Total Buildings Completed
Commercial						
Seke Unit A	8	7	18 232 538	7	0	7
Seke Unit B	3	3	327 727	3	0	1
Seke Unit C	6	4	3 483 799	4	0	2
Seke Unit D	18	16	10 878 845	16	0	14
Seke Unit E	0	0	0	0	0	0
Seke Unit F	3	3	1 958 804	3	0	3
Seke Unit G	133	103	63 063 441	94	0	94
Seke Unit H	33	2	3 157 585	2	0	1
Seke Unit J	20	17	2 742 633	18	0	15
Seke Unit K	22	14	4 212 447	13	0	11
Seke Unit L	16	6	25 625 371	5	2	4
Seke Unit M	18	11	4 772 517	11	0	10
Seke Unit N	28	13	32 927 157	13	0	9
Seke Unit O	23	17	8 723 296	11	0	7
Seke Unit P	3	3	3 176 169	3	0	3
Zengeza 1	3	3	5 770 168	3	0	3
Zengeza 2	32	16	31 287 223	9	0	9
Zengeza 3	21	15	16 172 479	14	0	14
Zengeza 4	40	28	30 804 323	27	0	25
Zengeza 5	15	3	33 033 430	2	1	1
Chaminuka	92	49	24 418 913	48	0	47
Town Centre	10	4	30 884 675	4	0	3
Tilcor Industrial	185	94	13 807 478	86	1	89
	732	**431**	**368 461 018**	**396**	**4**	**372**

M. KHOSLA
DIRECTOR OF ENGINEERING SERVICES
9 February, 2001

9. CAPITAL PROJECTS

9.1 PROJECTS FUNDED FROM COUNCIL FUNDS

9.1.1 **Name of Project**: St Mary's Infill - New 400mm diameter Pumping Main.

Contract Ref	: 3703/C1
Contractor	: WGB Kinsey (Pvt) Ltd.
Value of the Contract	: $15 558 454.14
Commencement Date	14 August 2000
Contract Period	: 16 weeks
Weeks Worked	: 17 weeks
Target Progress	: 100%
Actual Progress	: 100%
Overall Progress	: All work is now substantially complete

9.1.2 **Project Name** : Construction of Civil Works for a Raw Sewage Pumpstation and Ancillary Works – St Mary's.

Contract Ref :	3703/C2
Value of Contract:	$18 661 333.20
Commencement Date:	29 November 2000
Contract Period	: 39 weeks
Completion Date	: 29 August 2001
Weeks worked	: 9
Target Progress	: 10%
Actual Progress	: 11%
Overall Progress	: On programme

Comment To date BLT have carried out some site establishment and setting out. BLT commenced excavations on most of the structures. Some blinding concrete has also been placed at the intake works. The water reticulation to the site is 80% complete. Overally they are on programme mainly due to setting out which has been completed.

9.1.3 **Project Name**: Unit 'C; Infill – Construction of Roads and Stormwater Drainage

Contract Ref	: 3682/C1
Contractor	: Sasha Construction
Commencement Date:	30 November 2000.
Value of Contract	: $8 216 628.28
Contract Period	: 4 months (17 weeks)
Completion Date	: 30 March 2001
Weeks worked	9 weeks
Target Progress	39%
Actual Progress	25%
Overall Progress	1.5 weeks behind
Comment	Sasha have completed site establishment. They have also cleared all the road and stockpiled material at the borrow areas. They have indicated that they will work weekends to try and catch up.

9.1.4 **Project Name**: Unit 'C' Infill – Construction of Water and Sewerage Reticulation.

Name of Contractor:	MARE Civil Engineering Construction
Contract Ref :	3682/C2
Value of Contract:	$6 684 469.00
Contract Award:	1 November 2000
Contract Period	12 weeks
Extension Granted	2 weeks
Completion Date	30 March 2001
Weeks Worked	11 weeks
Target Progress	79%
Actual Progress	75%
Overall Progress	½ week behind
Comment	Mare have completed 95% of the excavations for both the water and sewer lines. Some 80% of water and sewer lines have already been laid. Rocky areas are outstanding. Mare were delayed by the change in route of the 300 Trunk Sewer which should have been carried out in December 2000. Revised drawings have now

been issued and Mare were granted an extension to two (2) weeks to complete all works.

9.2 PROJECTS FUNDED FROM URBAN II FUNDS

9.2.1 **Project Name** : Chitungwiza Incubators
Contract No : 3565/C1
Contractor : Dalmet Construction
Contract Value : Z$2 431 100.00
Progress : 86%

Comment

Brickwork by the Municipality staff is almost complete.

9.2.2 **Name of Project:** Replacement/Replacement of Dilapidated Sewer Lines – Extension of Existing Contract
Contract Ref: 3630/C1
Contractor: Forit Contracting (Pvt) Ltd
Contract Value (Original): $9 463 849.07
Contract Value (Revised) $13 063 849.07

EXTENSION TO CONTRACT

Commencement Date	16 October 2000
Contract Period	3 months (13 weeks)
Completion Date	15 February 2001
Weeks worked	11 weeks
Target Progress	84%
Actual Progress	80%
Overall Progress	On programme

Comment

Repair work to various pumpstations is in progress.

9.3. PROJECTS FUNDED FROM USAID LOANS

9.3.1. **Name of Project**: St Mary's Infill Phase 2C – Construction of Roads and Stormwater Drainage Infill Water and Sewer Reticulation.

Contract Ref : 3699/C1

Project Status

A technical report giving reasons for not awarding the contract to the lowest tenderer was submitted to the Ministry of Local Government, Public Works and National Housing on 1 February 2001. Awaiting reply from the Ministry.

9.3.2 **Name of Project** Supply And Installation Of Pumping Plant & Equipment – St Mary's Raw Sewage Pump Station

Contract Ref No	3703/M1
Contractor	Bateman Water Zimbabwe
Contract Value	Z$9 321 336.50
Commencement Date	16 January 2001
Contract Period	26 weeks
Completion Date	17 July 2001
Weeks Worked	2 weeks
Progress	2%
Comment	

The first meeting to initiate the project was held on 30 January 2001. Preliminary documentation has been submitted. Basic parameters of the pumps and compressors need to be verified before ordering.

M. KHOSLA
DIRECTOR OF ENGINEERING SERVICES

9 February, 2001

The Municipality of CHITUNGWIZA

CHITUNGWIZA MUNICIPALITY

WORKS DEPARTMENT

MONTHLY REPORT FOR THE MONTH OF FEBRUARY 2012 TO BE PRESENTED TO THE PUBLIC WORKS, TOWN LANDS AND ENVIRONMENTAL MANAGEMENT COMMITTEE MEETING TO BE HELD IN MARCH 2012

1.0 WATER SUPPLY

City of Harare is supplying Water to Chitungwiza for 4 days per week. Although the Water Section is carrying out water demand management during the 4 days period, Seke North and South suburbs are taking longer periods without water raising fears for diseases out breaks.

1.1 Water Availability – Weekly schedule

AREA	AVAILABILITY			
	24 HOURS	12 HOURS	6 HOURS	Less than 6 hours. No supply
Zengeza	Zengeza3, Zengeza 4 low, Zengeza 5, Chitungwiza Hospital, Tilcor Industry	Zengeza 1, 2	Zengeza 4 Extenstion, Zengeza 4 High.	Nil.
St. Mary's	Manyame Park, Chigovanyika Area, St. Mary's low.	St. Mary's High.	Chiratidzo Road/	Nil.
Seke South	Nil	Unit J, K, L low.	Unit M, K High	Unit M High
Seke North	Nil	Nil	D, E, H, A, C, F, N.	B, O, P, G

1.2 Technical Committee – Water Supply

Following the recent appointment of the Resuscitation Team by the Minister of Local Government, rural and Urban Development, a Technical Committee on Water Supply was formed comprising water Engineers from city of Harare, Ministry of Water Resources Development, Zimbabwe National Water Authority (ZINWA) and Council Officials. The Team of Reference for the Committee is to

① — Next report = Constitution' Meters } In Next meeting
② Action plan = Time Frame

③ Report on Surrendered HOD Vehicles } next meeting

produce a technical report on feasibility of water augmentation schemes in the short term as well as long term solutions on development of water treatment scheme for Chitungwiza Municipality.

1.2 **Maintenance Work**

02 Water meters were repaired.

08 Water meters were restored.

02 Water mains plugged for tempering.

44 Underground burst pipes repaired

37 Low water pressure pipes cleared.

05 Minor leakages were repaired.

03 Stop cork fitted.

41 New water connections were done.

120 Valves were repaired/serviced.

The individual stand/house numbers are attached at the end of the report.

STAFF SITUATION

POST	BUDGETED	ACTUAL	VACANT
Water Superintendent	1	0	1
Water Foreman	2	0	2
Assistant Foreman	4	0	4
Clerk	2	0	2
Charge Hands	5	1	4
Pump Operator	4	1	3
Operator	40	43	-3
General Hands	2	0	2
TOTAL	**60**	**45**	**15**

2.0 **SEWER TREATMENT AND DEBLOCKING SECTION**

See attached report

3.0 **ROADS SECTION**

ACTIVITIES	AREA	ROAD NAME/PLACE
Pothole Patching using Premix	St. Mary's	Chaminuka and Seke Road.
	Zengeza	Old Seke, Mukomberwa and

		Hombarume.
	Seke South	Chitungwiza.
Pothole Patching using Stabilized Emulsion	Zengeza	Old Seke, Waterland, Chimurenga and Batanai.
	Seke South	Hadzinanhanga.
	Seke North	Mpofu.
Pothole Patching using Gravel	St. Mary's	Chaminuka and Seke Road.
	Zengeza	Hombarume, Gudza, Tilcor, Chitungwiza and Chimurenga.
	Seke South	Seke South Administration, Unit 'C' Junction, Chitungwiza, Unit 'M' C/P Jumbo Church and Manyara.
	Seke North	Marufurira, Munava, Kasipiti and Mangwende.
Drain Cleaning	St. Mary's	St. Mary's Administration (55 m), Chaminuka (36 m) and Chigovanyika (85 m).
	Zengeza	Baribango (18 m) and Ingwe (99 m).
	Seke South	Unit 'L' C/P Community Hall (65 m), Sakuringwa (90 m), Unit 'K' C/P 32221 (20 m).
		Marufurira (182 m), Unit 'B' C/P 20608 (48 m).
Drain Excavation	Zengeza	Zengeza 3 ext. C/P 18217 (233 m).
	Seke South	Unit 'M' C/P 18991 (84 m).
	Seke North	Unit 'A' C/P 1818 (70 m)
Culvert Construction	St. Mary's	C/P Hunyani Beer Hall.
Catch pit Cleaning	Zengeza	Baribango (2 cleaned).
Kerbstone Cleaning	Zengeza	Seke Road (850 m).

	Seke North	Maeresera
Grass Cutting	Zengeza	Seke Road (790 m).
Mixing of Aggregate Stones with Emulsion	Industrial	Our Deport (5 m^3 mixed)
Tip – Truck 347	Carted 6 loads of Gravel from Burrow Pit to Mangwende, Maeresera, Mutsau, Jumbo Church and Chimurenga.	

Machinery Position

Machine	Remarks/Position
Grader Mitsubishi	Broken Down, await Spares
Excavator	Broken Down, await spares.
Roller/Plate Compactor	Nil
Grader 120 Cat	Functional
Tip – Truck 348	Broken Down, await spares
Tip – Truck 347	functional
Supervision vehicle 225	Broken Down, await spares

Material Position ZINARA

ITEM	REMARKS
7 mm Aggregate Stones	Procurement in progress.
13 mm Aggregate Stones	Procurement in progress.
Quarry Dust	Procurement in progress.
Emulsion Drums	18 drums available.
Protective Clothing	Procurement in progress.

MANPOWER POSITION

POST	BUDGETED	ACTUAL	VACANT
Superintendent	1	0	1
Foreman	2	1	1
Clerk	1	0	1
Charge Hands	4	3	1
Tin Smith	1	1	0
Sign Writer	2	2	0
Light Machine Operator	4	2	2
General Hands	36	17	19
TOTAL	**51**	**26**	**25**

4.0 FIRE BRIGADE SECTION

During the month of February 2012 the Fire Brigade Section did not attended to any emergency incident since the Fire Tender was broken down. All fires and accidents were referred to Harare Fire Brigade.

FIRE PREVENTION

All old and new Commercial buildings in Zengeza area were surveyed and recommendations were done on what type of Firefighting equipment were to be installed by the recommended Fire Engineering Campanies as per Fire Brigade By – Laws.

Certificates of occupation were recommended to Building Inspectorate to be issued to the following:

Stand No. 16134 Unit 'G' Seke
Bata Shoe Shop at Town Centre
Stand No. 18091 Zengeza 4
Stand No. 13580 Zengeza 3

STAFF POSITION

POST	BUDGETED	ACTUAL	VACANT
Chief Fire Officer	1	1	0
Deputy Chief Fire Officer	1	0	1
Divisional Officer	1	0	1
Leading Fire Fighter	5	1	4
Fire Fighters	35	33	2
General Hand	1	1	0
TOTAL	**44**	**36**	**8**

CHALLENGES

The Section requires a utility vehicle to carry out fire prevention and protection duties. There is still need to engage a Fire Engineering Company to fix and supply firefighting equipment in Council buildings, though Tender.

5.0 WORKSHOP SECTION

The Departmental Vehicle Status is attached below:

HEALTH DEPARTMENT

ITEM	FLEET NO.	TYPE OF VEHICLE	SECTION	STATUS
1.	387	Hard Body D/Cab	Administration	Functional.
2.	388	Toyota Hilux	Administration	Functional.
3.	389	Toyota Hilux	Administration	Functional.
4.	392	Nissan N.P 300	Administration	Functional.
5.	395	Toyota L/Cruiser Prado	Directorate	Functional.
6.	396	Toyota Hiace	Ambulance	Functional.
7.	399	Toyota Hiace	Ambulance	Functional.
8.	283	C.K.B 450	Refuse	Functional.
9.	284	C.K.B 450	Refuse	Functional.
10.	285	C.K.B 450	Refuse	Functional.
11.	295	C.K.B 450	Refuse	Functional.
12.	304	C.K.B 450	Refuse	Functional.
13.	271	Hard Body 2 000	Ambulance	Functional.
14.	384	Mazda Eagle	Doctor	Functional.
15.	291	Nissan C.K.B 450	Refuse	Functional.
16.	311	Nissan U.D 95	Refuse	Sublet for body repairs.
17.	302	C.K.B 450	Refuse	Non-Functional – Brake repairs in progress.
18.	293	C.K.B 450	Refuse	Accident Damaged.
19.	333	Nissan 1 400	Head Office	Non-Functional.
20.	260	Isuzu K.B 260	Head Office	Accident damaged.
21.	290	C.K.B 450	Refuse	Non-Functional.
22.	296	C.K.B 450	Refuse	Accident damaged.
23.	298	C.K.B 450	Refuse	Non-Functional.
24.	300	C.K.B 450	Refuse	Accident damaged.
25.	301	C.K.B 450	Refuse	Non-Functional.
26.	281	Front End Loader	Refuse	Non-Functional.
27.	242	Landfill Dynapak	Refuse	Non-Functional.
28.	287	Nissan D/Cab	Refuse	Non-Functional.
29.	292	Nissan C.K.B 450	Refuse	Non-Functional.

WORKS DEPARTMENT

30.	289	C.K.B 450	Sewer	Functional.
31.	299	C.K.B 450	Sewer	Functional.
32.	303	C.K.B 450	Sewer	Functional.
33.	347	Mitsubishi Tipper	Roads	Functional.
34.	130	Cat Grader	Roads	Functional.
35.	243	Nissan D/Cab	Water	Functional.
36.	249	Massey Ferguson	Sewer	Functional.
37.	210	Renault Camiva	Fire	Functional.
38.	219	Mazda B1 600	Workshop	Non-Functional.
39.	211	Land Rover V.8	Fire	Non-Functional.
40.	225	Mazda B1 600	Roads	Non-Functional.
41.	253	Mazda B2 200	Sewer	Non-Functional.
42.	322	Hard Body 2 000	Directorate	Non-Functional.
43.	323	Hard Body 2 000	Sewer	Non-Functional.
44.	325	Hard Body 2 000	Sewer	Non-Functional.
45.	209	Renault Camiva	Fire	Non-Functional.
46.	297	C.K.B 450	Workshop	Non-Functional.
47.	348	Mitsubishi Tipper	Roads	Non-Functional.

48.	367	Nissan Dump truck	Sewer	Non-Functional.
49.	276	Back HOE Loader	Roads	Non-Functional – Work in progress.
50.	282	Mitsubishi Grader	Roads	Non-Functional.
51.	268	Mitsubishi Loader	Sewer	Non-Functional.
52.	378	Mazda B2 500		Non-Functional.

HOUSING DEPARTMENT

53.	385	Mazda Eagle	Directorate	Functional.
54.	401	Toyota Fortuner	Directorate	Functional. ✓
55.	337	John Deere	Amenities	Non-Functional.
56.	223	Mazda T3 500	Social Welfare	Non-Functional.

MAYORAL

57.	390	Steed	Mayor	Limited runner.
58.	400	Ford Ranger	Deputy Mayor	Functional.

TOWN CLERK

59.	386	Mazda Eagle	Audit	Functional.
60.	397	Land Cruiser Toyota VX	Directorate	Functional. ✓
61.	286	Nissan D/Cab	Security	Non - Functional.
62.	369	Mazda B2 500	Security	Functional.
63.	254	Nissan Sunny	Public Relations	Functional.

TREASURY

64.	391	Nissan N.P 300	Banking	Functional.
65.	326	Hard Body 2 000	Banking	Functional.
66.	393	Nissan N.P 300	Directorate	Functional.
67.	206	Toyota Land Cruiser	Main Accounts	Non-Functional
68.	255	Nissan 2.7	Liquor	Non-Functional
69.	349	Mitsubishi Canter	Liquor	Non-Functional
70.	350	Mitsubishi Canter	Stores	Beyond economic repair.
71.	228	Mazda 626	Credit Control	Non-Functional – Work in progress.

ADMINISTRATION

72.	398	Toyota Fortuner	Directorate	Functional. ✓
73.	362	Hyundai Excel	Staffing	Functional

6.0 ELECTRICITY

PROJECTS:

TOWER LIGHTS REHABILITATION

TOWER LIGHT NUMBER	LOCATION	STATUS/CONDITION
J 57	Unit 'J'	Functional
M 106	Unit 'O'	Functional
K 64	Unit 'O'	Functional
St. Mary's 2	St. Mary's	Repaired – No power supply.
Z 64	Zengeza 2	Functional

L 99	Unit 'L'	Functional
K 68	Unit 'K'	Functional
0 – 89	Unit 'O'	Repaired – No power supply.
L 121	Unit 'L'	Functional
L 120	Unit 'L'	Functional
At House number 4891 Unit 'C'	Unit 'C'	Functional
F 16	Unit 'F'	Functional
At House number 68 Unit 'F'	Unit 'F'	Functional
Z 63	Zengeza 2	Functional
Opposite House number 11943 Zengeza 4	Zengeza 4	Functional
N 74	Unit 'N'	Functional
At House number 3118 Unit 'C'	Unit 'C'	Functional
N 82	Unit 'N'	Functional
0 – 94	Unit 'O'	Functional
0 – 96	Unit 'O'	Repaired - No power supply
0 – 92	Unit 'O'	Functional
0 – 93	Unit 'O'	Functional
0 – 91	Unit 'O'	Functional - Disconnected at Pole
0 – 97	Unit 'O'	Functional

A total of 24 tower lights were repaired in the month of February 2012.

STAFF SITUATION

POST	BUDGETED	ACTUAL	VACANT
Chief Electrical Technician	1	1	0
Electrical Technician	1	1	0
Electrician	2	2	0
Refrigeration Mechanic	1	0	1
Records Clerk	1	1	0
Technical Assistant	5	4	1
TOTAL	**11**	**9**	**2**

Challenges

1. **Material Supply**

   Most of the required materials for tower light rehabilitation are still outstanding and this is hampering progress.

2. **Tools and Equipment**

Council is still to provide the necessary tools and equipment for tower light repairs.

3. **Transport**

Council is still to provide the Section with transport.

7.0 BUILDING SECTION

PROJECTS: COUNCIL SCHOOLS

Zengeza Main Primary School Ablution Block: Work is on temporary stoppage due to bricks not yet ferried from Zengeza Administration. This is due to transport problem facing this Section.

Tadzikamidzi Primary School: Construction of brick footing is complete. Back filling is now in progress.

Farai Primary School: Excavation of six classroom block measuring forty seven meters is complete (Foundation depth is 1 m).

St. Aidan's School: Brick work on ablution block is in progress and is on door height.

Tadzikamidzi Primary School: Backfilling completed. Concrete slabbing is in progress.

GENERAL MAINTENANCE

The Section attended to all works orders raised by user Departments on Council Buildings.

8.0 COUNCIL EQUIPMENT AT DELATFIN

(1) The list of equipment which Delatfin took and did not return to Council is as follows:

(a) Fleet 226 – 1 x Front End Loader 916 – Registration Number 511–631V
(b) Fleet 308 – 1 x Grader Champion Registration Number 688 – 808 D
(c) Fleet 183 – 1 x Bulldozer D4H – Registration Number 395 – 551 W
(d) 1 x Bulldozer Shewa D6 – No Registration Number.
(e) Fleet 288 – 1 x Bulldozer D7XR – Registration Number 688 – 488 F

Delatfin is claiming US$283-000 form Council for repairs done before returning equipment to Council. The matter is still pending at High Court.

Council need to resolve on the legal course of action to be taken to recover the equipment.

9.0 **AFRICAN WATER FACILITY/AFRICAN DEVELOPMENT BANK (AWF/ADB) – CHITUNGWIZA: WATER AND SANITATION REHABILITATION PROJECT**

Work is now in progress at St. Mary's Pump Station Number 1, Manyame Park Trunk Sewer as well as the Water Mains from City of Harare. The project duration is seven (7) months i.e. up to the end of August 2012.

The recruitment of the Consultant is still outstanding with the AWF/ADB having indicated that the issue of the engagement of the consultant be solved in the shortest possible time.

A. TINOFA
DIRECTOR OF WORKS

5th March 2012

THE SEWERAGE SECTION

TREATMENT WORKS

Total inflow (approximate) 400000m^3
Total outflow (approximate) 400000m
Total grit removed (from channels) 25wheelbarrows (airlift pumps down)
Total screenings removed 41 wheelbarrows
(Please note all the flow readings given above are estimates, our flow recorders are broken down).
The new treatment works is not operational owing to numerous breakdowns as indicated hereunder.

3 grit pumps; (need replacing)
2 Water tower pumps (need service)
2 Choked sludge digester sludge – draw off pipes/
3 Broken thickener drives
3 Broken Sludge mixing pumps
1 Broken raw sludge pumps
2 Broken raw sludge collectors
1 Broken equalization mixer
10 Aerators; (10 oil pressure switches: 1 suspected burnt motor)
10 Anoxic mixers: (faulty bearings: couplings : burnt motors : stolen power supply cables).
4 RAS pumps;(worn impellers ; volutes; sliding shoes ; need overhauls ; 1 burnt motor)
6 Recirculation pumps; (moisture in motors; sliding shoes; overhauls required)
3 Waste sludge pumps (burnt motors)
3 Sludge collectors drive broken (final settling tanks)
2 infiltration pit pumps; (burnt motors)

All flow into the works is going to the old works' 2 pond (sets 3 and 4) . These are receiving all the flow coming into the plant. The ponds are chocked, full of sand and sludge which has to be removed. There is short circuiting due to missing sluice and pen stock gates. All 5 filters are broken down.. Currently all effluent is spilling to the river as the two effluent pumps are down due to electric motor and starter problems.

ZESA still have not energised our old plant saying we should erect a protective wall or steel screen to protect their transformer from further vandalism by oil thieves. Quotations have been sought and an indent has been raised for the purchase of the required materials.

ALL ST MARY'S PUMPSTATIONS:

The three transfer pumpstations in St Mary's are not operational for the reasons ranging from lack of power connection(ST MARY'S 1 , 2and 3) broken down pumps and burnt motors to burnt motor drives. The broken down pumps require major overhauls or outright replacements (ST MARY'S 1 , 2 and 3). ZESA informed of ST MARY'S pump stations' power problems, and have so far installed a new transformer at St Mary's 1 pumpstation. They are still to connect it to our pumpstation. Pumpstation 2 still to be energized. ZESA replaced the damaged transformer for St Mary's 3 pumpstation. We pumped out the flooded basements of both St Mary's 1 and three pumpstations.

STAFF SITUATION AT THE TREATMENT WORKS

POSITON	GRADE	BUDGETED NUMBER	ACTUAL NUMBER	VACANT
SENIOR SUPERINTENDENT	12	1	1	0
ELECTRICIAN	11	1	1	0
WORKS ATTENDANTS	9	9	7	2

TRADE WASTE INSPECTOR	9	1	0	1
FITTER	9	1	0	1
SENIOR LAB ANALYST	9	1	0	1
CHARGE HANDS	6	2	0	2
ASSISTANT ELECTRICIAN	6	1	0	0
JUNIOR LAB ANALYST	6	1	0	1
HEAVY DUTY LORRY DRIVER	5	1	1	0
OPERATOR ponds	4	47	9	38
OPERATOR Intake works	5	16	6	10
OPERATOR Sludge facility	5	4	4	0
OPERATOR Bioreactor	5	8	4	4
OPERATOR Effluent Pump station	5	8	3	5
OPERATOR ST Mary's Pump stations	5	17	7	10
WORKS CLERK	6	1	1	0
TYPIST	6	1	1	0
GENERAL HANDS	1-3	8	0	8
TOTAL		129	46	83

SEWERAGE SECTION STAFF SITUTION

POSITION	SALARY GRADE	BUDGETED NUMBER	ACTUAL NUMBER	VACANT POSITION
FOREMAN	9	1	0	1
ASSISTANT FOREMAN	8	4	0	4
PLUMBER CLASS 2	7	2	0	2
CHARGE HAND	6	9	8	1
CLERK	6	1	1	0
SENIOR OPERATOR	5	52	54	0
OPERATOR	4	26	26	0
TOTAL		96	89	8

SEWER PROJECTS

The collapsed section of the Zengeza trunk sewer to the west of Chiwenga street was rehabilitated by our projects section. A total of 31m of 450mm diameter a/c pipe was laid and backfilled. The sewage has been allowed to flow through the section although the two manholes at either end of the said section still have to have their channels done. We await the delivery of the cement that has already been ordered for the work.

SEWER PROJECTS STAFF SITUATION

POSITION	BUDGET 2010	GRADE 2011	BUDGETED	ACTUAL NUMBER	VACANT POSITION
FOREMAN	0	10	1	1	0
CLERK	0	7	1	1	0
PLUMBERS	0	6	6	6	0
SENIOR OPERATORS	0	6	44	11	0
OPERATORS	0	5	-	5	24
GENERAL HANDS	0	3	-	4	0
TOTAL			**52**	**28**	**24**

Report For February 2012

CHITUNGWIZA MUNICIPALITY
WATER RETICULATION
STANDARD MAINTAINANCE FORM
DAILY WORKSHEET

DAY	WATER METER REPAIRED	W/METER REMOVED ARREARS	WATER METER RESTORED	PLUGGED FOR TEMPERING	UNDERGROUND PIPE REPAIRED	LOW PRESSURE CLEARED	MINOR LEAKS REPAIRED	STOP-CORK FITTED	NEW CONNECTION	RE-ROUTING	VALVE REPAIRED/CLEARED	TOTAL
MONAY			2393'B`		TAPONA CLINIC				22260'K`		22338'D`	
06/02/12					PARAMOUNT SHOPS				PARAMOUNT SHOPS		5328'E`	
					260 ST MARYS						4272'D`	
TUESDAY					6625 ST MARYS						UCC2 'N`	
07/02/12												
					GUMBAKUMBA ZENGEZA 1	17125'M 2769 SM`		15333'O	18271 ZENGEZA 3		3178'D`	
						15345'O`			92456'N`		4339'D`	
						6576'O`			17000 Z4 SHOPS		4228'D`	
WEDNESDAY					80948'G`EXT	16TEMBWE ZENG 5			193312 ZENG 4 INFILL			
08/02/12						2670 ST M			19318 Z2 SHOPS		HONDOHWE Z2	
											CHOTO Z 3	
											DARIRO Z3	
					82408 'N`						VASHANDI Z3	
THURSDAY											DAHWA Z2	
09/02/12			TANGENHAMO SCHOOL		3502'D` 260A&B ST M	5916'J` 5620'J`					3147'D`	
					6473 ST M	CHAKANYUKA Z5					4350'D`	
					4988 ST M						4048'D`	
					8866 ST M						966'G`	
FRIDAY												
10/02/12												
					8866 ST M	5574'J`			91605		3540'D`	
						5059 ST M			DAAVIS		4388'D`	
						CHAKANYUKA Z5			16122 ZENGEZA 5		CHAKANYUKA ZENGEZA 3	
									34448'G` 34449'G`		4307'D`	
SATURDAY					19740'D`	CHAMINUKA Z5					4802 ST MARYS	
11/02/12					21795'D`							
					22186'K` 30459'P`							
					ST MARYS ADMIN							
SUNDAY						CHAKANYUKA					3954'D	
12/02/12					ST MONICA	2025'M`					3750'D`	
											4317'D`	

KWEKWE MUNICIPALITY
WATER RETICULATION
STANDARD MAINTAINANCE FORM
DAILY WORKSHEET

DAY	WATER METER REPAIRED	W/METER REMOVED ARREARS	WATER METER RESTORED	PLUGGED FOR TEMPERING	UNDERGROUND PIPE REPAIRED	LOW PRESSURE CLEARED	MINOR LEAKS REPAIRED	STOP-CORK FITTED	NEW CONNECTION	RE-ROUTING	VALVE REPAIRED/CLEARED	TOTAL
MONAY												
13/02/12									4893 SM		1961 ST MARYS	
									9574 ST M		CHINEMBIRI SCH	
											4999'D`	
											4517 'D`	
TUESDAY											6079'J`	
14/02/12	1777 SM		2009 ST M		ST MARYS ADMIN			7669'K`	5563 ST M		ST MARYS ADMIN	
					20842'A`				4944 ST M			
											6037 ST MARYS	
WEDNESDAY												
15/02/12					CHIGOVANHIKA SHOPS	16 KUBVUMBI Z1			5461 ST M		ANGLICAN CHURCH	
									5923 ST M		5562'J`	
					20841'A`	5499'J`					946'G`	
					1128 ST M				18339 Z5		CHOP-CHOP 'G`	
											210'G`	
THURSDAY					ZENGEZA 4 COMPLEX						300 'G`	
16/02/12											301 'G`	
											305 'G`	
											20 'G`	
FRIDAY												
17/02/12					INGWE DRIVE	5577'J`			19255 ZNG 3		8941 'K`	
					3855 ST M				19597 ZNG 5		4176 'D`	
					31526 'H`				18207 ZNG 5		5553 J	
					KUSHINGA BEERHALL				19847 ZNG 5			
SATURDAY												
18/02/12					15654 'P`						6736 'J`	
					UNIT N MARKET						9450 'K`	
					18840 'L`						9462 'K`	
					17055 Z4 INFILL 52 BISE Z1 HURUYADZO SHOPS						3102 'D`	
SUNDAY												
19/02/12					29854 'L`						5513 ST MARYS	
					19620 ZNG 3						6230 'J`	
											6705 'J`	
											8996 'J`	
											8968'J`	
											8908 'J`	

MUNICIPALITY
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STANDARD MAINTAINANCE FORM
DAILY WORKSHEET

DAY	WATER METER REPAIRED	W/METER REMOVED ARREARS	WATER METER RESTORED	PLUGGED FOR TEMPERING	UNDERGROUND PIPE REPAIRED	LOW PRESSURE CLEARED	MINOR LEAKS REPAIRED	STOP-CORK FITTED	NEW CONNECTION	RE-ROUTING	VALVE REPAIRED/CLEARED	TOTAL
MONAY												
13/02/12											HYDRANT	
											DUHWINO HYDRANT Z3	
											MATONGO VALVE Z3	
											MANDA VALVE Z3 ZENGEZA MAIN CHAMBER TILCO RD	
TUESDAY												
14/02/12											ZENGEZA MAIN CHAMBER	
WEDNESDAY											ZENGEZA BEERHALL	
15/02/12												
THURSDAY											KUBATANA BEERHALL	
16/02/12											6235 'J'	
FRIDAY												
17/02/12											8643 'K'	
											7886 'K'	
											3841 'D'	
SATURDAY												
18/02/12											7112 'J'	
											4556 'D'	
											7180 'J'	
SUNDAY											6303 'J'	
19/02/12												
											ZENGEZA MAIN CHAMBER	

GWERU CITY MUNICIPALITY
WATER REVENUE SECTION
STANDARD MAINTENANCE FORM
DAILY WORKSHEET

DAY	WATER METER REPAIRED	W/METER REMOVED ARREARS	WATER METER RESTORED	PLUGGED FOR TEMPERING	UNDERGROUND PIPE REPAIRED	LOW PRESSURE CLEARED	MINOR LEAKS REPAIRED	STOP-CORK FITTED	NEW CONNECTION	RE-ROUTING	VALVE REPAIRED/CLEARED	TOTAL
MONAY			182 F			9 VASHANDI Z3	1641 ST M		29856 L		UNIT L PHONE BUS	
20/02/12			15726 Z5								18002 M	
			4535 ST M						2901 ST M		17344 M	
									5923 ST M		17149 M	
TUESDAY												
21/02/12					8866 ST M		16067 Z5		27250 J		18211 L	
					2670 ST M				24513 P		18021 M	
					6309 ST M				9297 ST M		16681 M	
WEDNESDAY									15853 Z5			
22/02/12	1749 ST M				16505 M	1GUSHUNGO ZNG 5	1182 ST		8336 ST M		18204 L	
					6309 ST M				19694 Z3		17136 M	
					2177 ST M				9702 ST M		16797 M	
23/02/12			4716 ST M		16831 COSLA	2005 ST M		2830 ST M	UNIT L CEMETRY		17139 L	
THURSDAY									8943 ST M		16474 M	
							18343 L				MR ALSO M	
											17084 M	
						2007 ST M					8610 K	
24/02/12				16831 Z2	4629 ST M	2005 ST M			19900 Z3		19032 L	
FRIDAY						2009 ST M			19184 Z5		16487 M	
											16558 M	
											16356 M	
					123 F	2011 ST M			UNIT L CEMETRY		18286 L	
25/02/12											METHODIST CHURCH	
SATURDAY						12396 Z5					SEKE 13 SCH	
						12397 Z5					16541 M	
						2013 ST M					16670 M	
						2012 ST M					17336 M	
SUNDAY						2008 ST M						
26/02/12					15655 P	PUMP 1	7424 SM					
						11 ZNG 3						
						19282 Z2						
						BUMHUDZO						
						4429 ST M						

CHITUNGWIZA MUNICIPALITY
WATER RETICULATION
INDARD MAINTAINANCE FORM
DAILY WORKSHEET

DAY	WATER METER REPAIRED	W/METER REMOVED ARREARS	WATER METER RESTORED	PLUGGED FOR TEMPERING	UNDERGROUND PIPE REPAIRED	LOW PRESSURE CLEARED	MINOR LEAKS REPAIRED	STOP-CORK FITTED	NEW CONNECTION	RE-ROUTING	VALVE REPAIRED/CLEARED	TOTAL
MONAY												
20/02/12											1065 G	
											294 G	
											281 G	
											21347 G 21371 G	
TUESDAY												
21/02/12											282 G	
											CHIKWANHA MAIN CHAMBER	
WEDNESDAY												
22/02/12											1028 G	
											1000 G	
											1051 G	
											1077 G	
THURSDAY											1102 G	
23/02/12											2607 B	
											2657 B	
											2719 B	
											2329 B	
FRIDAY											2651 B	
24/02/12												
											2315 B	
SATURDAY												
25/02/12											SHANA ZNG 1	
											NHEMBE ZNG 1	
											MBAKUMBA Z1	
SUNDAY											MBIRA Z1	
26/02/12												

Appendix 4.1

Estimation of Harare Population

1. Study of Census Data carried out on September 2012

To estimate year 2012 population of the Distribution Area for the Harare Water, the most recent and reliable data source is the 1992 and 2002 National Population Census. In 2012, the census has been carried out, but the results will be announced by the Central Statistical Office (CSO) one or two years later. The results of the date of 1992 and 2002 for the supply area of Harare Water Works are shown in Table A4.1.1, in which increase ratio is calculated. The population growth tendency of the country by the national census is shown in Table A4.1.2.

Table A4.1.1 Population of Water Supply Area by Harare Water

Division	Name	Area (km^2)	Population		Increase Ratio (%)
			1992	2002	
Harare Province	Urban District	579	1,126,473	1,435,784	2.46
	Rural Dis.	225	21,600	23,023	0.64
	Chitungwiza Dis.	42	274,912	323,260	1.63
	Epworth Dis	26	62,630	114,067	6.18
	Sub-total	872	1,485,615	1,896,134	2.47
Surrounding Area	Ruwa	8	1,500	23,681	31.77
	Norton	20	24,500	27,332	1.1
	Sub-total	28	26,000	51,013	6.97
Total		900	1,511,615	1,947,147	2.56

As shown in Table A4.1.1, the population growth rate is drastically down to be 1.1% from 1992 to 2002 compared prior decades of over 3%. It was mainly caused by the outbreak of HIV and exodus of white people from the country. Harare Area's growth rate is around 2.5%, much higher than that of whole country as shown in Table A4.1.2. In the supply area, the growth rate of Ruwa and Epworth was very high because this area had been totally developing in this period, and it was almost completed after the year of 2002. From the study done by SAPROF Team, the population densities of low, medium, high, very high density residential areas was calculated in 1995. Table A4.1.3 shows modified calculation results, in which population was calculated proportionally to the growth rate between 1992 and 2002 shown in Table A4.1.1.

Table A4.1.2 Population Growth Tendency of the Country

Year	Population	Growth Rate (%)
1901	713	---
1911	907	2.4
1921	1,147	2.4
1931	1,464	2.5
1941	2,006	3.2
1951	2,829	3.5
1961	3,969	3.5
1969	5,134	3.3
1982	7,608	3.0
1992	10,412	3.1
2002	11,632	1.1

Source: Central Statistical Office

Table A4.1.3 Population Density by each Categorized Area

Item/Category	Low	Medium	High	Very High	Total(Ave.)
Area(km^2)	68.68	146.07	35.57	16.66	266.98
Rate of Area (%)	25.7	54.7	13.3	6.2	100
Population	44,264	273,569	466,200	427,489	1,211,522
Rate of population (%)	3.65	22.58	38.48	35.29	100
Average density (Popu./ha)	6.4	18.7	131.1	256.6	45.4

2. Estimation of Current Population

CIA World Fact Book has assumed the population of many countries including Zimbabwe. The results are shown in Table A4.1.4 and as shown in the table, the growth rate was quite unstable due to the economical and social debacle. If the assumption is correct, the growth rate for 10 years is only 0.78%, very low, while the assumption by the same source of population of Harare City is 1,609 thousands in 2009. It means that average growth rate from 2002 (by the census, the population of Harare city is 1,459 thousands) to 2009 is 1.4% {= (1609/1459-1)^1/7} and it is around two(2) times larger than the whole country. Therefore the population increase rate of Harare Water distribution area is adapted to be at 1.4%, except for Chitungwiza District, of which current population was determined by some methods mentioned next section. The estimated results of Harare Metropolitan Area are shown in Table A4.1.5, while that of Chitungwiza District is derived from next section. As shown in the table, the Total increase ratio was 12.7% (annually 1.2%).

Table A4.1.4 Projected Population of the Country

Year	Population	Growth Rate (%)	Source
2002	11,632	1.11	Census
2003	12,577	--	CIA
2004	12,672	0.76	CIA
2005	12,746	0.58	CIA
2006	12,237	-3.99	CIA
2007	12,311	0.60	CIA
2008	11,350	-7.81	CIA
2009	11,393	0.38	CIA
2010	11,652	2.27	CIA
2011	12,084	3.71	CIA
2012	12,619	4.43	CIA
2002-2012		0.78	Census/CIA

Table 4.1.5 Estimation Results of Harare Metropolitan Area

Division	Name	Area (km^2)	Population		Increase Rate(%)	
			2002	2012	Total	Annual
Harare Province	Urban District	579	1,435,784	1,650,000	14.9	1.40
	Rural Dis.	225	23,023	26,000	12.9	1.40
	Chitungwiza Dis.	42	323,260	330,000	2.1	0.21
	Epworth Dis	26	114,067	131,000	14.8	1.40
	Sub-total	872	1,896,134	2,137,000	12.7	1.20
Surrounding Area	Ruwa	8	23,681	27,000	14.0	1.40
	Norton	20	27,332	31,000	13.4	1.40
	Sub-total	28	51,013	58,000	13.7	1.29
Total		900	1,947,147	2,195,000	12.7	1.21

3. Comparison to Preliminary Census Report

January 2013, a preliminary census data was announced and then above estimation results are evaluates as below. Table A4.1.6 shows a comparison between estimated population and census data and Table A4.1.7 shows in crease ratio from 1992 to 2002 and 2002 to 2012 using census data. As shown in Table A4.1.6, the difference of total population was very small but each area's differences were large. As shown in Table A4.1.7, the population growth rates of surrounding Harare urban areas have increased very rapidly while that of the urban area has been was very small.

Table A4.1.6 Comparison between Census and Estimation

Division	Name	Area (km^2)	Population(2012)		Difference (%)
			Estimation	Census	
Harare Province	Urban District	579	1,650,000	1,468,767	11.0
	Rural Dis.	225	26,000	113,120	-335.1
	Chitungwiza Dis.	42	330,000	354,472	-7.4
	Epworth Dis	26	131,000	161,840	-23.5
	Sub-total	872	2,137,000	2,098,199	1.8
Surrounding Area	Ruwa	8	27,000	56,333	-108.6
	Norton	20	31,000	58,421	-88.5
	Sub-total	28	58,000	114,754	-97.9
Total		900	2,195,000	2,212,953	-0.8

Table A4.1.7 Population Growth Ratio between Census Data

Division	Name	Area(km^2)	Population			Increase Ratio (%)	
			1992	2002	2012	1992-2002	2002-2012
Harare Province	Urban District	579	1,126,473	1,435,784	1,468,767	2.46	0.23
	Rural Dis.	225	21,600	23,023	113,120	0.64	17.26
	Chitungwiza Dis.	42	274,912	323,260	354,472	1.63	0.93
	Epworth Dis	26	62,630	114,067	161,840	6.18	3.56
	Sub-total	872	1,485,615	1,896,134	2,098,199	2.47	1.02
Surrounding Area	Ruwa	8	1,500	23,681	56,333	31.77	9.05
	Norton	20	24,500	27,332	58,421	1.1	7.89
	Sub-total	28	26,000	51,013	114,754	6.97	8.44
Total		900	1,511,615	1,947,147	2,212,953	2.56	1.29

For the study of the Plan, the populations are modified as Table A4.1.8 because the Census data was only preliminary one.

Table A4.1.8 Planned Population in 2012

Division	Name	Population
Harare Province	Urban District	1,468,800
	Rural Dis.	113,100
	Chitungwiza Dis.	354,500
	Epworth Dis	161,800
	Sub-total	2,098,200
Surrounding Area	Ruwa	56,300
	Norton	58,400
	Sub-total	114,700
Total		2,212,900

Appendix 4.2

Estimation of Chitungwiza Population

1. Official Registration by Municipality Council

The registered numbers of housing and population are recorded in the municipality office, which are collected from four area administration offices in Seke North, Seke South, Zengeza and St. Marry. The number of registered housing and population at the end of March 2012 are shown in Table A4.2.1 The registered housings means that is officially registered to the municipality, and the registered population means that is composed by only the number of family of house owners.

Then officers of municipality said that there are many unregistered houses and unregistered residence, and then the actual number of housing and population is larger than the figure shown in Table A4.2.2

Table A4.2.1 Number of Registered Housings and Registered Population

Category/Area	Seke N	Seke S	Zengeza	St. Mary	Total
No. of Registered Housing units	15,538	12,665	14,893	9,839	52,935
Rate to the Total (%)	29.4	23.9	28.1	18.6	100.0
Registered Population	180,000	55,257	771,218	63,642	1,070,117
Rate to the Total (%)	16.8	5.2	72.1	5.9	100.0
Average No. of Residents/housing	11.6	4.4	51.8	6.5	20.2

In Table A4.2.1, average numbers of residents of each area are quite widely fluctuated, and that of Zengeza area is considered unreasonably many. The rate of population accounts 72.1% to the total population though the rate of number of registered housing is only 28.1%. Therefore other approaches to the real population are required.

2. Estimation from the Number of Pupil going to Primary school

In Zimbabwe, since education is considered being important for the people, almost all young generation in age range of the compulsory education is said to go to school. The officer of Ministry Education worked for Harare Metropolitan Province said that commonly only 3% of young people drop out from primary school. It is easy to grasp the number of pupil of primary school and the number is relatively reliable, thus for the estimation of total population, the number of pupil and the ratio of age range to the total population in Zimbabwe is used as below.

The number of pupil in Chitungwiza Municipality at the end of March 2012 is shown in Table A4.2.2. The number is collected from every school by the area offices and the officers in charge assured the reliability. We visited two primary schools and asked the principals how much percentage of young people drop out of primary school. The principal of the school located in St. Mary's Area said that the estimated ratio was 5%. Another principal of the school located in Zengeza Area near St. Mary's boundary said that all young people who should go to primary school are attending school.

Table A4.2.2 Number of Pupils going to Primary School

Category/Area		Seke N	Seke S	Zengeza	St. Mary	Total
No. of Registered Housings units		15,538	12,665	14,893	9,839	52,935
Pupil of Primary school	Government School	14,218	7,827	12,668	1,871	36,584
	Council School	3,602	3,585	12,048	4,946	24,181
	Private School	86	351	258	1,221	1,916
	Total	17,906	11,763	24,974	8,038	62,681
Rate to Registered Housing		1.2	0.9	1.7	0.8	1.2

As shown in Table A4.2.2, the number of St. Mary's pupils relative to the registered housing units is small and that of Zengeza is large, and the reason is that many pupils living in St. Mary's are going to schools located in Zengeza Area because there are not enough schools to accommodate the pupils in St Mary's area.The demographic distribution in Zimbabwe is acquired from internet as shown TableA4.2.3 and Figure A4.2.1.

From Table A4.2.3, the ratio of age range of 6-12 years (total seven year of range), is calculated in Table A4.2.4. This is the age of young people who go to primary school. Chitungwiza Municipality can be judged to be an urban area, and the distribution of urban area is used in Table A4.2.4

In the table, the range aged 5-9 and 10-14 are 11% and 10.4%, respectively. Therefore the range of pupils going to primary school (i.e. pupils aged 6 to 12) is 15.1% as shown in Table A4.2.5.

From Table A4.2.6 and Table A4.2.7, the total population can be estimate for each area from the number of pupils, however the number in Zengeza and St. Mary's should be modified, because many pupil living in St. Mary's are going to the schools in Zengeza. The number of the pupil is modified as below:

The ratio of pupil's number to registered housing units is assumed to be same as shown in Table A4.2.5 of modified No. of pupil.

Table A4.2.3 Population Distribution in Zimbabwe

Age Range	Urban			Rural			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0-5	14.0	12.3	13.1	16.2	14.9	15.5	15.5	14.1	14.8
5-9	11.6	10.5	11.0	16.0	14.3	15.1	14.7	13.2	13.9
10-14	10.5	10.3	10.4	17.0	14.6	15.8	15.1	13.3	14.1
15-19	9.6	11.9	10.8	10.8	8.9	9.8	10.4	9.8	10.1
20-24	10.9	12.7	11.9	7.2	7.9	7.6	8.3	9.4	8.9
25-29	10.8	11.2	11.0	6.4	7.3	6.9	7.8	8.5	8.2
30-34	8.4	8.6	8.5	5.1	5.9	5.5	6.1	6.7	6.4
35-39	6.9	5.8	6.3	4.4	5.1	4.8	5.2	5.3	5.2
40-44	5.0	4.2	4.6	3.1	3.1	3.1	3.7	3.5	3.6
45-49	2.9	3.5	3.2	2.3	3.1	2.7	2.4	3.2	2.8
50-54	2.8	3.1	2.9	1.9	3.9	3.0	2.2	3.7	3.0
55-59	2.7	2.1	2.4	2.5	2.8	2.7	2.6	2.6	2.6

APPENDIX 4

Age Range	Urban			Rural			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
60-64	1.3	1.3	1.3	2.0	2.5	2.3	1.8	2.1	2.0
65-69	1.2	0.9	1.0	1.6	1.6	1.6	1.4	1.4	1.4
70-74	0.4	0.6	0.5	1.1	1.4	1.3	0.9	1.2	1.0
75-79	0.6	0.6	0.6	1.1	1.0	1.0	0.9	0.9	0.9
80<	0.5	0.6	0.5	1.2	1.6	1.4	1.0	1.3	1.2
Total Surveyed Number	5,714	6,589	12,303	13,380	14,660	28,040	19,094	21,249	40,343

Source: Zimbabwe National Statistics Agency

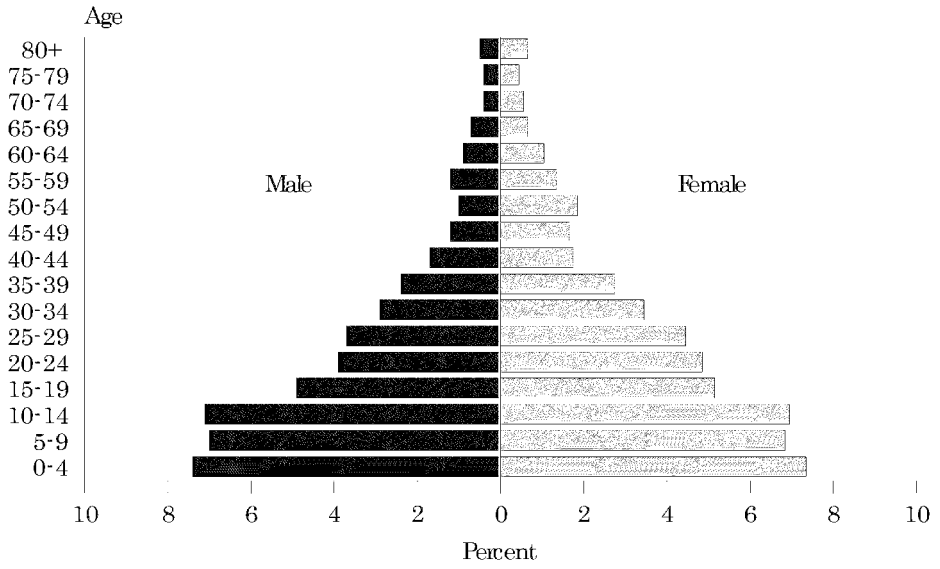


Figure A4.2.1 Population Pyramid in Zimbabwe

Table A4.2.4 Rates to the Total Population of Pupil going to Primary School

Age Range	Urban Area			
	Male	Female	Total	Ave.
5-9	11.6	10.5	11	2.20
10-14	10.5	10.3	10.4	2.08
Ave. of 6-12				2.16
Total : age 6-12(Primary school)				15.10

Source: Zimbabwe National Statistics Agency

Table A4.2.5 Estimation of Total Population

Category/Area	Seke N	Seke S	Zengeza	St. Mary	Total
Registered Population	180,000	55,257	771,218	63,642	1,070,117
No. of Registered Housings units	15,538	12,665	14,893	9,839	52,935
Rate to Registered Housing units	1.2	0.9	1.7	0.8	1.2
Modified Rate	1.15	0.93	1.33	1.33	1.18

Category/Area	Seke N	Seke S	Zengeza	St. Mary	Total
Modified No. of Pupils (1)	17,906	11,763	19,879	13,133	62,681
Modified No. of Pupils (2)	18,443	12,115	20,475	13,526	64,559
Estimated Total Population	122,100	80,200	135,600	89,600	427,500
Ratio to registered Population	0.68	1.45	0.18	1.41	0.40

For the estimation, the ratio of young people who dropped out from primary school is assumed to be three (3) %. In Table A4.2.5, 3% of additional young generation is added to the modified no. of pupils (2). Accordingly, the total population of each area is estimated: modified no. of pupil divided 15.1%. The populations are much different to the registered population, and it is 427.5 thousand, much smaller than the total registered population shown in Table A4.2.1.

3. Estimation by the counting Housing Number and actual Research of Residents

In order to evaluate the results of counting of housing number, the area of residential zones of each sub-district was measured. The layout of sub-districts is shown in Figure A4.2.2. As the results of the measurement, total residential area is 1,744 ha (17.44 km^2). However some areas do not have housings units and thus the area filled by housings units completely is 1,389ha (13.89 km^2).

The actual number of housing in each area is counted from Google Map taken in November 2011. The results are shown in Table A4.2.6, and total number is less than 38 thousands housing units and the difference is around 15 thousands housing units compared to official data of municipality. While one housing building is divided into two for some areas, the number of housing is added to each area.

Table A4.2.6 Counted Number of Housings

Area/Number	Number of Building			Divided Housing	Housing	Total	Official Data	Difference
	Housing	Others	Total					
St. Mary's	5,694	105	5,799	205	5,899	6,004	9,839	3,835
Zengeza1,2,3,5	7,238	189	7,427	1,983	9,221	9,410	14,983	2,679
Zengeza 4	2,703	191	2,894	0	2,703	2,894		
Seke South	9,686	138	9,824	1,459	11,145	11,283	12,665	1,382
Seke North	7,049	162	7,211	1,077	8,126	8,288	15,538	7,250
Total	32,370	785	33,155	4,724	37,094	37,879	53,025	15,146

Since it is impossible to search the number of dwellers for all housing in the municipality, the statistically liable number for target housings was determined as below.

Usually necessary number of sample is determined based on below formula;

Necessary sample number = (meaningful standard^2*P*(1-P))/(target error^2)

P: usually 0.5 is adopted because maximum error is 50%

Meaningful standard: usually 5% of meaningful standard is adopted and in this case the value is 1.96 from the ‘standard normal distribution table’

Target error: applicable error is decided to be 5% (0.05)

Necessary sample number = (1.96^2*(0.5*(1-0.5))/0.05^2 = 384 → **500**

In the case sample number of 500, target error is calculated below:

Target error = (1.96^2*0.5*(1-05) /500)^(1/2)=0.044 → 4.4%

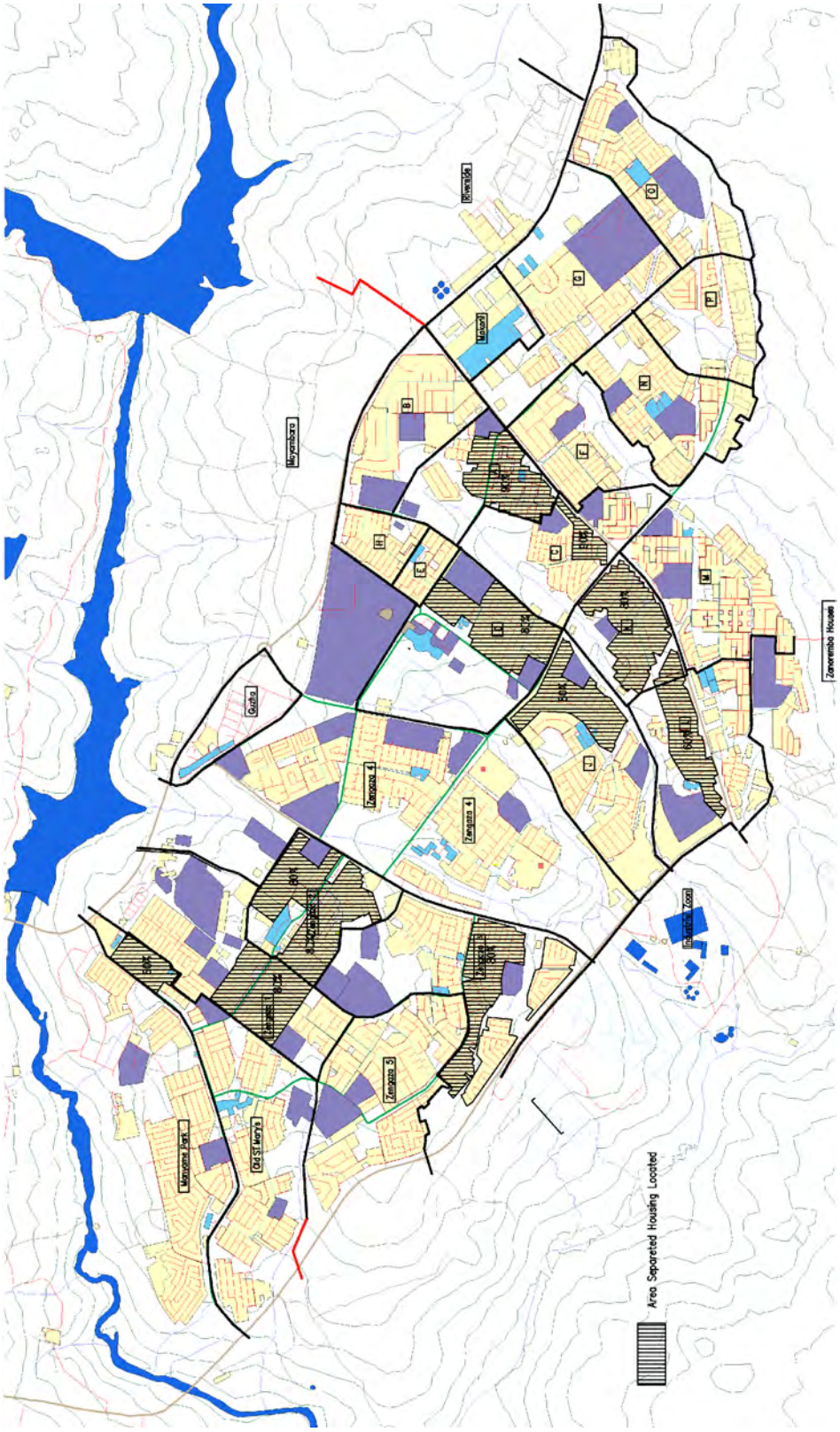


Figure A4.2.2 Location of Wards in Municipality

The sample number of housings at each ward is determined in proportion to housing number. For the calculation of sample housing number in each sub-district, the number of each area shown in Table A4.2.8 distributed to each ward in proportion to modified residential area. The determined numbers of housings are calculated in Table A4.2.7, which was surveyed during visits by surveyors who were not biased for the target areas.

The survey results are summarized in Table A4.2.8. As shown the table, average dweller number of each area is between 8.0 and 11.4, while total average is at 9.1 persons/housing (flat). The average family number living at a housing is between 1.9 and 3.1 in each ward, while total average is at 2.4. The calculated population is at 337,700, and total families number is 90,260. It means average member of families is 3.7.

From 2002 Census, the number of households (families) in Chitungwiza was 79,963 and the average member of the households was 4.04 persons/households. In 2011 January, JICA pre-study team heard from a staff of National Statistic Authority as bellows:

- For 2012 Census, preparation study had been already started.
- In Chitungwiza Municipality, Based on the survey results of the number of households and average members of that, the number of households may be increased and the average members may be decreased.

As shown in Table A4.2.7, above comment was exactly correct.

Therefore the total population is not unreasonable, but the estimated population calculated based on the number of primary school pupils of 427,500 is much more than above calculated population.

Table A4.2.7 Determined Sample Number of each Sub-district

Area/Number		Residential Area(ha)	Area Weight	Num.of Buildings			Sample Number	Average House(unit/ha)	Offical Housing
				Housing	Others	Total			
St. Mary's	Old St. Mary's	95	0.477	2,816			38		
	Manyame P	104	0.523	3,083			41		
	Sub-total	199	1.000	5,899	105	6,004	79	29.6	9,839
Zengeza1,2,3,5	Zengeza1	78	0.258	2,382			32		
	Zengeza2	50	0.166	1,527			21		
	Zengeza3	92	0.305	2,809			38		
	Zengeza5	82	0.272	2,504			34		
	Bub-total	302	1.000	9,221	189	9,410	125	30.5	
Zengeza 4		124	1.000	2,703	191	2,894	38	21.8	
Zengeza All		426		11,924	380	12,304	162	28.0	14,893
Seke South	UnitD	41	0.110	1,225			16		
	UnitE	13	0.035	388			5		
	UnitJ	143	0.383	4,273			57		
	UnitK	40	0.107	1,195			16		
	UnitL	52	0.139	1,554			21		
	UnitM	59	0.158	1,763			24		
	Zanoreba	25	0.067	747			10		
	Sub-total	373	1.000	11,145	138	11,283	149	29.9	12,610
Seke North	Unit A	36	0.092	739			10		
	Unit B	59	0.151	1,351			17		
	Unit C	34	0.087	698			10		
	Unit F	34	0.087	698			10		
	Unit G	47	0.121	965			13		
	Unit H	23	0.059	472			6		
	Unit N	66	0.169	1,355			18		
	Unit O	50	0.128	1,026			14		
	Unit P	33	0.085	677			9		
	Guzha		0.000	0			0		
	Mayambara		0.000	0			0		
	Mokani		0.000	0			0		
	Reverside	8	0.021	284			2		
	Sub-total	390	1.000	8,126	162	8,288	109	20.8	15,538
Total		1388		37,094	785	37,879	500	26.7	52,880

Table A4.2.8 Survey Results and Evaluation

Area-Ward/Items		Residential Area(ha)	Survey Results					Number of Housing	Calculated Results				Registed Population	Estimated Population from Pupils
			Sample Num.	Total Dwellers	Total Families	Arerage Dwellers	Average Families		Population	Family	Ave.Family Menber	Population Density		
St. Mary's	Old St. Mary	95	38	533	159	14.0	4.2							
	Manyame P	104	41	364	87	8.9	2.1							
	Sub-total	199	79	897	246	11.4	3.1	5,899	66,900	18,370	3.6	337	63,642	74,500
Zengeza1,2,3,5	Zengeza1	78	33	295	75	8.9	2.3							
	Zengeza2	50	21	156	43	7.4	2.0							
	Zengeza3	92	39	239	101	6.1	2.6							
	Zengeza5	82	34	320	84	9.4	2.5							
	Bub-total	302	127	1,010	303	8.0	2.4	9,221	73,100	22,000	3.3	243		
Zengeza 4		124	38	272	73	7.2	1.9	2,703	19,300	5,190	3.7	156		
Zengeza All		426	165	1,282	376	7.8	2.3	11,924	92,400	27,190	3.4	217	771,218	150,600
Seke South	UnitD	41	18	174	41	9.7	2.3							
	UnitE	13	5	52	16	10.4	3.2							
	UnitJ	143	57	528	127	9.3	2.2							
	UnitK	40	17	119	33	7.0	1.9							
	UnitL	52	23	185	44	8.0	1.9							
	UnitM	59	23	226	56	9.8	2.4							
	Zanoreba	25	12	66	18	5.5	1.5							
	Sub-total	373	155	1,350	335	8.7	2.2	11,145	96,900	24,090	4.0	260	55,257	117,000
Seke North	Unit A	36	10	84	19	8.4	1.9							
	Unit B	59	17	206	51	12.1	3.0							
	Unit C	34	10	96	20	9.6	2.0							
	Unit F	34	10	96	26	9.6	2.6							
	Unit G	47	13	129	37	9.9	2.8							
	Unit H	23	7	63	15	9.0	2.1							
	Unit N	66	18	192	48	10.7	2.7							
	Unit O	50	14	135	36	9.6	2.6							
	Unit P	33	9	86	25	9.6	2.8							
	Riverside	8	2	9	2	4.5	1.0							
	Sub-total	390	110	1,096	279	10.0	2.5	8,126	80,800	20,610	3.9	208	180,000	85,300
Total		1,388	509	4,625	1,236	9.1	2.4	37,094	337,000	90,260	3.7	243	1,070,117	427,400

4. Estimation from the Number of Water-meters

In Chitungwiza Municipality, almost all housing units except for those located in a part of Zanoremba Ward are connected with water pipes, while housing units located in a part of Zanoremba Ward are supplied by stand post type of faucets. Therefore the number of private housing can be calculated by: the number of meters plus the number of housing units (350 housings) located in a part of Zeanoreba Ward.

The number is shown in Table A4.2.9 and estimated number of housing units is also shown. From the meters counted in the table, tariff charges are actually collected. This presents the number of housing units, said officers from the Municipality. As shown in Table A4.2.9, the official data of number of housing units is similar to the number of meters.

Table A4.2.9 Number of Water Meters and estimated Number of Housing

Area/Number	Number of Water Meters				Number of Housings		
	Residential	Industries	Others	Total	From Meters	Counted	Official
St. Mary's	8,379	0	427	8,806	8,379	5,899	9,839
Zengeza	15,031	308	467	15,806	15,031	11,924	14,873
Seke South	12,946	0	485	13,431	13,296	11,145	12,665
Seke North	15,357	0	333	15,690	15,357	8,126	15,538
Total	51,713	308	1,712	53,733	52,063	37,094	53,775

Number of housings served by stand posts in Zanoremba is 350

In this case, the number of housing units shown in Table A4.2.9 is used for the assumption of population and the average numbers of dwellers shown in Table A4.2.9 are also used. The estimated results are calculated in Table A4.2.10.

Table A4.2.10 Calculated Population

Area/Item	Number of Housing	Average Dweller Number	Calculated Population
St. Mary's	8,379	11.35	95,100
Zengeza	15,031	7.77	116,800
Seke South	13,296	8.71	115,800
Seke North	15,357	9.96	153,000
Total	52,063	9.09	480,700

5. Estimation of Current Population in the Municipality

(1) Comparisons of every Estimation Results

Table A4.2.11 shows a comparison of registered value and estimated results for housing number and population. The number of housing was actually counted by each area from Google Map taken in November 2011 and the results (b) were much different to the registered value (a) and the value (c) estimated by the number of water-meter. The counted results (b) are considered correct, because each

house buildings, which are one-story except for special few exceptions, can be clearly distinguished on Google map.

Table A4.2.11 Comparison of registered Value and estimated Results

Area/Item	Number of Housing			Population			
	(a) Registered	(b) Counted	(c) From Meter	(d) Registered	(e) From Pupils	(f) Counted	(g) From Meter
St. Mary's	9,839	5,899	8,379	63,642	89,600	66.900	95,100
Zengeza	14,893	11,924	15,031	771,218	135,600	92,400	116,800
Seke South	12,665	11,145	13,296	55,257	80,200	96,900	115,800
Seke North	15,538	8,126	15,357	180,000	122,100	80,800	153,000
Total	52,935	37,094	52,063	1,070,117	427,500	337,000	480,700

As the population, registered value is not reliable, because the registered population of Zengeza Area is 771 thousands (d) with number of housings of 15,031 (c) estimated from meters. It means that the average dwellers number is calculated to be 51 and 2.0m^2/persons due to average area of housing of 100m^2. It is an apparently impossible density, and in addition, the survey result of average dwellers number is 9.1 from Table A4.2.8. Therefore the registered population of municipality is also considered not reliable apparently.

The estimated results between value by pupils number and that by number of water-meter are relatively near, while estimated results from the counted housing units is much different. The surveyed average dweller number shown in Table A4.2.9 is used for the population (f) and (g).

The Census office of National Statistic Authority have started pre-survey for population census, and we can get the results of survey from 2011 to 2012 provided from Mr. Washington (Population census and survey director). It shows the population and No. of families are 326,793 and 79,171, respectively. The population was quite similar with our assumption (f), even though the number of families has relatively a large difference.

However real census survey was carried out on August 2012, the preliminary results were published by internet on January 2013: the result of population was 354,472 and number of families was 87,103. Thus the comparison between Census and estimation was small as shown in Table A4.2.10.

Table A4.2.10 Comparison between Census and Estimation

Item	Census	Estimation	Difference (%)
Population	354,472	337,000	-5.2
No. of Families	87,103	90,260	3.5

Thus we decided to use the population of **354,500** because the census data was only preliminary one.

APPENDIX 5.1

BCHOD
CONSULTING ENGINEERS
Brian Colquhoun Hugh O' Donnell and Partners

CHITUNGWIZA – IMPROVEMENT OF WATER SUPPLY, SEWERAGE AND SOLID WASTER MANAGEMENT.

REPORT ON WATER FLOW MEASUREMENT

CTC PEDWW MAY 2012

APPENDIX 5

1. General

Brian CoQuhoun Hugh O`Donnel (BCHOD) carried out a flow measurement of from Prince Edward Water Treatment Plant (PE-WTP) to Chitungwiza Municipality. The measurement was implemented from 17 May to 27, however that from 17 to 19 May was founded inaccurate and then the flow meter was again rearranged. After confirmation of the accuracy of the measurement, the flow rate had been measured for one week, from 19 around 12 a.m. to 26 May 12 a.m. May.

(1) Position

A portable flow mater was attached at a pipe flowing to Seke reservoir in Chitungwiza Municipality from PE-WTP down stream from existing meter pit, of which the electro magnetic flow meter with diameter 750mm was not working. The pipe attached needed to be excavated and exposed because there are not enough strait portion, which five times longer than diameter of strait portion is desirable, in the meter pit as shown in Photo A5.1.1. The location of the attached place is shown in Figure A5.1.1

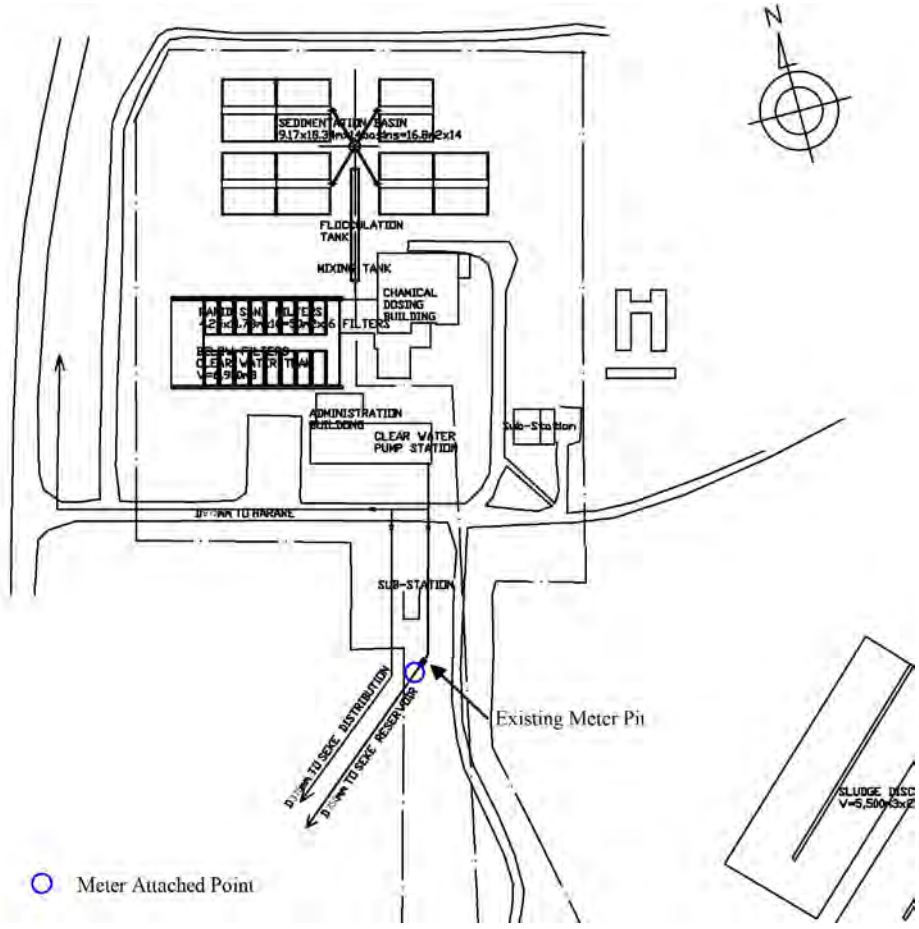


Figure A5.1.1 Position of Meter Attached Point

Excavated place was around 5 m down stream from the pit as shown Photo.A5.1.2, and the depth of the pipe was 2m at the centre of it.

(2) Flow meter

The equipment used is a Sitelab SL1188P Ultrasonic transit-time flow meter. The specifications are detailed below: Flow Range; 0 to 12 m/sec. Accuracy; +/- 0.5% of measured value. Repeatability; 0.15%. Pipe size clamp on; 1" – 200" (25 mm to 5000 mm). Storage PDA with 1GB memory card. Unit is battery powered and continuous battery operation is 8hours + spare battery for 24 hours. Analogue output 0/4 – 20 ma comes standard. Standard sensor cable of 5mtrs. Medium temperature -40Deg. C to approximately 80Deg. C Maximum. Please see Appendix.

Photo A5.1.1 Inside of Meter Pit
There is almost no strait pipe

(3) Attachment

The attached pipe was a 762mm (outer diameter) steel pipe epoxy coated on the outside. The flow meter was attached as Photo. A5.1.3 and the flow rate was recorded in the executive recorder and indicated at the chart for existing flow meter designed to handle up to a maximum 0f 4000 m^3/hr of flow rate as shown at Photo A5.1.4.

The coating was removed and the sensors were attached exposed steel pipe directly.

Photo A5.1.2 Excavated Place, 5m down stream from the pit

2. Measured Results

2.1 Flow Chart

Flow chart is shown in Photo. A5.1.5.

2.2 Flow record

Flow record averaged each one hour was shown in Table A5.1.1 and Figure 5.1.2.

2.3 Explanation of the Records

(1) From 19th 12:38 to 22th 10:38

The gate valve regulating flow from PE-WTP to Chitungwiza was closed but since the disk was eroded the flow cannot be stopped completely. The flow rate was 420- 450 m^3/hr, around 10,000 m^3/d.

Photo A5.1.3 Attached Flow Meter

Photo A5.1.4 Utilizing Existing Flow Chart

(2) From 22th 10:30-23th 8:38

The gate vale was opened 15 turns out of total 110 turns, which the 15 turns is normal opening to Chitungwiza. Flow rate was 1250-1350 m^3/d, around 30,000 m^3/d.

(3) From 23th 9:38-25th 17:38

The gate valve was opened to be 30 turns. Flow rate was increased to be 1,400-1,550 m^3/hr, around 35,000-36,000 m^3/d.

(4) From 15th 18:38-15th22:38

Because the power to PE-WTP was stopped, the water flows from City of Harare to Chitungwiza by gravity. Flow rate was 1,060 m^3/hr, 25,000 m^3/d.

(5) From 25th 23:38-26th 12:38

The water was distributed from PE-WTP again with 30 turns. Flow rate was 1,250-1,400 m^3/hr, 30,000-34,000 m^3/d.

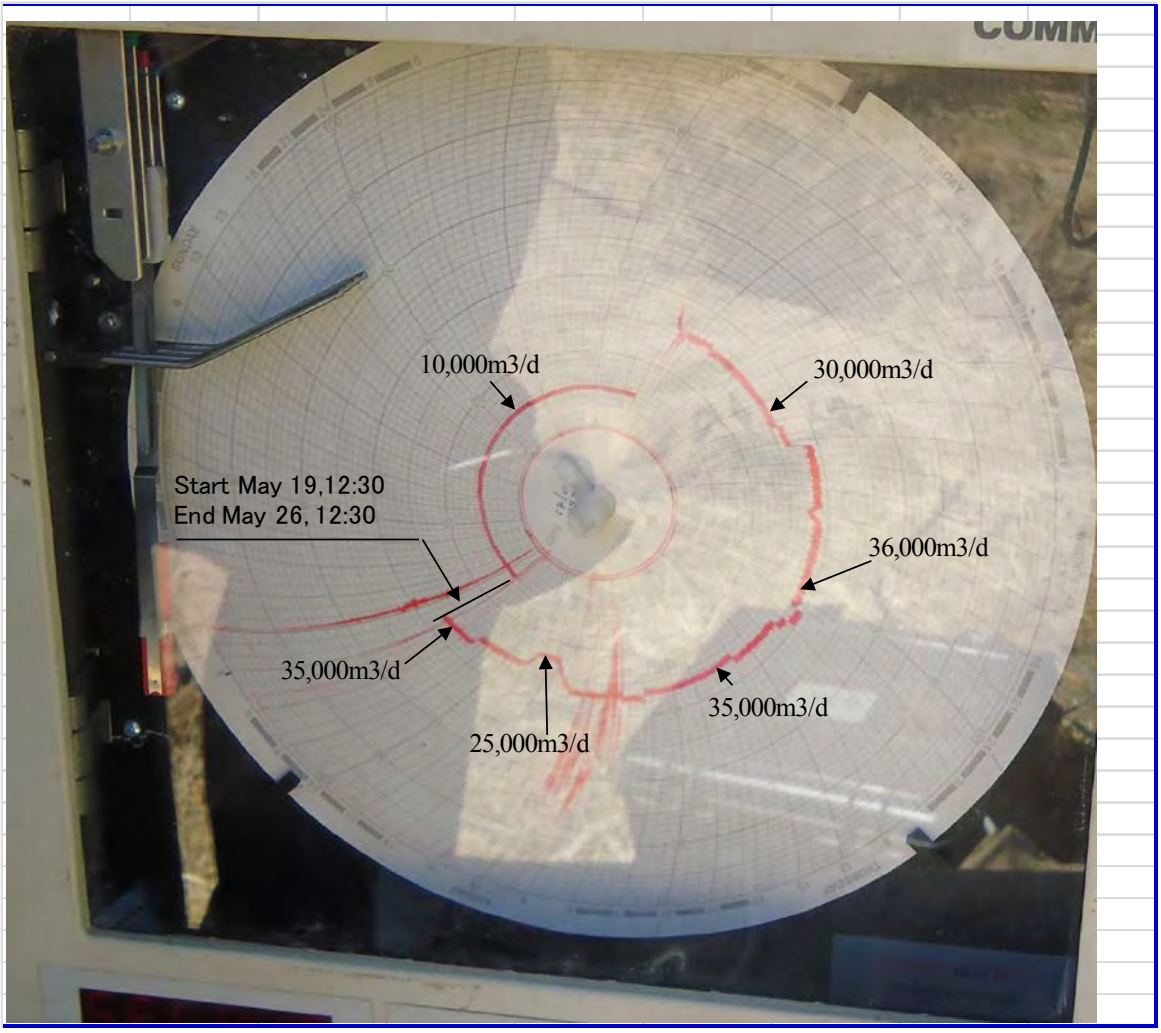


Photo A5.1.5 Flow Record Chart

APPENDIX 5

Table A5.1.1 Flow Records

5/19			5/20			5/21			5/22		
Time		Flow Rate	Time		Flow Rate	Time		Flow Rate	Time		Flow Rate
Actual	Nominal	(m^3/h)	Actual	Nominal	(m^3/h)	Actual	Nominal	(m^3/h)	Actual	Nominal	(m^3/h)
	0		0:38:31	0	439.33	0:38:02	0	419.51	0:38:41	0	411.06
	1		1:38:31	1	439.73	1:38:03	1	432.26	1:38:41	1	415.56
	2		2:38:31	2	420.93	2:38:03	2	433.34	2:38:44	2	426.91
	3		3:38:33	3	454.04	3:38:03	3	440.00	3:38:45	3	425.50
	4		4:38:33	4	437.47	4:38:03	4	443.74	4:38:47	4	429.51
	5		5:38:33	5	429.32	5:38:06	5	457.54	5:38:47	5	430.68
	6		6:38:33	6	446.09	6:38:06	6	444.01	6:38:47	6	393.26
	7		7:38:33	7	436.49	7:38:11	7	432.27	7:38:47	7	411.88
	8		8:38:33	8	424.15	8:38:11	8	443.32	8:38:48	8	423.30
	9		9:38:34	9	436.33	9:38:11	9	431.29	9:38:51	9	407.52
	10		10:38:34	10	450.71	10:38:11	10	436.83	10:38:05	10	432.95
	11		11:38:34	11	434.12	11:38:22	11	409.90	11:38:08	11	1366.90
12:38:58	12	437.08	12:38:40	12	439.24	12:38:22	12	416.78	12:38:11	12	1281.90
13:38:58	13	419.66	13:38:40	13	432.71	13:38:22	13	443.89	13:38:19	13	1210.10
14:38:00	14	446.74	14:38:41	14	438.41	14:38:22	14	434.88	14:38:19	14	1264.90
15:38:00	15	425.71	15:38:46	15	426.48	15:38:22	15	417.64	15:38:24	15	1237.10
16:38:00	16	441.69	16:38:47	16	442.49	16:38:22	16	434.41	16:38:24	16	1300.20
17:38:00	17	459.52	17:38:48	17	438.73	17:38:25	17	406.31	17:38:33	17	1241.80
18:38:20	18	437.46	18:38:53	18	452.44	18:38:25	18	429.89	18:38:33	18	1273.50
19:38:24	19	408.07	19:38:54	19	425.98	19:38:33	19	440.13	19:38:34	19	1262.20
20:38:25	20	454.41	20:38:55	20	433.88	20:38:37	20	418.58	20:38:34	20	1241.70
21:38:27	21	436.35	21:39:00	21	445.77	21:38:37	21	446.30	21:38:35	21	1260.80
22:38:30	22	441.54	22:38:01	22	423.40	22:38:38	22	435.87	22:38:36	22	1246.90
23:38:30	23	433.21	23:38:02	23	425.80	23:38:40	23	435.48	23:38:37	23	1275.50
Accumulated Flow:m^3		5,241	Accumulated Flow:m^3		10,474	Accumulated Flow:m^3		10,384	Accumulated Flow:m^3		21,072
5/23			5/24			5/25			5/26		
Time		Flow Rate	Time		Flow Rate	Time		Flow Rate	Time		Flow Rate
Actual	Nominal	(m^3/h)	Actual	Nominal	(m^3/h)	Actual	Nominal	(m^3/h)	Actual	Nominal	(m^3/h)
0:38:40	0	1329.30	0:38:34	0	1486.90	0:38:27	0	1409.10	0:38:24	0	1292.60
1:38:43	1	1242.90	1:38:34	1	1558.90	1:38:29	1	1365.10	1:38:29	1	1278.00
2:38:43	2	1253.80	2:38:34	2	1496.90	2:38:29	2	1386.80	2:38:29	2	1280.90
3:38:43	3	1256.60	3:38:34	3	1522.50	3:38:29	3	1380.50	3:38:29	3	1268.80
4:38:43	4	1252.10	4:38:34	4	1506.80	4:38:30	4	1340.60	4:38:36	4	1274.50
5:38:48	5	1326.70	5:38:40	5	1554.30	5:38:30	5	1407.50	5:38:36	5	1260.90
6:38:48	6	1326.70	6:38:40	6	1606.40	6:38:30	6	1394.90	6:38:36	6	1276.90
7:38:56	7	1339.10	7:38:45	7	1613.80	7:38:39	7	1425.10	7:38:36	7	1437.30
8:38:56	8	1307.40	8:38:50	8	1545.80	8:38:39	8	1413.10	8:38:36	8	1436.00
9:38:56	9	1510.00	9:38:53	9	1515.70	9:38:41	9	1398.40	9:38:36	9	1403.20
10:25:56	10	1538.70	10:38:54	10	1432.80	10:38:30	10	1401.50	10:38:46	10	1428.50
11:38:29	11	1538.00	11:38:56	11	1419.30	11:38:42	11	1387.50	11:38:30	11	1379.70
12:38:29	12	1538.00	12:38:56	12	1435.10	12:38:48	12	1377.60	12:12:48	12	1374.30
13:38:29	13	1538.00	13:37:59	13	1428.20	13:38:48	13	1404.40		13	
14:38:29	14	1538.00	14:38:12	14	1397.40	14:38:50	14	1403.60		14	
15:38:29	15	1498.00	15:38:12	15	1432.80	15:38:53	15	1431.60		15	
16:38:29	16	1538.00	16:38:12	16	1440.80	16:38:02	16	1415.80		16	
17:38:29	17	1537.50	17:38:12	17	1369.90	17:38:02	17	1338.10		17	
18:38:29	18	1537.50	18:38:14	18	1368.70	18:38:30	18	1172.50		18	
19:38:29	19	1537.50	19:38:14	19	1349.30	19:38:03	19	1062.20		19	
20:38:29	20	1537.40	20:38:16	20	1390.90	20:38:03	20	1088.90		20	
21:38:29	21	1494.70	21:38:16	21	1370.30	21:38:10	21	1062.60		21	
22:38:31	22	1524.60	22:38:16	22	1416.60	22:38:10	22	1048.60		22	
23:38:34	23	1496.10	23:38:30	23	1372.00	23:38:14	23	1245.50		23	
Accumulated Flow:m^3		34,537	Accumulated Flow:m^3		35,032	Accumulated Flow:m^3		31,762	Accumulated Flow:m^3		17,392

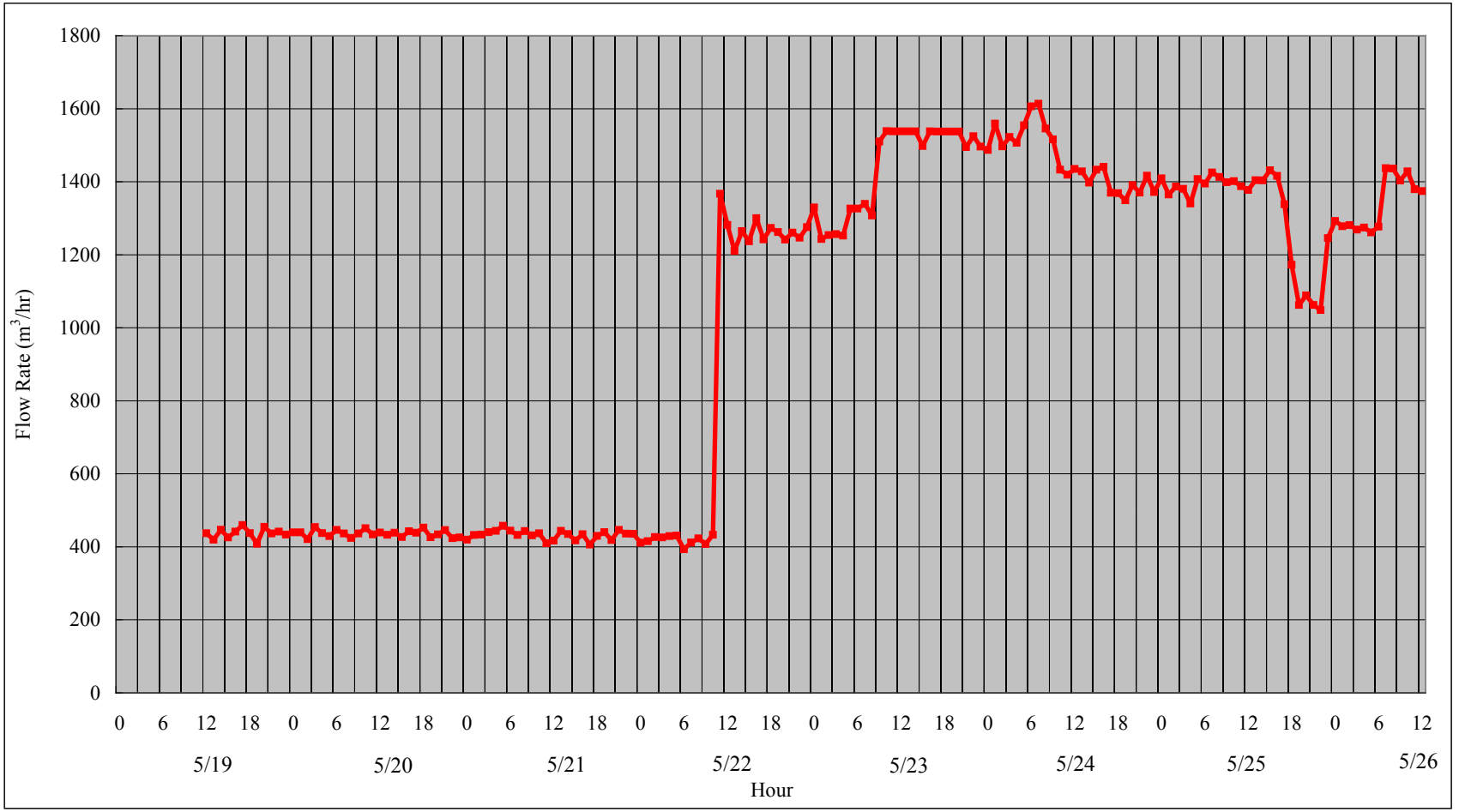
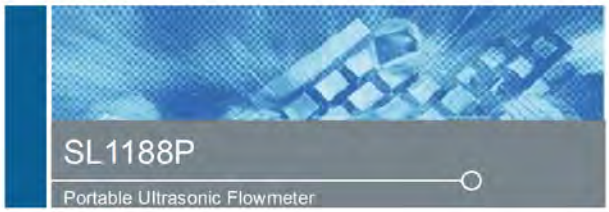


Figure A5.1.2 Flow Record

Attachment



Rev. 2010/06/21

Description

Model SL1188P is a Portable Ultrasonic Meter. It collects Flow Data via a PDA, and uses "UFM" software to download the Flow Data.

The SL1188P Portable Ultrasonic Flow Meter consists of flow sensors (ultrasonic), a flow transmitter and a Personal Digital Assistant (PDA). The Model SL1188P Portable Ultrasonic Flow-meter is the only flowmeter for which operation is a specialty between the electronics and operational interface. The SL1188P package has convenient magnetized transducer racks, good operational interface, and high memory card. It is designed to be user friendly, and even in the worst industrial environments, it is well protected by its high-strength impact resistant case with rubber ring seals and NEMA4 rating. Even if it is dropped into water it should continue to work normally. It a portable flowmeter made with expertise.

Parameters

Data storage: 1GB (512 days)
Cable signal attentuation:-0.9dB/100m
Cable tensile strength: 300 Newtons
Rise/fall time: 40 picoseconds
Transducer installation time: 55s
Portable transducer rack magnetic force: 200 Newtons
Bluetooth communications Distance: up to 160ft (50m)

Specifications

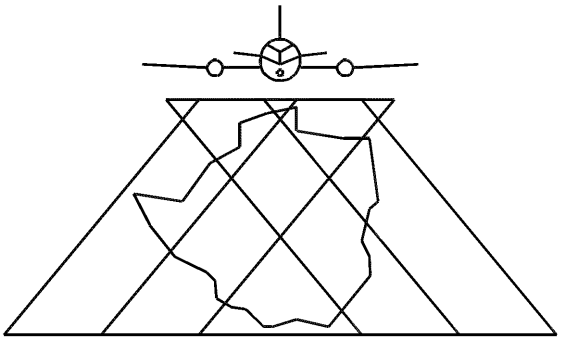
Transmitter (standard):
Flow range: 0 to ±40ft/s (0 to ±12m/s)
Accuracy: ±0.5% of reading
Repeatability: 0.15%
Power supply: internal lithium battery with 8 hours of use
Output: 0/4~20mA, maximum 750Ω
Power consumption: 1W
Weight: 3.3lbs (1.5kg)

P type Transducers (magnetic clamp-on)
Measurement Pipe range: 1" to 200" (25mm to 5000mm)
Protection rating: IP65
Temperature range: -40F to 176F (-40°C to 80°C)
Transducer cable standard length: 16ft (5m)

SITELAB

APPENDIX 5.2

BCHOD
CONSULTING ENGINEERS
Brian Colquhoun Hugh O' Donnell and Partners



Report on Depth Survey

for Chivero and Manyame Lake

October 2012

BCHOD Consulting Engineers

Africa Surveys Zimbabwe (Pvt) Ltd

APPENDIX 5

1. Preamble

The survey was managed by BCHOD Consulting Engineers, and Africa Surveys Zimbabwe (Pvt) Ltd (ASZ) carried out to obtain information for water volume analysis of Lakes Chivero and Manyame subject to specifications and locations provided by JICA Study team.

2. Equipment Used

Leica Kinematic GPS System 1200 Smart Rover with ATX 1230 SmartAntenna.

Measurement Accuracy (rms with RTK): *Horizontal:* 10 mm + 1 ppm, *Vertical:* 20 mm + 1 ppm

Leica Laser Total Station TS 09

Measurement Accuracy: *Distance:* 1mm+1.5ppm, *Direction:* 1-2 seconds

3. Methodology of Survey

The survey was undertaken using global positioning survey (GPS) techniques due to the vast area covered by the two lakes. The procedure commenced with a calibration of the GPS equipment using existing trigonometrical bacons covering the two lakes in order to obtain calibration parameters that enable subsequent accurate measurement of points on the lakes.

A motorised boat was hired to traverse the lakes to predetermined points on the lakes. A hand hold GPS was used to provide the location of the points to within an accuracy of +/- 30 m. Using a base station mounted off-shore to transmit GPS information to a rover on the boat, it was possible to accurately measure the three dimensional positions (X, Y, Z) of the points to 0.05 m. The measurement technique involved a calibrated plunger (rope with weight) that was thrown into the lake at each designated point to determine the depth; the plane coordinates were measured by GPS. A total of 53 points were measured on both lakes. Current water levels of the lakes were also measured. Spillways were measured. Design full water marks were availed by the JICA. Photographs were also captured of the survey exercise at various sites showing the measurement method.

3. Schedule of Survey

The survey was undertaken in August and September 2012 as follows:

Calibration of GPS Equipment: 8-11 August 2012

Measurement of Points on Lakes: 29 August - 3 September 2012, 19-22 October 2012

Calculations and Report Presentation: 25October 2012

4. Presentation of Results: Annexures

The results of the survey are presented on a 1: 50 000 scale digitized map depicting all the GPS points surveyed, in UTM, Zone 36. The coordinate list presents the points as measured.

5. Results

The survey points of both lakes are shown in Figure A5.2.1. The distance of each point in Lake Chivero is 1.0 km and that in Lake Manyame is 1.5 km, respectively.

APPENDIX 5

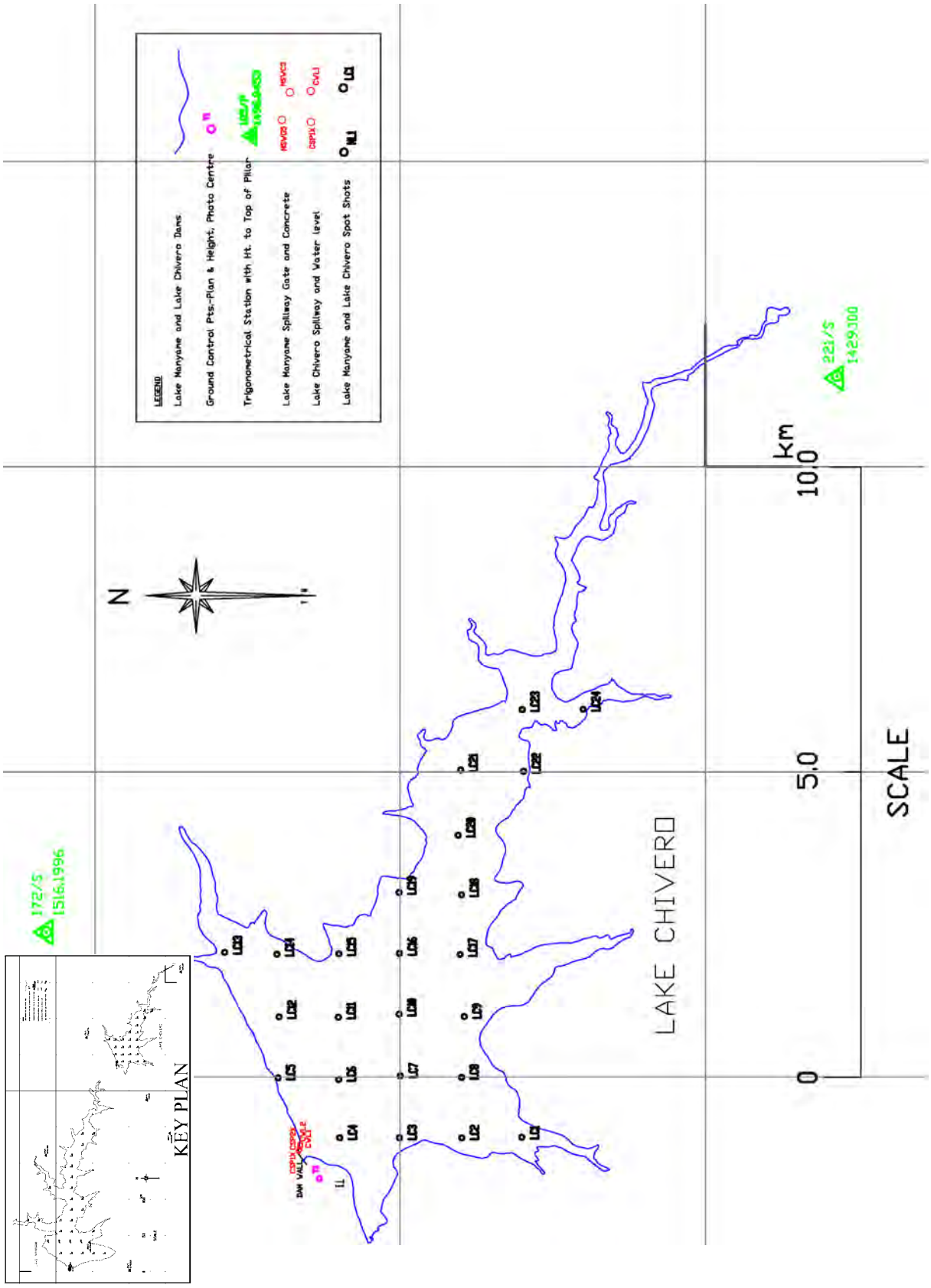


Figure A5.2.1 (1) Survey Points for Chivero Lake

APPENDIX 5

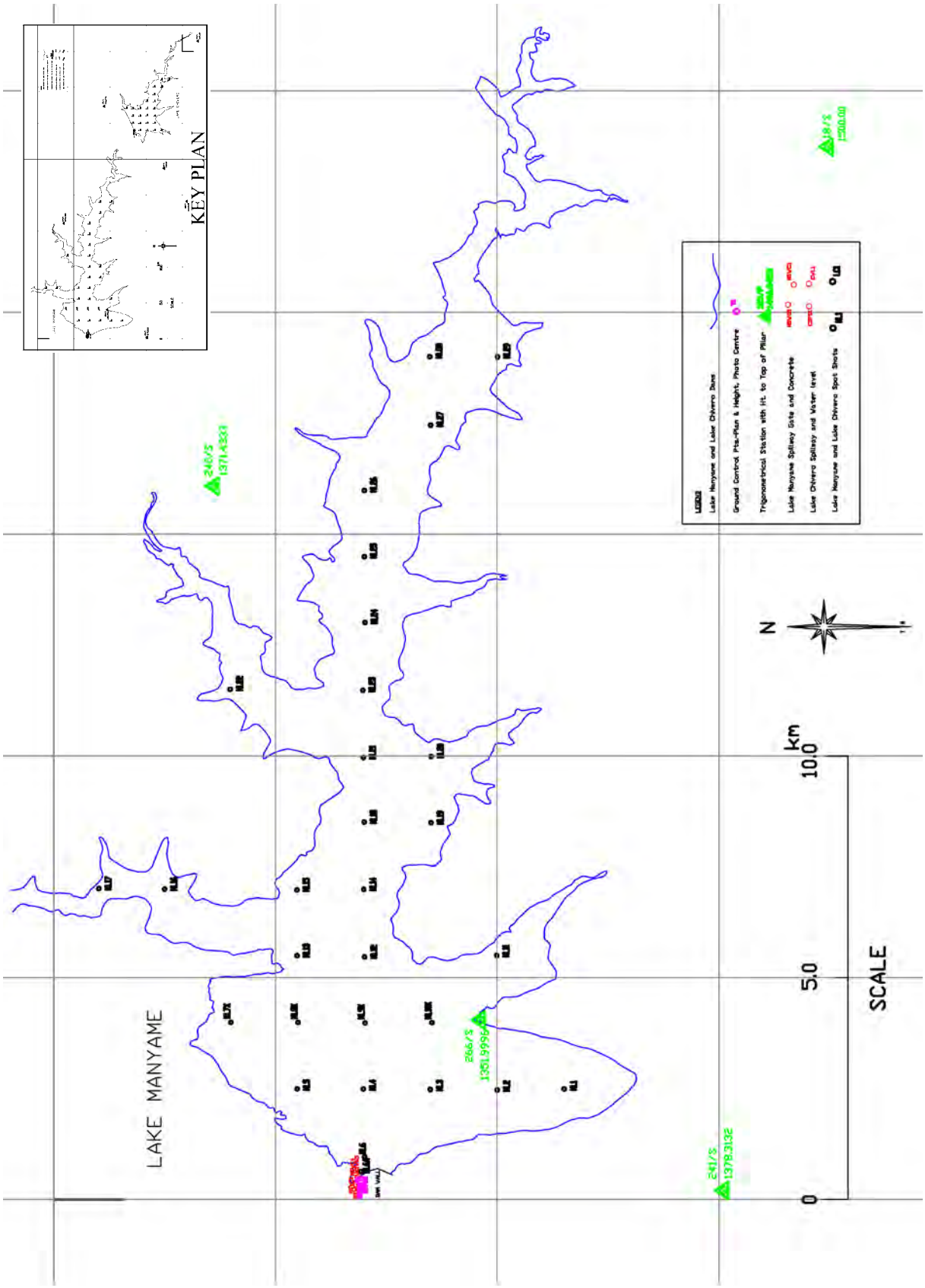


Figure A5.2.1 (1) Survey Points for Manyame Lake

APPENDIX 5

TableA5.2.1 Description of the Survey

Item	Details	Notes
Survey points	Total: 53 points (Lake Chivero: 24 points, Lake Manyame: 29 points)	
Times	One time, measured in real time	
Method	Measured XYZ coordinates using GPS, depth of water measured using calibrated plunger	See coordinate list attached in Lo 31 and UTM
Water level	Measured using GPS	See coordinate list
Photos	Photos show the GPS survey technique, the water intake, the boat being taken to Lake Manyame	See "annexures"

Measured results of coordination and level of bottom with calculated results of depth are shown in Table A5.2.2 for Lake Chivero and Table A5.2.3 for Lake Manyame. Water depth is calculated as: HWL – Bottom level

Lake Chivero

HWL is the top level of spill way: 1,364.81 m (designed level =1,363.59 m)

Water level of the surveyed day (L1): 1,363.93 m

Difference between HWL and L1: 1,364.81-1,363.93=0.88 m

Lake Manyame

HWL = Top level of Gate – (1,342.88 m (Design level of gate top)-1,341.1 m (HWL) = 1.78 m)

Top level of gate: 1,341.05 m

HWL: 1,341.05 – 1.78 = 1,339.27 m (design level = 1,341.1 m)

Water level of the surveyed day (L1): 1,340.2 m

Difference between HWL and L1: 1,339.27 - 1,340.2= - 0.93 m (higher than HWL)

Table A5.2.2 Survey Results for Chivero Lake

Lake Chivero Points Coordinate List

Surveyor: R Chigumete
Assisted by: G Mbanje, M Chikoto, T N Fusire
Date of survey: August, September, October 2012

Abreviations

LC- Lake Chivero Water Level approx. = 1363.93m
Height of Spillway Top (HWL of Lake): 1364.81m

Point	Gauss Y metres	Lo 31 X	Bottom(m) Z	UTM E	Zone 36K N	Depth(m)
LC1	24115.706	1981389.861	1359.736	264 013,76	8018 005,81	5.074
LC2	24115.257	1980404.734	1357.888	264 003,63	8018 991,16	6.922
LC3	24103.934	1979384.249	1356.581	264 004,00	8020 012,00	8.229
LC4	24091.288	1978406.986	1345.158	264 006,16	8020 989,62	19.652
LC5	23099.906	1977407.720	1357.037	264 987,04	8021 999,74	7.773
LC6	23137.849	1978402.538	1348.809	264 959,76	8021 004,30	16.001
LC7	23088.795	1979409.782	1350.152	265 019,64	8019 997,36	14.658
LC8	23124.710	1980412.835	1355.541	264 994,48	8018 993,70	9.269
LC9	22128.625	1980467.186	1356.328	265 991,37	8018 950,04	8.482
LC10	22078.525	1979401.045	1351.664	266 030,03	8020 016,94	13.146
LC11	22115.903	1978407.675	1353.020	265 981,99	8021 010,12	11.790
LC12	22101.167	1977435.018	1354.124	265 986,29	8021 983,15	10.686
LC13	21033.986	1976556.854	1362.409	267 044,28	8022 872,94	2.401
LC14	21076.511	1977410.043	1358.477	267 010,90	8022 019,12	6.333
LC15	21079.571	1978427.300	1360.393	267 018,75	8021 001,61	4.417
LC16	21083.988	1979416.456	1349.548	267 024,95	8020 012,20	15.262
LC17	21112.361	1980411.155	1356.145	267 007,25	8019 016,99	8.665
LC18	20134.290	1980442.798	1349.946	267 985,87	8018 995,85	14.864
LC19	20084.879	1979421.307	1359.910	268 024,32	8020 018,08	4.900
LC20	19156.825	1980400.173	1342.535	268 963,07	8019 048,98	22.275
LC21	18088.849	1980453.085	1344.227	270 031,83	8019 007,53	20.583
LC22	18121.258	1981481.595	1362.576	270 010,46	8017 978,47	2.234
LC23	17112.976	1981471.929	1359.310	271 018,83	8017 998,97	5.500
LC24	17119.212	1982467.952	1359.519	271 023,30	8017 002,70	5.291
Average						10.184

Table A5.2.3 Survey Results for Chivero Lake

Manyame Lake Points Coordinate List

Abreviations

ML- Manyame Lake Water Level approx. = 1340.20m
Height of Gate: 1341.05(-1.78)
HWL = Height of Gate-1.78m
(Design Top of gate:1342.88-design water depth:1341.1=1.78m)

Point	Gauss	Lo 31	Bottom(m)	UTM	Zone 36K	Depth(m)
	Y	X	Z	E	N	
ML1	50569.601	1975628.202	1337.565	237 490,17	8023 485,25	1.705
ML2	50575.535	1974117.243	1334.555	237 468,05	8024 996,70	4.715
ML3	50545.886	1972606.326	1331.478	237 481,53	8026 508,48	7.792
ML4	50522.414	1971096.796	1326.082	237 488,86	8028 018,81	13.188
ML5	50504.777	1969605.631	1331.605	237 490,56	8029 510,71	7.665
ML6	52049.987	1971108.406	1318.026	235 960,84	8027 990,86	21.244
ML6A	52382.510	1971022.441	1322.365	235 627,27	8028 073,30	16.905
ML7X	48988.402	1968126.526	1337.891	238 991,68	8031 006,54	1.379
ML8X	49005.328	1969639.641	1329.363	238 990,92	8029 492,71	9.907
ML9X	49031.644	1971152.412	1324.155	238 980,77	8027 979,12	15.115
ML10X	49043.044	1972662.696	1327.218	238 985,52	8026 468,18	12.052
ML11	47544.100	1974137.579	1338.172	240 500,79	8025 008,82	1.098
ML12	47546.164	1971156.373	1332.122	240 466,82	8027 991,04	7.148
ML13	47500.523	1969633.607	1338.024	240 496,19	8029 514,83	1.246
ML14	46022.299	1971154.765	1330.522	241 991,20	8028 008,95	8.748
ML15	46018.094	1969648.038	1334.737	241 979,29	8029 516,23	4.533
ML16	45968.321	1966663.071	1329.127	241 997,21	8032 502,75	10.143
ML17	45939.254	1965180.838	1335.695	242 010,47	8033 985,79	3.575
ML18	44504.016	1971181.253	1332.468	243 510,28	8027 998,69	6.802
ML19	44537.038	1972686.660	1334.592	243 493,35	8026 492,43	4.678
ML20	43041.141	1972703.515	1334.529	244 989,92	8026 491,58	4.741
ML21	43051.298	1971177.411	1333.110	244 963,44	8028 018,07	6.160
ML22	41481.056	1968192.460	1333.365	246 502,29	8031 020,76	5.905
ML23	41539.214	1971181.623	1329.624	246 476,06	8028 030,03	9.646
ML24	40006.460	1971246.921	1330.961	248 009,99	8027 981,10	8.309
ML25	38522.792	1971246.726	1329.256	249 494,12	8027 997,16	10.014
ML26	37030.158	1971263.172	1332.466	250 987,37	8027 996,67	6.804
ML27	35573.272	1972775.558	1335.396	252 460,87	8026 499,44	3.874
ML28	34032.359	1972771.899	1334.741	254 002,18	8026 519,59	4.529
ML29	34052.398	1974301.075	1334.933	253 998,51	8024 989,77	4.337
Average						7.465

APPENDIX 5

6. Evaluation of the Results

6.1 Lake Chivero

(1) Design Dimension of the Lake (from O&M manual)

Full volume of the lake: 251,200,000 m^3

Area: 26,500,000 m^2

HWL: 1,363.59 m

(2) Calculated depth

From above data

Average Depth = 251,200,000/26,500,000 = 9.48 m

Surveyed depth is: 10.184 m,

It is deeper than the designed depth.

Because the survey points are selected in the lake, centered in the middle of the lake, it is considered that the measured depth was deeper than design depth, which may show actual average depth.

6.2 Lake Manyame

(1) Design Dimension of the Lake (from O&M manual)

Full volume of the lake: 491,820,000 m^3

Area: 79,760,000 m^2

HWL: 1,341.1 m

(2) Calculated depth

From above data

Average Depth = 491,810,000/79,760,000 = 6.17 m

Surveyed depth is: 7.465 m,

It is deeper than the designed depth.

Because the survey points are selected in the lake centered in the middle of the lake, in addition majority of the points are lined one series. It is considered being reason why the measured depth was deeper than design depth, which may show actual average depth.

APPENDIX 5

Attachment –Photo

LAKE CHIVERO WATER LEVEL MEASUREMENT

MEASUREMENTS AT LAKE MANYAME

LAKE CHIVERO SPILLWAY MEASUREMENT

LAUNCHING BOAT INTO LAKE

TOTAL STATION SETUP AT LAKE MANYAME

MEASUREMENT OF LAKE DEPTHS WITH GPS

APPENDIX 5.3

Survey results of wells

1. Location of target wells

Locations of surveyed wells are shown in Figure A5.3.1, while No.1 - 4 wells are shallow well and No.4,5 wells are borehole with hand pump.

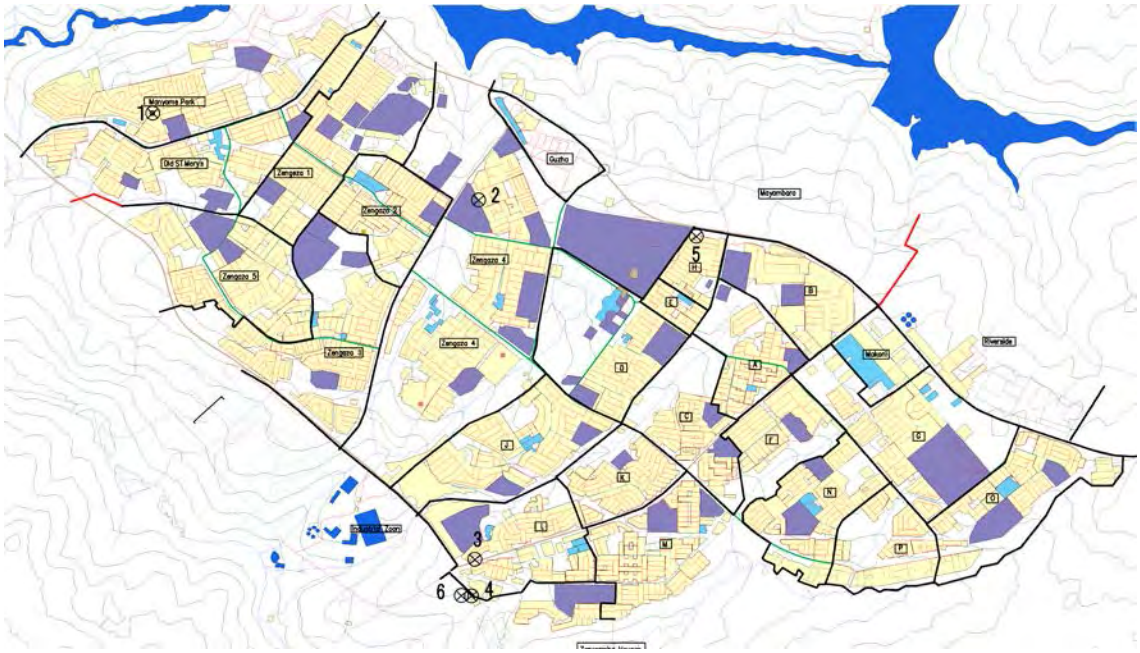


Figure A5.3.1 Locations of Surveyed Wells

2. Well Yield Tests

2-1 Execution

The tests are executed on 28th and 29th August. The test was carried out by submerged pump with the capacity of 1 around litter/s, water flow was measured by bucket. The photo of packaged facilities and testing condition is shown in Photo A5.3.1 and 2, respectively.

Photo A5.3.1 Packaged Facilities

Photo A5.3.2 Testing Condition

The results of test are shown in attachment 1-6.

APPENDIX 5

2-1 Analysis of the Yield Test Results

The calculated results of yield capacity are shown in Table A5.3.1.

Table A5.3.1 Calculated Results of Yield Capacity

Well Yield Capacity	Shallow Well				Borehole	
	1	2	3	4	5	6
	Manyame Park	Zengeza4	Unit L	Zenoremba	Unit H	Zenoremba
Start Time	6:30	6:00	7:20	7:40	14:30	14:30
Start WL(m)	3.6	8.1	2.6	2.4	9	9.4
Pumping time(sec)	600	442	600	132	4200	900
Pump Dischage(L/s)	0.417	0.758	0.758	0.781	0.893	0.893
Total Withdraw(L)	250	335	455	103	3,751	703
Finish WL(m)	3.6	8.9	2.6	2.6	23	36.5
Measurement Start	6:55	6:08	7:30	7:43	15:40	15:10
Recovered WL(m)	3.6	8.6	2.6	2.3	107	18
Elapse(min)	640	562	317	310	20	20
Yield capacity(m^3/d)	36.03	0.32	65.49	0.72	77.16	34.55
Yield capacity(L/s)	0.417	0.004	0.758	0.008	0.893	0.400

As shown in Table-1, yield capacities of shallow wells were much different, while these for both of boreholes are relatively large. Figure A5.3.2 (1) shows water level lowering for boreholes, and Figure A5.3.2 (2) shows water level recovering after finish of pumping up.

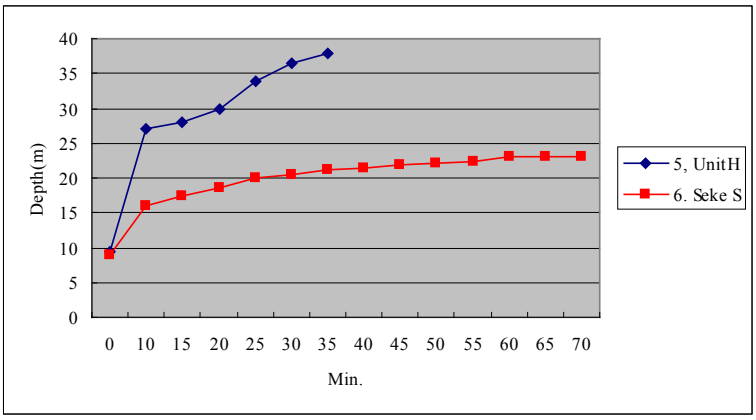


Figure A5.3.2(1) Water Level Lowering of Boreholes

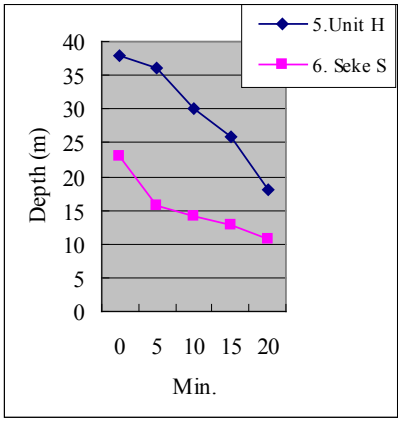


Figure A5.3.2(2) Water level Recovering of Borehole

3. Water Quality Analysis

The samples from target wells were taken 3rd September 2012, and the analysis results are shown in Table A5.3.2.

APPENDIX 5

Table A5.3.2 Water Quality of Wells

Item	unit	WHO Standard	Shallow Well				Borehole	
			1	2	3	4	5	6
			Manyame Park	Zengeza4	Unit L	Zenoremba	Unit H	Zenoremba
pH	---	**6.5-8.9**	6.15	5.51	6.43	6.24	5.87	6.45
Alkalinity	mg/L	**---**	164	56	52	102	82	100
Hardness	mg/L	**250**	58	60	94	192	76	80
Colour	mg/L	**15**	5	5	5	5	5	5
Turbidity	NTS	**5**	2.4	2	2.7	2	2.5	2.2
Iron	mg/L	**0.3**	<0.01	<0.01	<0.01	<0.01	0.07	<0.01
Manganese	mg/L	**0.1**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate	mg/L	**10**	<0.01	<0.01	4	<0.01	<0.01	<0.01
SS	mg/L	**100**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride	mg/L	**15**	0.09	0.1	0.08	0.08	0.07	0.1
Bacteria	no./ml	**<100**	**200**	33	**200**	**500**	27	1
Coliform	no./100ml	**Nil**	**7**	**7**	**17**	**26**	**2**	**2**
E-coli	---	**Negative**	Negative	Negative	Negative	Negative	Negative	Negative

As shown above table, the bacteria numbers of three shallow wells are exceed WHO Guidelines, in addition the number of coliform is detected, which should not be detected. Within the wells, No.4 well's quality is the worst including high hardness. Therefore the water taken from wells should be boiled before drinking.

APPENDIX 5.4

WASTE AMOUNT AND COMPOSITION SURVEY (WACS) AND ILLEGAL DUMPING WASTE SURVEY

FINAL REPORT

October, 2012

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Suite 21, No. 1 Kwame Nkrumah Avenue

Acknowledgements

The consultant wishes to thank all those who participated in the survey. Particular thanks go to the JICA Team for coordinating the whole study and Municipality of Chitungwiza for coordinating survey logistics and accompanying the team to the field. A special mention goes to the Chitungwiza community i.e. residents, schools, factories, kiosks, supermarkets and markets for their unmatched cooperation and assistance. The research assistants and data capturers did a great job given the limited time frame.

Executive Summary

The overall objective of the study on Waste Amount and Composition Survey and Illegal Waste Dumping Survey was to provide the basic information required for review, revision and formulation of the Master Plan for Chitungwiza Municipality. The limitations noted for this survey included: some households not willing to provide information on family income or personal information, having limited information for the other families at the same stand as well as the tendency of disposing waste prior to sample collection. Regarding the illegal dumping waste survey, challenges included roads not having labels with the majority of residents not sure of their names. The new areas did not record a lot of dumping sites because they have dug refuse pits at their yards.

A total of two types of generation source were defined, and these were the residential area and the establishment/institution waste stream. The residential area was divided into the low income, middle income and high income areas while the establishments were subdivided into schools, kiosks, supermarkets, factories and markets. The methodology for the solid waste survey was drafted as direct waste analysis as this method provides data that is accurate and detailed. Sixty samples were collected every day for eight days from the different income areas giving a total of 480 samples. Each establishment sector provided three samples for five days giving a total of 15 samples every day. For illegal dump sites, the survey team went around the municipality mapping, identifying the illegal dump sites, recording the area and volume of the waste as well as location (coordinates) of the actual sites were the dump sites are found.

The following were the findings of the survey:

<u>Waste amount</u>

- There were 538 people in the sampled households with the majority of households in the high income area being occupied by single families while the middle and low income areas, residences were mostly occupied by 2 to 3 families.
- The average per capita waste generation amount was obtained as 0.41 kg/day/person, 0.38 kg/day/person and 0.49 k g/day/person for high, middle and low income areas respectively

with the inclusion of yard waste. However, without the influence of yard waste, high income area has the highest waste generation per capita per day per person (0.31 kg/d/person), the middle income followed with 0.29 kg/d/person while the low income was the least with 0.19 kg/d/person.

Waste composition

- Food and yard waste occupies most of the waste produced by the residential communities. The results show that high and middle income areas produced higher food waste quantities as compared to low income areas. On the other hand the low income areas generated more yard waste as compared to the other income areas.
- Among establishments, yard waste is mostly generated by schools, while supermarkets and kiosks, had very similar compositions although the kiosks had higher or very significant values for paper and plastic. The factories involved in the survey were all food factories (beer brewing, dairy juice production and bread making) which explain the high food waste component on the waste generated. The markets had very diverse waste components although food waste remained the main waste component generated.

Bulk density

- The study results show that the middle income areas had a higher bulk density than the other income areas ranging from 74.72 kg/m^3 to 466.51 kg/m^3 with a mean of 187.68 kg/m^3. The establishments had generally low bulk densities as compared to residential areas with the factories having the highest waste density as compared to other sectors.

Moisture content

- Among the residential area, the middle income had the highest (average of 38.8%) moisture content for the waste analysed while the markets had the highest moisture (average of 50.38%) content for the samples analysed. The moisture analysis of the municipality ranged from 15.23% to 50.38% with an average of 29.64%.

Illegal Dumping Waste Survey

- Three hundred and ninety (390) illegal dump sites were recorded throughout the municipality with the majority of sites being located in St Mary's and Zengeza districts. The majority of the sites were visible to the public right-of-way and a great majority of the sites were located in close proximity to streams. The areas most affected by illegal dumping of waste in Chitungwiza Municipality are St Mary's, Manyame and Unit D.
- Dumping sites contained common household wastes, household hazardous wastes, construction and demolition debris, scrap metal, household appliances, plastics, beverage cans, pet bottles, diapers and sanitary pads.

The following facts can be concluded from the survey

- The waste generation per capita per day for the residential waste was 0.43 kg/day/person which compares well with documented typical values for developing countries where it is estimated to range between 0.2-0.4 kg/day/person. The low income area generated more waste than other income areas as a result of a lot of yard waste that is produced. The figures ranged from 0.21 kg/day/person to1.54 kg/day/person with a mean of 0.49 kg/day/person. However, when yard waste is excluded, the high income area has the highest per capita waste generation of 0.31 kg/day/person and the low income area has the lowest per capita waste generation of 0.29 kg/day/person.
- Waste was mainly composed of high organic content, making it appropriate for composting.
- The moisture analysis of the municipality ranged from 15.23 - 50.58% with an average of 29.64%. The medium income area and the markets had significantly high moisture content levels compared to others indicating considerable amounts of organic matter in the waste.
- The majority of illegal dump site are found in low and middle income areas which could be attributed to the high population densities in such areas. Zengeza and Seke North districts had the largest area of waste in illegal dump sites with the least area and volume being in Seke South district
- Substantial amounts of waste were observed at major shopping centres in the city, along school perimeter fences/ durawalls and along roads as well as in storm water drains.

Table of Contents

1.0 Introduction

Chitungwiza Municipality is one local authority in Zimbabwe, currently facing challenges in the management of solid waste and chief amongst the challenges are inefficient Solid Waste Management (SWM) services. Lack of accurate data on the waste amount and composition by type is among the direct causes of this inefficiency. In order for SWM to be effective and efficient, members of the community should know how much solid waste they are generating and how fast it is being generated so that they can assess their current and future needs in budgeting, operation and processing and disposal facilities (Yuan, 2002). Successes by any municipality in SWM revolves around the development of a sound Integrated Solid Waste Management (ISWM) system where the main aim would be to reduce the final volumes of waste that find their way to a landfill through reduction, reuse and recycling of waste (The 3Rs). Although Zimbabwe has supportive policies and legislation in place regarding solid waste management, the need for proper use of environmentally sound technologies as well as appropriate financial instruments to support implementation of an ISWM system cannot be overemphasised. The unavailability of data on waste amount and composition in Chitungwiza Municipality resulted in consultancy services being sort from Ncube Burrow (Pvt) Ltd Engineering and Development Consultants to undertake a Waste Amount and Composition Survey (WACS).

This report provides the results of the study of amount and composition of solid waste disposed in Chitungwiza Municipality during the months of July and August 2012. The report consists of three components of the survey i.e. Waste Amount survey, Waste Composition survey and the Illegal dumping waste survey.

1.1 Objectives of the survey

- The overall objective of the study was to provide the basic information required for review, revision and formulation of the Master Plan. Specifically the objectives of the study were to
- Determine the amount of waste being generated from both residential and establishments/ institutions of Chitungwiza City
    - Daily and average waste generation rate per capita day of each waste stream
    - Average waste generation rate per day of the Municipality
- Determine the composition of waste generated in each waste stream and for the municipality
    - Wet base weight of each component
    - Volume of composite sample
    - Bulk density of composite sample
    - Moisture content of composite sample
- Illegal Dumping Waste survey

- Identify, list and map all illegal waste dumping areas within the jurisdictional area of Chitungwiza municipality
- Information on the state and issues of interest on the illegal dumpsites
- Photo album of the illegal dumps

2.0 Survey Approach and Methodology

The waste amount generation and composition survey and Illegal Dumping Waste Survey were executed by a local company, Ncube Burrow (Pvt) Engineering and Development Consultants, Ltd under the supervision of the JICA Survey Team. The data collection for the survey commenced on the 25th of July 2012 and ended on the 9th of August 2012 for the Waste Amount and Composition surveys. The Illegal Dumping Waste Survey was completed on the 18th of August 2012 as shown in Table A5.4.1.

Table A5.4.1 Actual Work Schedule for the Waste Amount and Waste Composition survey and Illegal Dumping Waste Survey

	July		August				Dates	Estimated Days	Responsible people:
Activity	wk 3	wk 4	wk 1	wk 2	wk3	wk 4			
Inception meeting (agreeing on the TORs by all Parties)							19-Jul	0.5	rp;
Work plan submission and contract signing							23-Jul	0.5	rp; bm
Purchasing equipment for waste amount and composition surveys							24-Jul	1	rp; bm
Develop and refine field tools							20-Jul	0.5	rp; bm
Recruitment of project assistants and training							24-Jul	0.5	rp; bm
Waste amount and waste composition survey (school)							25 Jul - 31 Aug		Team 2: (bm; wv; lm; t)
Waste amount survey (low, middle, high income, 4 other establishments)							30 Jul -6 Aug	8	Team 1: (rp; wm; nm) Team 2: (bm; wv; lm; t) Team 3 (lp; tt; lm; cm)
Waste amount survey (low, middle, high income, 4 other establishments)							30 Jul-6 Aug	8	Team 1: (rp; wm; nm) Team 2: (bm; wv; lm; t) Team 3 (lp; tt; lm; cm)
Data Entry							30 Jul-6 Aug	3	rp; bm; wm; nm
Data Analysis							7-8 Aug	2	rp; bm
Illegal dumping waste (mapping/photos)							25 Jul-29 Jul	5	Team 1: (rp; wm;nm) Team 2: (bm; wv; lm; t) Team 3 (lp; tt; lm; cm)
Illegal dumping waste (CD Rom finalisation)							17-Aug	2	rp; bm
Report writing	Draft						02-Aug	2	rp; bm
	Final						28-Sep	1	rp; bm
Printing and binding							28-Sep	0.5	rp; bm
Total No. of days								34.5	

Team Members

rp-regina pawaringira	lm-luke mukanyimaho
bm-belladonah muzavazi	nm-natasha manyau
wm-wisdom masakure	lc-lydiete magura
lp-liliosa pahwaringira	tt-talent tandi
wv-washington vambe	cm-chipo manyau

2.1 Preparations for Survey

2.1.1 Permission for sample collection

A letter from the Municipality of Chitungwiza authorizing the consultants to conduct the survey was used to create the necessary relationship with the households and establishments selected for the survey. The sample letter is attached in Annex 1

2.1.2 Sampling equipment

A detailed list of all the equipment used for the survey is provided in Annex 2

2.1.3 Recruiting Personnel

Research Assistants for the survey were a necessity. The survey took off with an initial 10 research assistants and two research experts; however after a few days into the survey the team appreciated the work and also the need to increase the number of research assistants. Thus in total the survey was conducted by 15 research assistants under coordination of two researchers. The team was divided into two: i.e. one team was responsible for the waste amount and composition (14 members) while the other was responsible for Illegal Dumping Waste Survey (3 members). However, the team members were constantly being shuffled so that every team members had an appreciation of the different components of the survey. The list of the survey team members is provided in Annex 3.

2.1.4 Staff Training

Half day training was sufficient for the research team to have an understanding of the purpose of the study and its working conditions. In terms of the actual work to be done, on-site training for each component of the study was conducted during the first two days of the survey. The JICA team was also present to verify and clarify the research methods being employed by the team.

2.1.5 Health and safety of team members

Every team member was encouraged to be conscious of one's safety during the exercise. The members were given safety clothing for the survey (work suits, gloves and respirators). Antiseptic liquid soap and washing facilities were also available for the team. The waste amount and composition processing was done at the Municipality workshop. A well ventilated shed was provided for processing the samples.

2.2 Limitations

The following limitations were noted:

Residential area

- Some households were not willing to provide information on family income or some personal information
- For multifamily households, the interviewee would sometimes have limited information for the other families
- During sampling some households had the tendency of disposing waste prior to sample collection on the basis that they forgot. For some households, samples could not be collected as household members were absent and no bin was left outside for collection.

Establishment waste stream

- One of the Initial selected factories had its workers on strike thus sampling for factories delayed as the team tried other options
- One of the sampled schools had a tendency of disposing some of its waste prior to collection.
- One of the markets had no skip bin
- Samples from supermarkets ended up being very rough estimates as sample collection competed with scavengers. The owners would sometimes dispose some of the waste prior to collection
- One of the factories sampled acknowledged low production levels which were prevailing during the time of the survey. Thus the samples might be slightly biased.

Illegal dumps mapping survey

- Most roads were not labelled and the residents were not sure of their names
- For new areas assessment was very biased as most households had dug pits inside their yard thus illegal dumps were close to zero
- A significant number of illegal dumps were less than $10m^3$ thus in some cases just photographs would be taken

2.3 Waste generation source

For the purposes of the study, a total of two Waste generation source were defined, i.e. the residential area and the establishment/institution waste stream. The residential area was further divided into three more sections that is: the low income area, Middle income area and High income area. The establishments were subdivided into five sections, schools, kiosks, supermarkets, factories and markets.

2.3.1 Residential area

This encompassed waste generated by households from single families to multiple families living on the same residence. Three income categories were investigated in the study i.e. Low income area,

middle income area and high income area. The different income areas were based on the municipality's discretion on the land and house values of the income areas. Low income areas have cheaper houses than the high income areas. Table A5.4.2 shows some of the locations put in different income categories according to the Municipality's discretion. Specifically for the survey, St Mary's represented the low income area; Zengeza 4 represented the medium income area while Rockview represented the high income area.

Table A5.4.2 Classification of Residential Areas

Residential Area	District	
	St Mary's	Zengeza
Low income area	St Mary's	
Middle income area		Zengeza 4
High income area		Rockview

2.3.2 Establishments

These included municipal solid waste generated in the commercial, institutional and industrial sectors. Waste is generated from production, customers, workforce and communities attending the institutions. The following sectors were sampled for the study (see Table A5.4.3 below). Although the survey sampled 5 sectors which are a representative sample, the hospitals could not be sampled by the virtue of the type of waste they produce. The following sectors were sampled:

- Schools- three out of sixty-seven schools were sampled. Majority of the schools have a number of pupils more than 1,000.
- Kiosks - three out of three hundred and nine were sampled. Kiosks are small shops which are also known as tuck-shops or convenient shops and sell basic food stuffs and other groceries. The shops are located in the residential areas
- Supermarkets- there are about 400 supermarkets in Chitungwiza. However they are diverse in their trade e.g. there are restaurants, hair salons, supermarkets, and hardware. For the survey three supermarkets were sampled.
- Factories- Chitungwiza has approximately seventy factories running with establishment sizes ranging from less than 10 to 600 employees. Three factories were sampled for the survey. Most factories are involved in the food factory i.e. bakeries, beverages and soya bean products.
- Markets- There is six markets in Chitungwiza and three out of the six were sampled. Markets have different merchandising components running. In Chitungwiza most markets have vegetable and food stuffs stalls, clothes and shoes stalls and other accessories e.g., hardware, kitchenware. Markets have on average more than 500 people as workforce.

Table A5.4.3 List of Establishments for Sampling

Sector	Schools	Kiosks	Supermarkets	Factories	Markets
Sampled establishments	Zengeza 4 Primary School	Zengeza 4 shop 7	T M Zengeza 2	Chibuku Breweries	Jambanja
	Zengeza 2 High School	Zengeza 5 Matandi Enterprise	FCG Makoni	National Bakeries	Makoni
	Dudzai Primary School	Unit F	OK Makoni	Dairibord Nutriplus	Chigovanyika

2.4 Survey Approach

2.4.1 Waste Amount and Composition Survey

(1) Survey area

The locations of the sampling sites were plotted properly on a map for the residential areas and the establishments. Fig A5.4.1 below shows the study area on the map for Chitungwiza municipality.

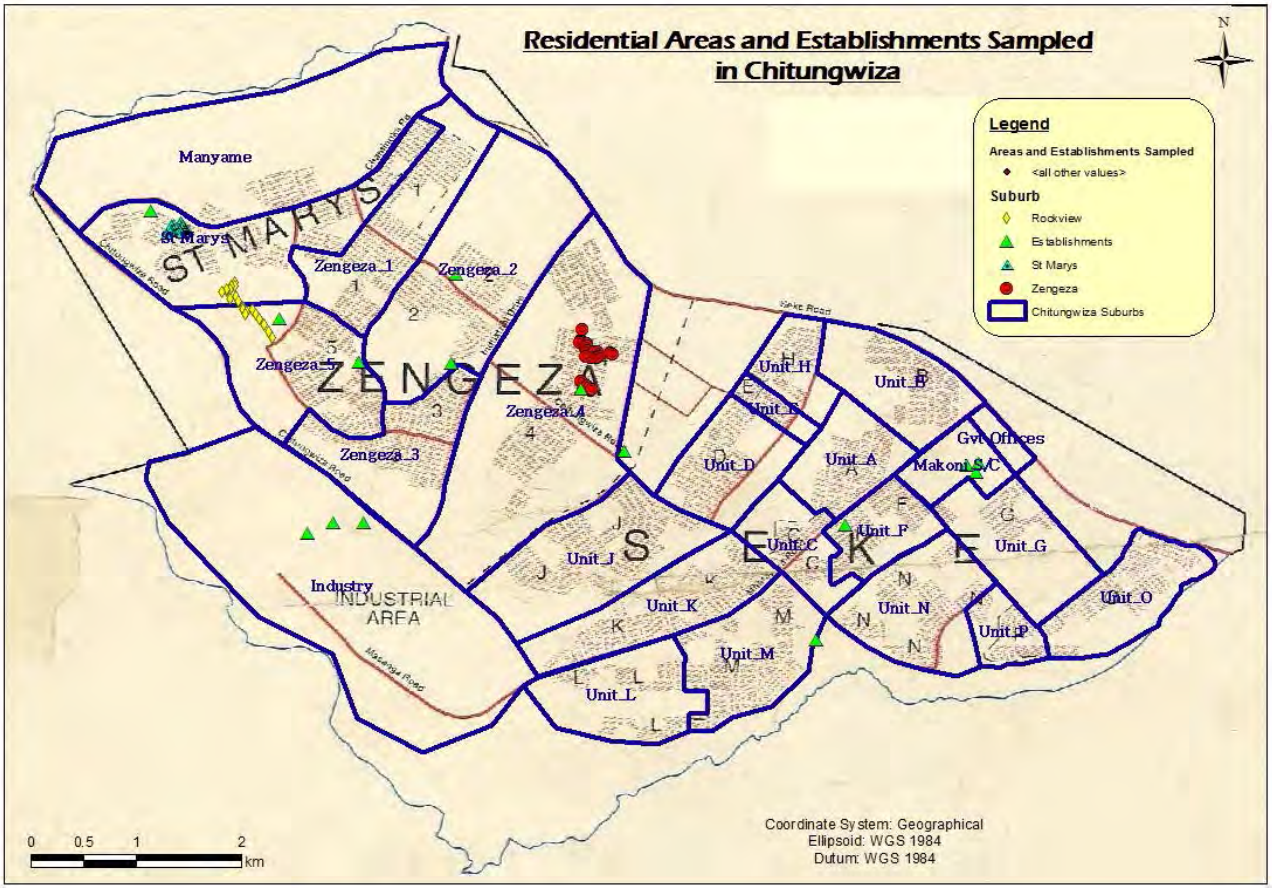

Fig. A5.4.1 Sampled Residential Areas and Establishments in Chitungwiza municipality

Residential Area

The methodology for solid waste survey was drafted as direct waste analysis at the households. The method was employed mainly because it provides data that is accurate and detailed. Prior to sample collection the target households were visited by the survey team in order to obtain their consent of

participating in the survey. The initial visit was also done in order to collect some background information on the household. The questionnaire used to obtain the information is attached in Annex 4. The background information requested included the number of families, members of each family residing at the place (house) and households estimated income and expenditure. Three residential areas were randomly selected with each selected area representing a ce rtain income area. The samples collected were used to determine the amount and composition of waste generated.

Establishments

Five establishment sectors were sampled as stated above. From each, sector three establishments were randomly selected and consent was sought for their participation in the survey. A questionnaire was also administered to inform the study on the background information (see Annex 4). The background information has been summarized in Table AN5.1.13 (Annex 5). The samples collected were used to determine amount and composition of waste generated.

(2) Number and Size of Samples

For households, 60 samples were collected every day for eight days from the different income areas giving a total of 480. Each establishment sector provided three samples for five days thus a total of 15 samples were sampled every day. Table 2.4 below shows total number of samples collected for the survey. It is important to note although the survey intended to sample 555 samples, 528 samples were collected. This was as a result of some households forgetting and disposing the waste either by burning or throwing it outside their yard.

Table A5.4.4 Total Sample Numbers of Residential Area and Establishments

Waste Stream	Samples per Day (theoretical)	Number of sampling days	Samples Collected	
			Planned	Actual
Residential area High income area	20	8	160	144
Medium income area	20	8	160	156
Low income area	20	8	160	155
Sub Total	60		480	455
Establishments Schools	3	5	15	15
Kiosks	3	5	15	14
Supermarkets	3	5	15	14
Factories	3	5	15	15
Markets	3	5	15	15
Sub Total	15		75	73
Total			555	528

(3) Determining waste amount and composition

The samples collected were taken to the workshop (sorting area) of the municipality, weighed and then sorted into constituent waste components. The samples were collected between 8 am – 1 pm on each day of sampling. The team would collect the households' samples first then move on to establishments. During collection, the sampled households and establishments were provided with the black polythene plastics beforehand so that they put the waste being generated, making it easy for the team as they would just pick up the waste. However, for some of the establishment that arrangement was not possible hence the team would go and collect from establishment waste points. It is important to note that for this survey the team was forced to start collection of school samples earlier than the agreed work plan because the schools were closing earlier than expected. Their schedule had been changed by the ministry in order to prepare for the national census which was going to be conducted in the month of August 2012. Photo A5.4.1 below shows typical waste from schools.

Photo A5.4.1 Typical waste from schools

Sorting for each waste stream was done on large polythene sheets which were approximately 4m by 5m. These were laid flat on the workshop floor. After sorting the items for every category, they were weighed and recorded in data sheets (see attached in Annex 4). Categories for waste included food waste, recyclable paper, textiles and pet bottles among others.

The waste amounts recorded were used for determining both waste amounts generated and waste composition as follows

1. Residential waste amount- the samples collected were considered for both amount and composition

2. Schools – similar to residential waste
3. Kiosks – similar to residential waste
4. Factories –for two of the factories the approach was similar to residential waste while the other amount had to be calculated based on the representative sample collected and the number of waste containers generated for each day
5. Supermarkets- similar to households. However, these were very difficult to assess for the amount and composition because some of their waste was being collected by scavengers (plastic and cardboard boxes etc.). Thus the team would only access the food waste and paper till slips among the waste generated. In some instances the shop owners would forget and dispose some of the waste before our team collected.
6. Markets- Samples collected were used to determine the waste composition. The amount of waste generated was calculated based on the status of the skip bin each time samples were collected and also information from the market users. According to information provided by the municipality, skip bins in use by the city had a tonnage of 3 tonnes when full. It is important to note that one of the markets skip bin was solely being used by residents thus for sample collection the team collected samples from the pits which the market users confirmed they were using to dispose their waste

(4) Bulk Density Measurement

After completion of the waste amount and composition survey all the sorted waste categories for each waste stream would be mixed well using a shovel. The team also introduced a more effective method of mixing, where 4-5 members would hold polythene sheet corners high. They would then take turns to approach each other' side and through this the waste material would be turning and turning inside the sheet. Thus the composite sample would be well mixed. Photo A5.4.2 shows team members mixing the waste. The waste was then placed in a 75 L container. The container weight was determined and recorded. On filling the container the waste was not compacted but the team would just shake the container lightly several times to ensure that every space had been filled up with waste. The waste had to be level with the container. The filled waste was measured to obtain the net volume and weight of the solid waste. The bulk density was obtained by measuring weight of waste in a container with a volume of 75 L through dropping the samples three times from the height of 30 cm above ground level and followed by dividing its average weight by the volume of the container. The bulk density of the waste was obtained by computation in kg/m^3 as follows:

Bulk density = weight of waste (kg)/ volume of waste (L)

= weight of waste (kg)/ volume of waste (m^3)* 10^{-3}

= weight of waste (kg)/0.075 (m^3)

Photo A5.4.2 Mixing Waste for Bulk Density and Moisture Analysis

(5) Moisture content analysis

After measuring the bulk density about 2 kg of the well mixed waste was removed from the container. The 2 kg sample was the wet base weight for the sample to be used for moisture analysis at the laboratory.

Samples were taken to the University of Zimbabwe, Biological Sciences Department's Hydrobiology Laboratory on daily bases after sorting for drying. At the lab with assistance of a lab technician the 2kg sample would be repackaged into envelops and then placed inside the incubators. The samples were dried at 105 ^{0}Celcius for a day or two until the dry weight became stable.

Dried weights were then recorded and moisture content was calculated using the following formulae

Moisture content = (W-D)/W*100

Where W=wet weight of sample

D=dried weight of sample

2.4.2 Illegal Dumping Survey

The methodology is fully discussed in Chapter 5 of this report.

3.0 Results of Waste Amount and Composition Survey

The quantity of waste generated depends on many factors. The most important ones are population growth, economic growth and the efficiency of reuse and recycling system. The following sections show the results of how much waste is being generated by the Municipality of Chitungwiza.

3.1 Residential area

The sampled households had a total population of 538 people (see Table A5.4.5). The total population was obtained from the household questionnaire analysis (based on responses of interviewees). Sixty households were sampled. Most households in the high income area are occupied by single families (90%) see Fig A5.4.2. However in the middle and low income areas, residences are mostly occupied by 2 to 3 families, 35% each respectively as established by the study. The average occupants for High, Middle and Low income areas were 7, 10 and 10 respectively.

Table A5.4.5 Family Survey

Residential Areas	Number of households	Number of families	Population surveyed	Average Population per household	Average number of families per household	Average Population in a family
High Income	20	23	131	6.6	1.2	5.7
Middle Income	20	45	203	10.2	2.3	4.5
Low income	20	64	204	10.2	3.2	3.2
Total	**60**	**132**	**538**	**8.97**	**2.2**	**4.1**

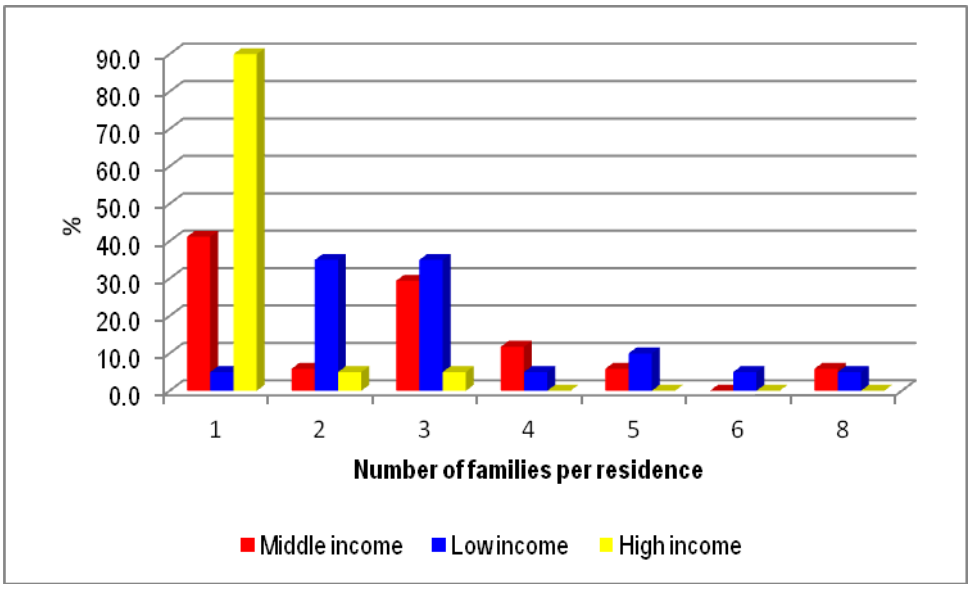

Fig. A5.4.2 Number of Families per Residence

3.1.1 Per Capita Waste Generation

The daily and average waste generation rate per capita per day for each house is shown in Table AN5.1.1 to AN5.1.3 in Annex 5. The range and average per capita waste generation for each income area is shown in the table below (Table A5.4.6). Calculation of per capita waste generation was based on total amount generated by household for the eight sampling days and this was divided by the number of sampling days. The answer was divided by the total population for that household. The average per capita waste generation amount was obtained as 0.41 kg/day/person, 0.38 kg/day/person and 0.49 kg/day/person for high, middle and low income areas.

Table A5.4.6 Waste Generation per Capita per Day for Residential Area

Income area	Minimum (kg/day/person)	Mean (kg/day/person)	Maximum (kg/day/person)
High Income	0.17	0.41	0.86
Middle Income	0.13	0.38	0.96
Low Income	0.21	0.49	1.54
Total	**0.17**	**0.43**	**1.12**

The results show that the low income area had the highest waste generation per capita rate (Fig 3.2). Further analysis of the results indicated that the low income area had the highest per capita waste generation because more than half the waste produced was yard waste. Table A5.4.7.a shows the average per capita waste generation excluding yard waste for the income areas surveyed. Detailed information on calculating the average per capita waste generation inclusive and exclusive of yard waste is shown in Table AN5.1.4, Annex 5.

Table A5.4.7.a Average Per Capita Waste Generation excluding Yard Waste

Income Area	Mean(kg/day/person)
High Income	0.31
Middles Income	0.29
Low Income	0.19

Fig A5.4.3 shows the mean waste generation per capita per day, yard waste included and excluded for the residential areas. From Fig A5.4.3, it can be seen that without the influence of yard waste the high income area has the highest waste generation per capita per day per person (0.31 kg/d/person), middle income followed with 0.29 kg/d/person while the low income was the least with 0.19kg/d/person. The high income area is a new residential area which has little trees planted compared to the low income areas. The low income areas, on one hand, were built in older times compared to the high income areas. Therefore, it is estimated that the large amount of yard waste generation is identified in low income areas.

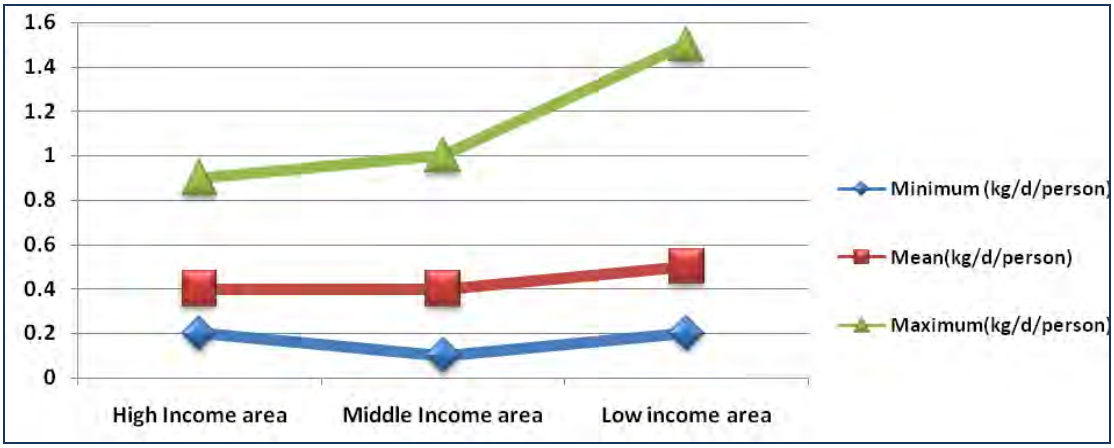

Fig. A5.4.3 Waste Generation Per Capita Per Day

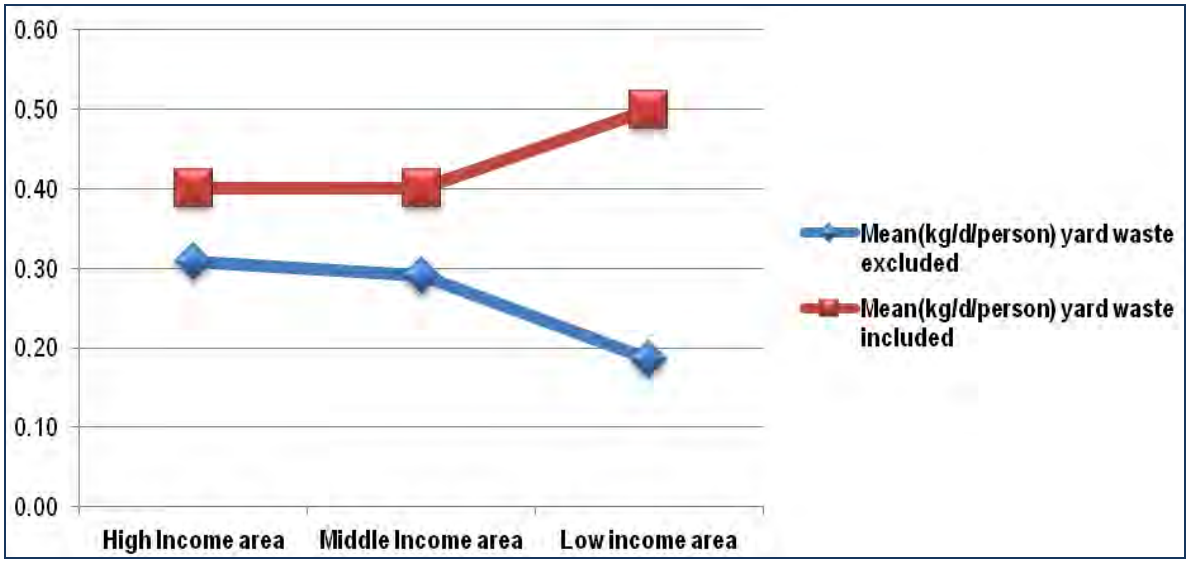

Fig. A5.4.4 Per Capita Waste Generation including / excluding Yard Waste

3.1.2 Residential Area

Total waste generated by the households in the eight sampling days of the survey is summarized in Table A5.4.7.b below. When yard waste was included in the analysis, the low income area had the highest waste generation rate. However, when yard waste was removed the low income indicated the least amount of waste generated per household. Detailed analysis of the amount generated by the three income areas is summarized in Table AN5.1.5 to AN5.1.7 in Annex 5.

Table A5.4.7.a Summary of Amount of Waste Generation by Income Area

	High Income	Medium Income	Low income
Total waste (kg)	425.2	623.7	802.7
Average kg/ household/day (yard waste included)	2.7	3.9	5.0
Average kg/ household/day (yard waste excluded)	2.0	3.0	1.9

3.1.3 Economic Data and Waste Generation

Waste generation often increases with incease in wealth of communities and Medina (2002) reported a positive correlation exist between a community's income and the amount of solid waste generated. Wealthier individuals consume more than lower-income ones, which result in a higher waste generation rate for the former. It is therefore important to establish any relationships between the different income areas and waste generation in terms of the economic facts available. In this survey, a number of households did not provide their monthly incomes or even expenditures, therefore the trend shown does not reveal what Visvanathan & Trankler (2003) reported that in a family with rich socioeconomic condition, daily waste generation rates were generally higher than the lower

socioeconomic families. Table AN5.1.9 to AN5.1.11 in Annex 5 show the incomes of the households and per capita waste generation.The findings are based on the information given by survey households.

3.2 Establishments' Waste

A total of 15 establishments were sampled for the survey. Table A5.4.8 shows the amount of waste produced by the establishments in the five days of sampling. Field notes indicating amount status for each establishment during sampling is shown in Table AN5.1.12 (Annex 5) and background information for the sampled household is shown in Table A5N.1.13 (Annex 5).

Table A5.4.8 Waste Amount produced by Establishments

Sector	Sampled establishment	Day 1	Day 2	Day 3	Day 4	Day 5	Total Waste generated (kg)	Average waste per day (kg/day)
School	Zengeza 4 Primary School	13.97	38.72	27.14	31.42	18.99	130.23	26.05
	Zengeza 2 H igh School	11.59	12.72	3.39	2.53	5.72	35.94	7.19
	Dudzai Primary School	35.42	18.62	22.10	12.81	29.09	118.02	23.60
	Sub Total	**60.97**	**70.05**	**52.63**	**46.75**	**53.80**	**284.19**	**3.79**
Average waste for schools								**18.95**
Kiosks	Zengeza 4 shop7	1.10	3.15	0.00	0.98	1.27	6.49	1.30
	Zengeza 5 Matandi Enterprise	0.56	0.25	0.58	0.02	0.05	1.44	0.29
	Unit F	1.02	0.26	0.66	0.28	0.82	3.02	0.60
	Sub Total	**2.67**	**3.65**	**1.23**	**1.27**	**2.14**	**10.95**	**0.73**
Average waste for Kiosks								**3.65**
Supermarkets	T M Zengeza 2	9.91	7.64	10.39	8.32	5.63	41.88	8.38
	FCG Makoni	13.44	19.17	8.62	21.05	14.31	76.59	15.32
	OK Makoni	1.22	14.60	0.00	8.39	18.08	42.28	8.46
	Sub Total	**24.57**	**41.41**	**19.01**	**37.75**	**38.02**	**160.75**	**10.72**
Average waste for Supermarkets								**53.58**
Factories	Chibuku Breweries	55.64	5.91	56.33	26.08	75.22	219.18	43.84
	National Bakeries	397.02	373.71	64.22	326.72	84.47	1,246.13	249.23
	Dairibord Nutriplus	7.39	11.48	14.88	11.83	6.99	52.56	10.51
	Sub Total	**460.04**	**391.09**	**135.43**	**364.63**	**166.67**	**1,517.87**	**101.19**
Average waste for Factories								**505.96**
Markets	Jambanja	3.07	10.36	5.55	4.21	4.62	27.79	5.56
	Makoni	3,000.0	3,000.0	3,000.0	2,250.0	3,000.0	14,250.00	2,850.00
	Chigovanyika	3,000.0	3,000.0	3,750.0	5,250.0	3,000.0	18,000.00	3,600.00
	Sub Total	**6,003.07**	**6,010.36**	**6,755.55**	**7,504.21**	**6,004.62**	**32,277.79**	**2,151.85**
Average waste for Markets								**10,759.26**

3.3 Waste Generation of the Municipality

3.3.1 Total Estimated Waste generation for Chitungwiza Municipality

Table 3.4 shows the total estimated waste amount generated by the municipality based on each of the establishments and residential areas surveyed. The residential area is the highest contributor to the total amount of waste generated. This is probably due to the high populations occupying the residential areas. The kiosks are the least contributor to the total waste generated. This is probably due to the low

number of employees and the nature of business i.e. customers just come to buy and instantly leave the premises therefore generate less waste. Table A5.4.9 also shows particularly the amount of waste generated by each residential area excluding yard waste. The survey results showed that yard waste was one of the main components on the waste generated by households (Table A5.4.9). The total amount of waste generated exclusive of yard waste was calculated by subtracting total yard waste generated by each income area for the eight sampling days from the total waste generated by each income area for the eight sampling days. Table AN5.1.4 in Annex 5 shows the amounts of waste used for the calculations.

Table A5.4.9 Total Estimated Waste Amount for Chitungwiza City

Waste Generation Stream							
Establishments		**Sampling Place**	**Period of Sampling (Days)**	**Total Waste generated (Kg)**	**Average Waste Amount (Kg/Day)**	**Total Number of Establishments / Households**	**Estimated Total Waste Amount (Kg/Day)**
	School	Zengeza 4 Primary School	5	130.23	26.05		
		Zengeza 2 High School	5	35.94	7.19		
		Dudzai Primary School	5	118.02	23.60		
		Sub Total		**284.19**	**56.84**	**67**	**1,269**
		Average			**18.95**		
	Kiosks	Zengeza 4 shop7	5	6.49	1.30		
		Zengeza 5 Matandi Enterprise	5	1.44	0.29		
		Unit F	5	3.02	0.60		
		Total		**10.95**	**2.19**	**309**	**226**
		Average			**0.73**		
	Supermarkets	T M Zengeza 2	5	41.88	8.38		
		FCG Makoni	5	76.59	15.32		
		OK Makoni	5	42.28	8.46		
		Total		**160.75**	**32.15**	**400**	**4,287**
		Average			**10.72**		
	Factories	Chibuku Breweries	5	219.18	43.84		
		National Bakeries	5	1,246.13	249.23		
		Dairibord Nutriplus	5	52.56	10.51		
		Total		**1,517.87**	**303.57**	**70**	**7,083**
		Average			**101.19**		
	Markets	Jambanja	5	27.79	5.56		
		Makoni	5	14,250.00	2,850.00		
		Chigovanyika	5	18,000.00	3,600.00		

Waste Generation Stream							
Establishments		Sampling Place	Period of Sampling (Days)	Total Waste generated (Kg)	Average Waste Amount (Kg/Day)	Total Number of Establishments / Households	Estimated Total Waste Amount (Kg/Day)
		Total		**32,277.79**	**6,455.56**	**6**	**12,911**
		Average			**2,151.85**		
	TOTAL for all Establishment			**34,251.54**	**6,850.31**	**852**	**25,776**
Residential							
	High Income	Rockview	8	425.21	0.41	7,090	**2,907**
	Yard waste excluded		8	323.26	0.31		**2,198**
	Middle Income	Zengeza 4	8	623.65	0.38	104,223	**39,605**
	Yard waste excluded		8	473.59	0.29		**30,225**
	Low Income	St Mary's	8	802.70	0.49	243,187	**119,162**
	Yard waste excluded		8	302.32	0.19		**46,206**
	TOTAL for Households			**1,851.55**			**161,674**
	Yard waste excluded			**1,099.17**			**78,629**
	TOTAL for the Municipality						**187,450**
	Yard waste for residential areas excluded						**104,405**

The data of the number of establishments was obtained by the municipality and the population data of the residential areas was obtained by the JICA team. The summary of the number of establishments and the population data is shown in Table A5.4.10.

Table A5.4.10 Number of Establishments and Population of Residential Areas

Sample	Number	Population
Establishment		
School	67	
Kiosks	309	
Supermarkets	400	
Factories	70	
Markets	6	
Sub Total	**852**	
Residential Area		
High Income		7,090
Middle Income		104,223
Low Income		243,187
Sub Total		**354,500**

4.0 Waste Composition Survey Findings

The waste composition survey consisted of measuring the wet base of each component, volume of composite sample, bulk density of composite sample (in calculation) and moisture content of composite sample for the proposed waste generation source.

4.1 Waste Composition

As observed in Table A5.4.11, there are substantial differences in the composition of wastes from the different waste streams. Differences can be explained by the diverse activities of the waste streams that create the waste. Therefore some waste components are unique to certain streams or stream while others are universal for all municipal waste i.e. food waste, paper and plastics. Dirt, stones and sand were unique to schools (16.69%).

Table A5.4.11 Average Waste Composition for Residential and Establishments

		Average waste composition (%)							
Waste Composition		Residential Area			Establishments				
		High income Area	Middle income area	Low income area	School	Kiosks	Supermarkets	Factories	Markets
Food Waste	Food Waste	55.68	54.00	26.95	5.81	19.95	72.15	76.38	38.78
Paper	Mixed Paper	0.00	0.00	0.00	5.77	0.00	0.00	0.00	0.62
	Recyclable paper	2.19	1.53	1.53	9.23	10.90	8.85	1.90	2.25
	cardboard	0.24	0.72	0.37	1.41	22.08	5.06	2.41	3.21
	Diapers	3.19	4.07	1.03	1.10	1.05	0.00	0.00	1.99
Plastics	Plastic Coolite	0.11	0.14	0.05	0.48	0.00	1.15	0.01	0.87
	Plastic Sheet	0.00	0.00	0.19	0.00	0.00	0.00	0.70	2.05
	Recyclable plastics	3.53	3.14	2.07	7.64	26.63	9.32	2.48	0.87
	PET bottles	1.65	2.32	0.75	3.37	2.63	2.02	3.92	2.94
	other plastics	0.02	0.10	0.04	0.20	0.00	0.00	0.29	0.25
Rubber and leather		1.09	1.02	0.92	0.03	0.00	0.00	0.02	1.61
Textiles		1.54	1.66	2.09	1.38	0.29	0.02	4.22	3.40
Yard waste		23.85	23.99	62.18	45.33	9.99	0.00	0.00	23.63
Lumber and logs		0.00	0.00	0.00	0.51	0.00	0.00	0.48	0.00
Other Organic Waste		5.08	5.26	0.47	0.00	2.77	0.57	1.24	15.92
Glasses	Other Live Bottles	0.04	0.28	0.00	0.00	0.00	0.00	0.00	0.00
	Broken Glass	0.30	0.39	0.42	0.35	0.00	0.09	4.51	0.12
Metals	Tin cans	0.16	0.22	0.21	0.15	0.29	0.02	0.00	0.60
	Aluminium cans	0.21	0.26	0.07	0.50	0.29	0.07	0.02	0.19
	Copper	0.42	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	Other metals	0.00	0.36	0.38	0.03	0.00	0.00	0.06	0.19
Human Waste		0.21	0.00	0.01	0.00	0.00	0.00	0.00	0.02
Dirt, stones , sand		0.00	0.00	0.00	16.69	0.00	0.00	0.00	0.00
Battery(Dry Cells)		0.04	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Unclassified Residual Waste		0.45	0.48	0.27	0.02	3.14	0.67	1.38	0.49
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Average compositions were used for the construction of pie charts for visual display of the actual level of material present in residential waste sample collection.

4.1.1 Residential Waste

The results for each residential waste composition are illustrated in Fig A5.4.5 to Fig A5.4.7. Based on the values shown, food waste and yard waste occupies most of the waste produced by the residential communities. The results show that high and middle income areas produced higher food waste quantities as compared to low income areas. On the other hand the low income areas generated more yard waste as compared to the other income areas. This can probably be explained by that, the low income area sampled had smaller yards and no refuse pits were observed therefore all waste generated from sweeping their yards was thrown into the refuse bin.

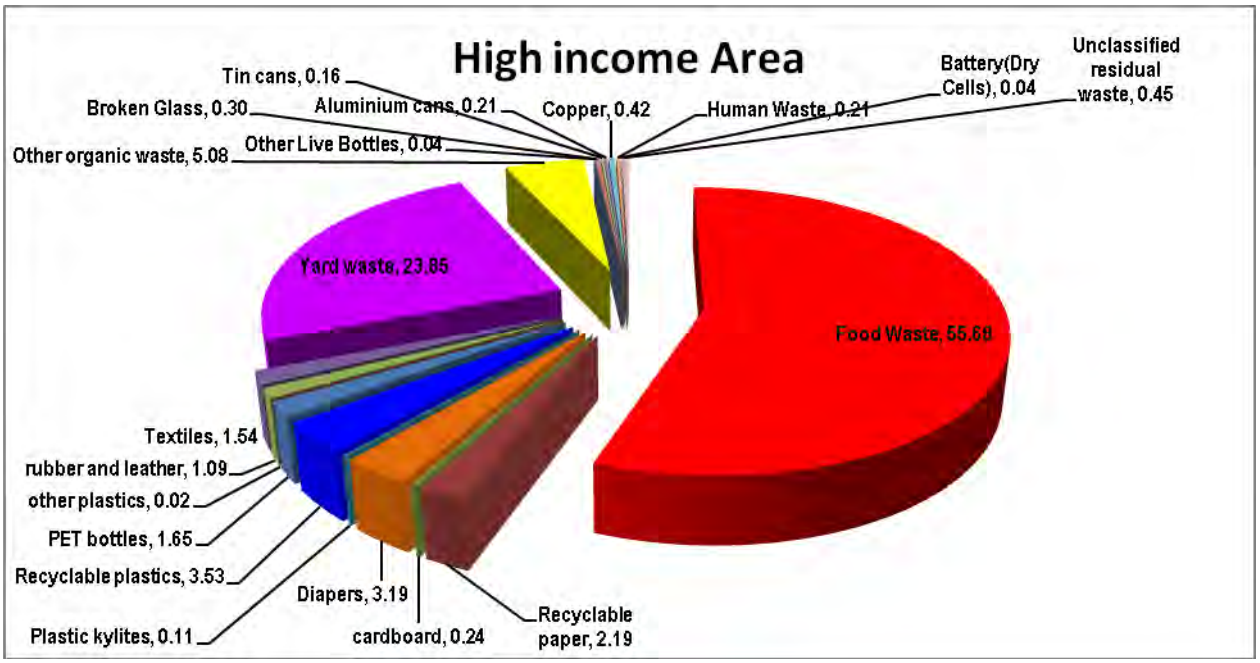

Fig. A5.4.5 Waste Composition for High Income Area

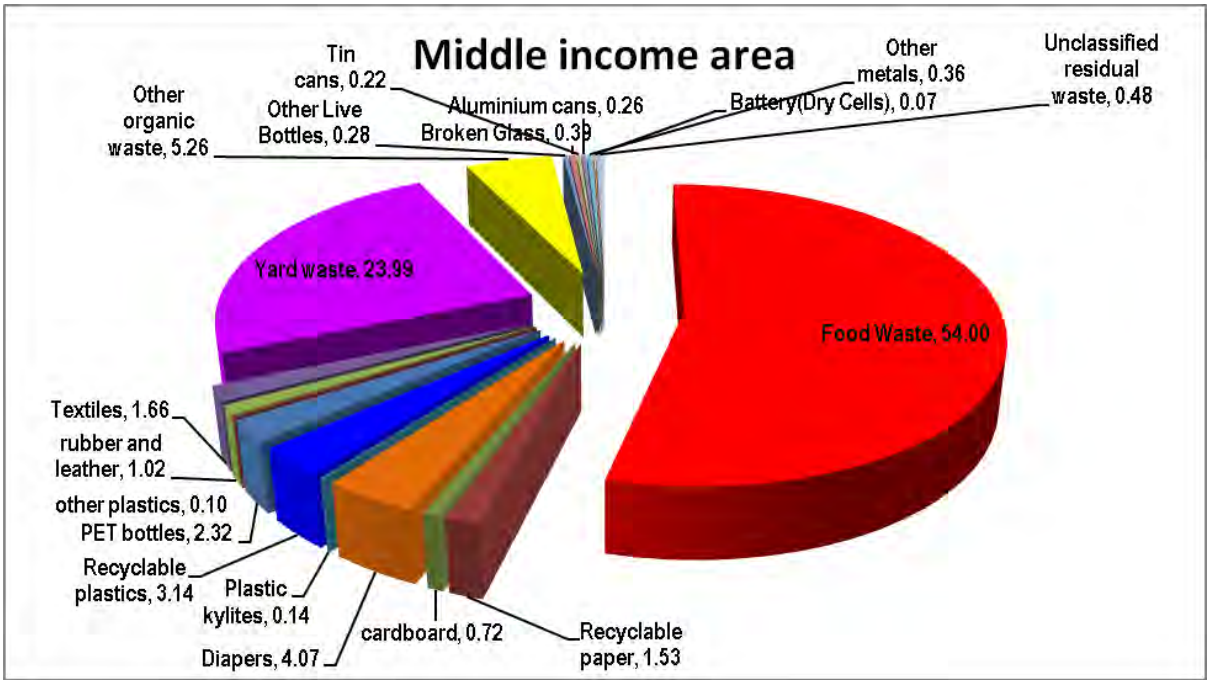

Fig. A5.4.6 Waste Composition for Middle Income Area

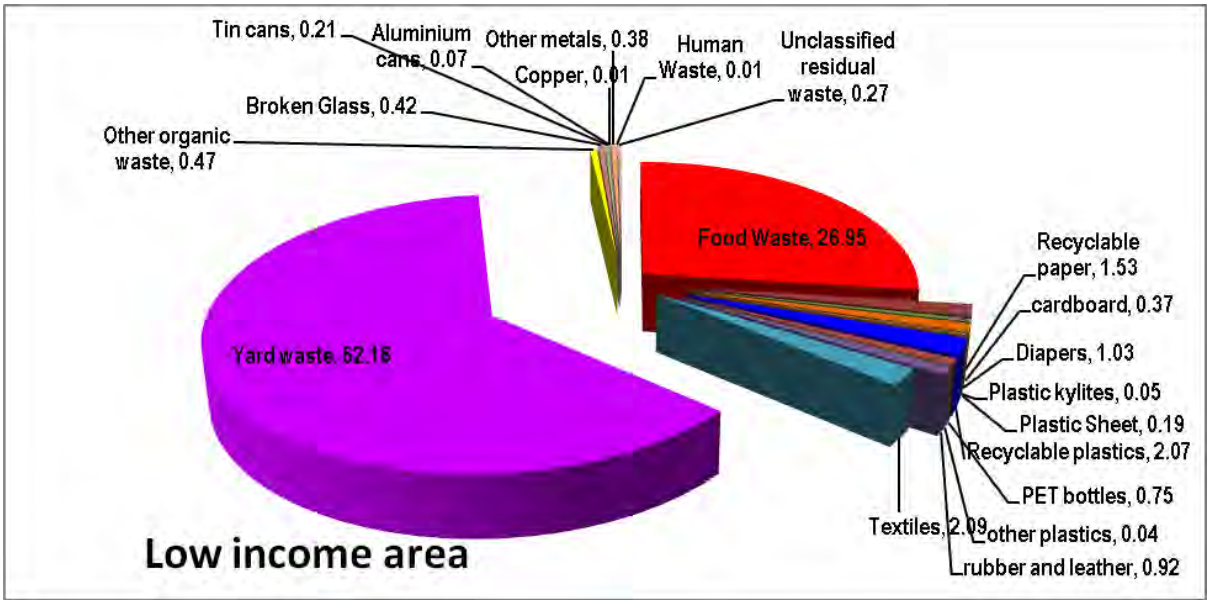

Fig. A5.4.7 Waste Composition for Low Income Area

4.1. 2 Establishments Waste Composition

The results for each establishment sector waste generator are illustrated in Fig A5.4.8 to Fig A5.4.12. As mentioned before, the composition of waste for the establishment depends very much on the nature of business. The results show that for schools, yard waste (45.33%) occupies most of the waste generated. This is because cleaning school yards is mandatory and it's done on a daily bases to keep the school an attractive institution. For supermarkets and kiosks, their compositions were very similar although the kiosks had higher or very significant values for paper and plastic. During sampling of supermarkets getting a representative sample was difficult as there were other competing factors. Most paper and plastic are collected by scavengers on a daily bases and the shop owners have established

relationships with them. Therefore in most instances, only food waste was available for collection. The factories involved in the survey were all food factories i.e. beer brewing, dairy juice production and bread making and this could explain the high food waste component (76.38%) on the waste generated. The markets had very diverse waste components although food waste (38.78%) remained the main waste component generated.

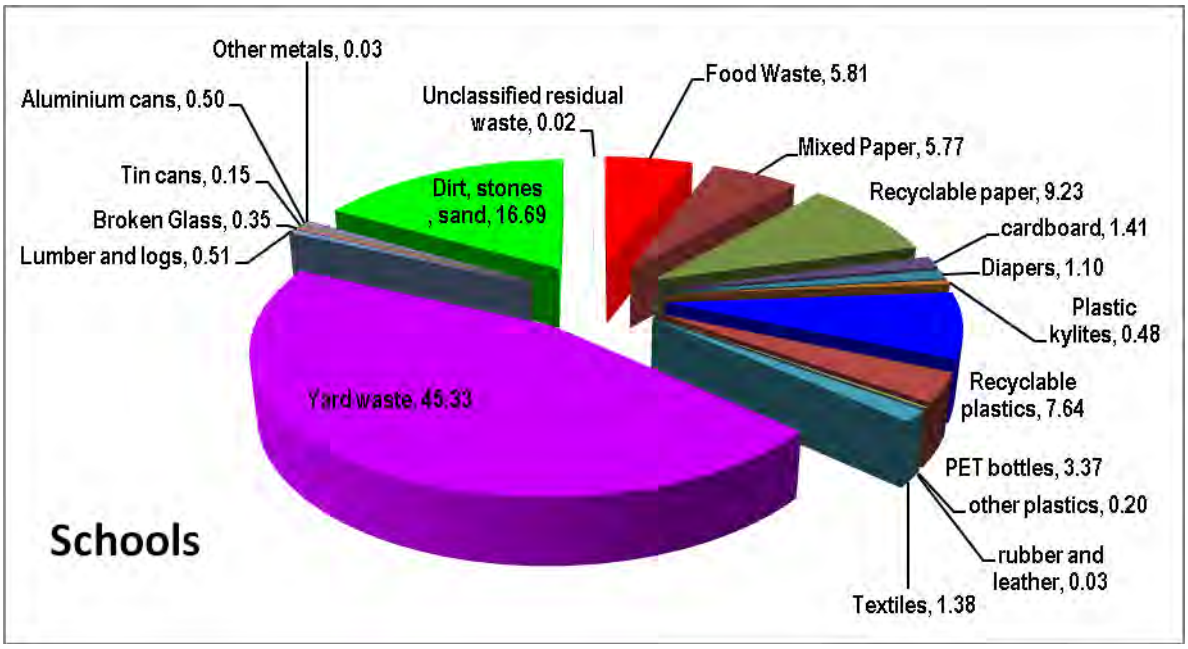

Fig. A5.4.8 Waste Composition for Schools

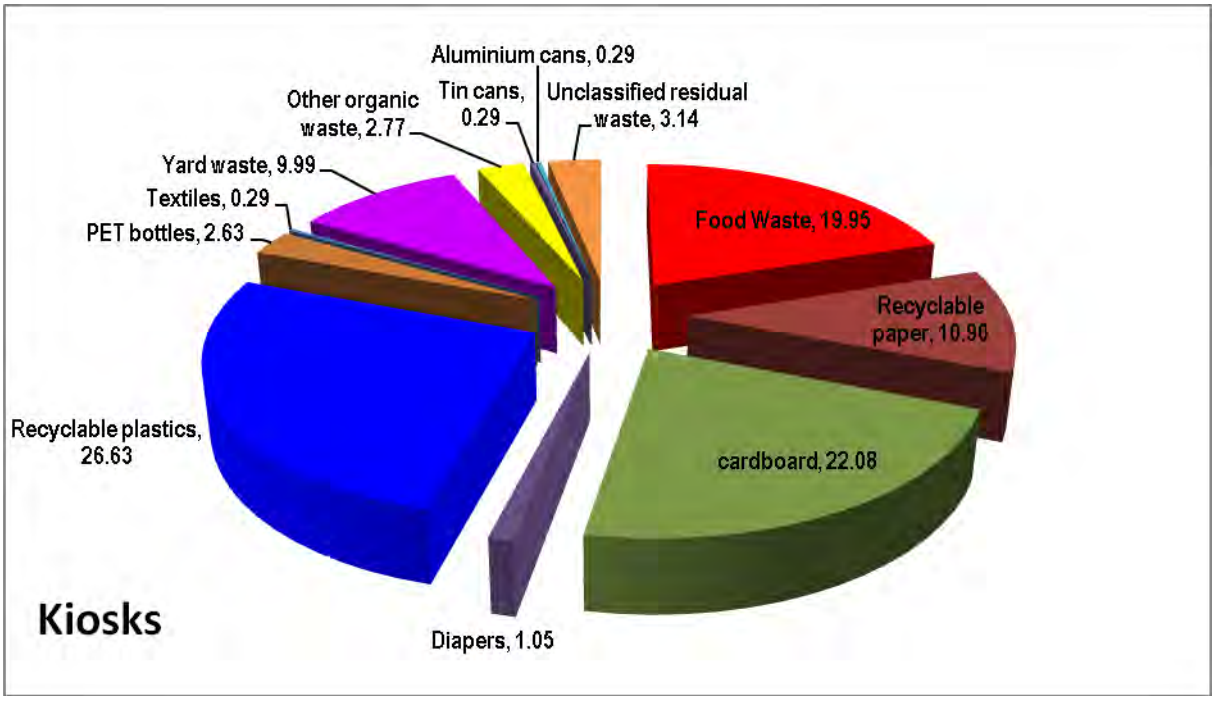

Fig. A5.4.9 Waste Composition for Kiosks

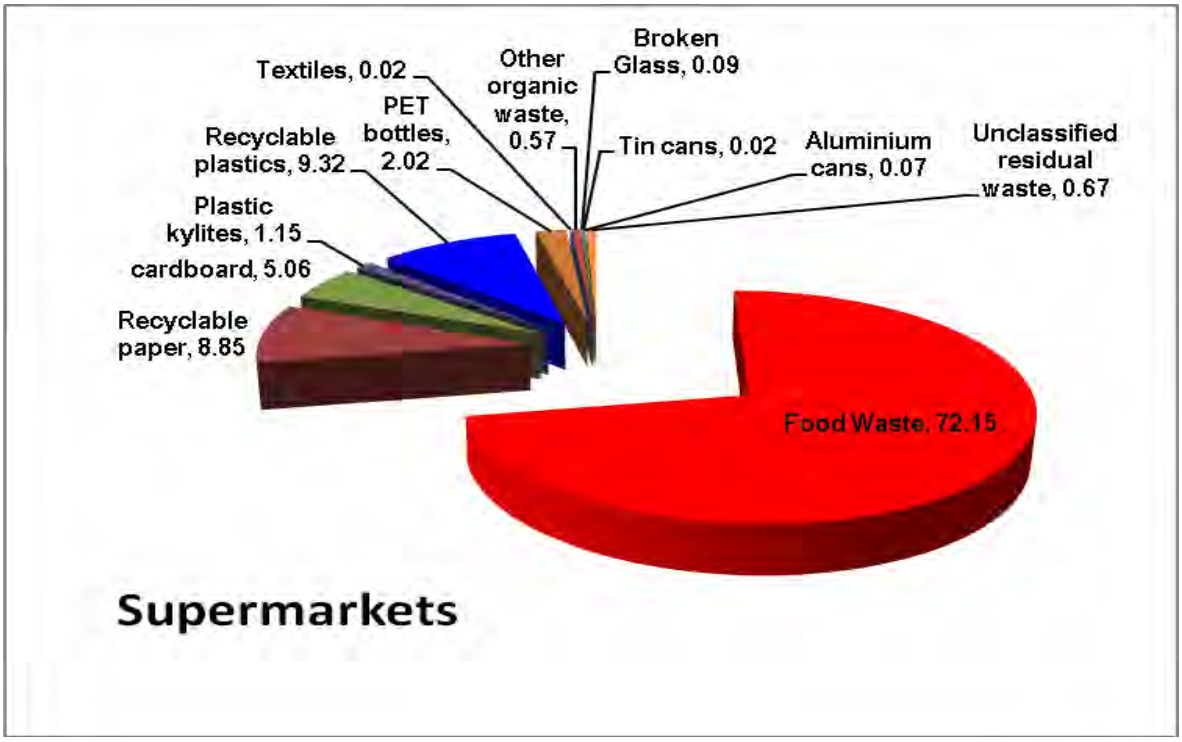

Fig. A5.4.10 Waste Composition for Supermarkets

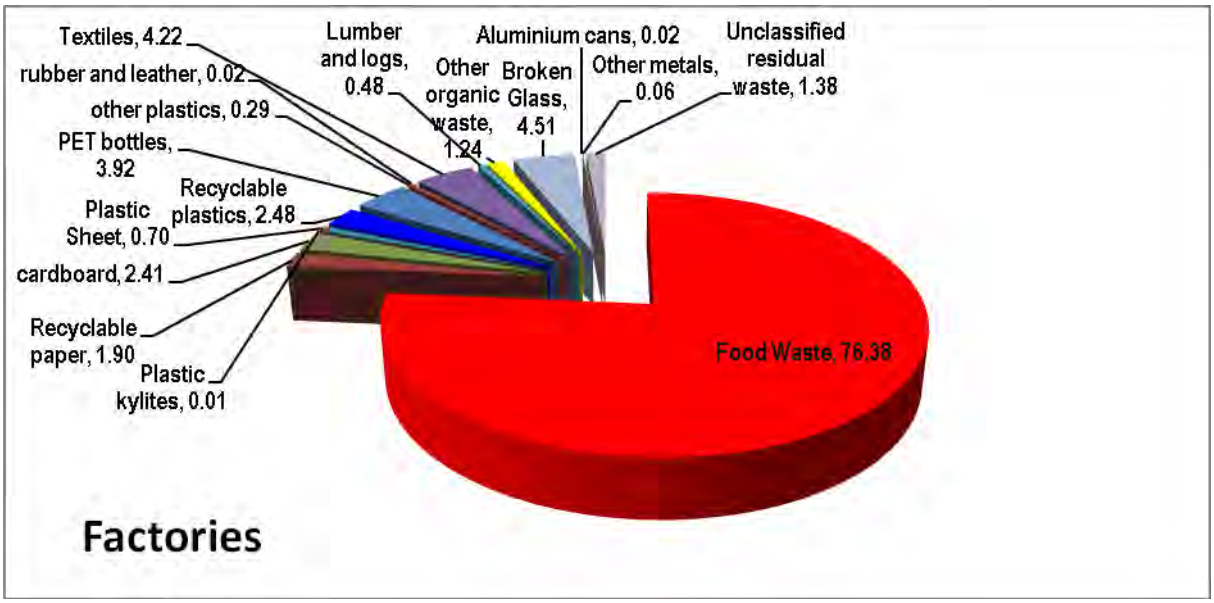

Fig. A5.4.11 Waste Composition for Factories

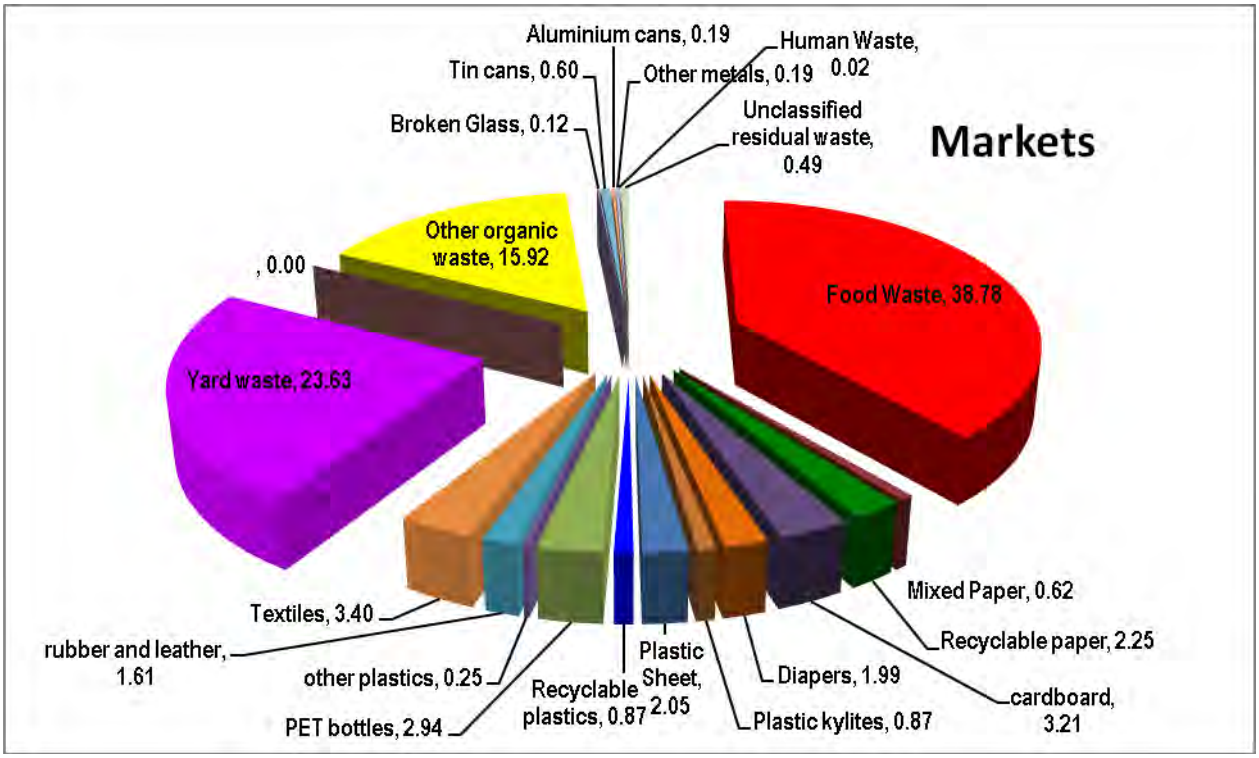

Fig. A5.4.12 Waste Composition for Markets

4.2 Bulk Density of Waste

Bulk density was measured as p art of the waste composition survey. Both residential and establishment bulk density was established in the study as shown in Table A5.4.12 and Table A5.4.13 and Fig A5.4.13.a and Fig A5.4.13.b. The detailed analysis bulk density is shown in Table AN6.1.1 and Table AN6.1.2 in Annex 6.

4.2.1 Bulk Density of Residential Waste

The study results show that the middle income areas had a higher bulk density than the other income areas. The average values of bulk density ranges from 139.3 to 187.7 kg/m^3.

Table A5.4.12 Bulk Density for each income area

	High income Area	Middle income area	Low income area
Minimum (kg/m^3)	50.13	74.72	131.82
Average (kg/m^3)	139.33	187.68	181.61
Maximum (kg/m^3)	202.88	466.51	374.23

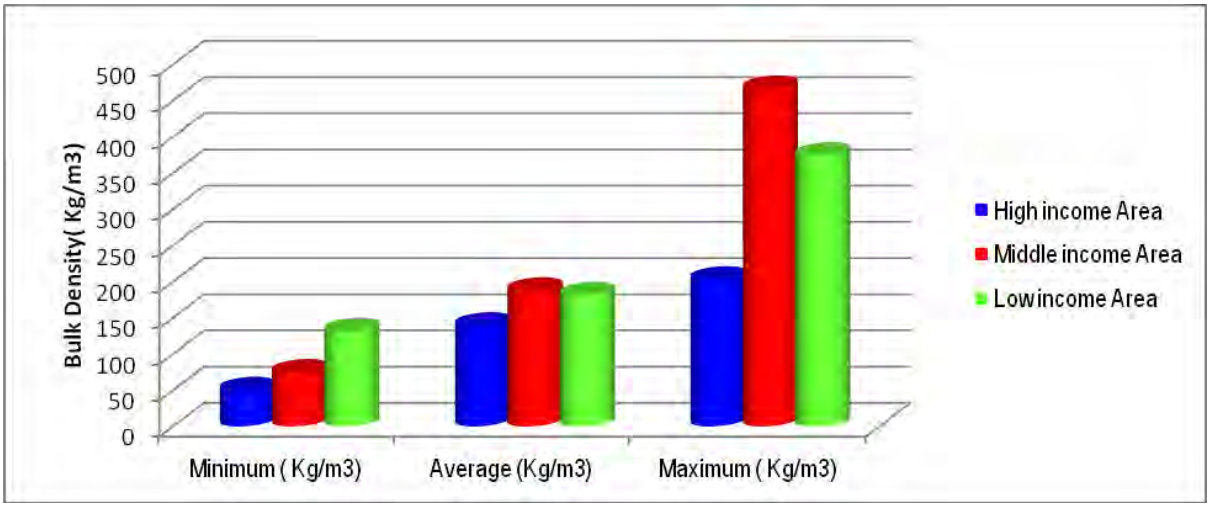

Fig. A5.4.13.a Bulk Densities by Income Area

4.2.2 Bulk Density of Establishment Waste

Establishments had generally low bulk densities as compared to residential areas. The results in Fig A5.4.13.b show that the factories had the highest waste density as compared to other sectors. The bulk density for kiosks could not be obtained because its waste amount could not fill the container of 75 L.

Table A5.4.13 Bulk Density by Establishment Type

	Schools	Kiosks	Supermarkets	Factories	Markets
Minimum (Kg/m^3)	26.3	-	30.2	76.6	39.4
Average (Kg/m^3)	49.3	-	80.4	168.1	73.4
Maximum (Kg/m^3)	89.2	-	123.5	290.4	100.5

NB: "-" indicates that a low bulk density figure was obtained for the kiosks.

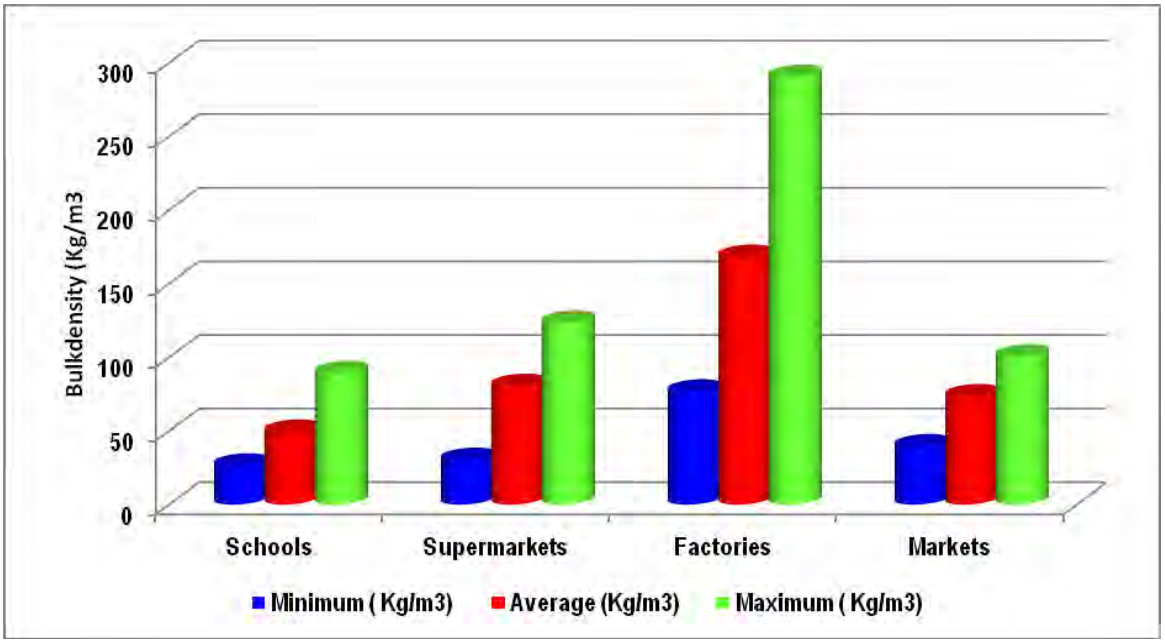

Fig. A5.4.13.b Bulk Densities by Establishment Type

4.3 Waste Moisture Content Analysis

Waste moisture content analysis was prepared for both Establiment waste and Residential waste.The detailed analysis is shown in Table AN6.1.3 and Table AN6.1.4 (Annex 6). High moisture content in waste samples usually reflects a higher propotion of organic waste like food waste. However some organic waste do not contain much moisture eg cardboard.

4.3.1 Residential Waste Moisture Content Analysis

The results of the moisture content analysis for residential waste are shown in Table A5.4.14 and Fig A5.4.13.c. The middle income had the highest moisture content for the waste analysed.

Table A5.4.14 Moisture Content by Residential Income Area

	High Income Area	Middle Income Area	Low Income Area
Minimum (%)	16.54	26.72	16.54
Maximum (%)	50.89	61.07	55.98
Average (%)	31.49	38.88	35.5

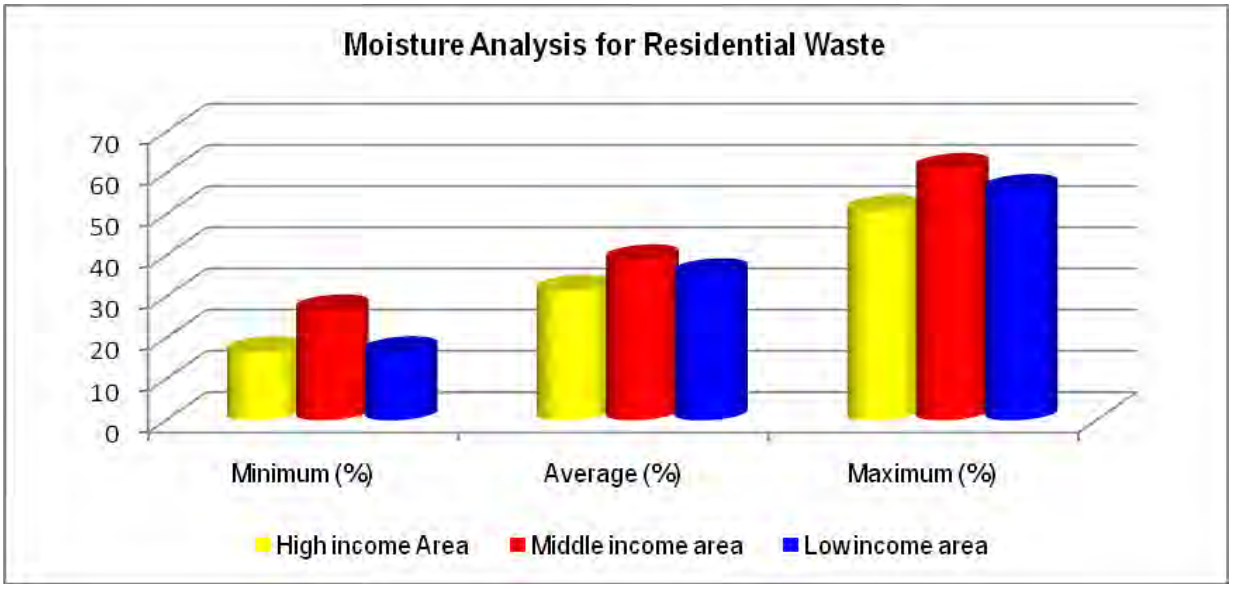

Fig. A5.4.13. c Moisture Content by Residential Area

4.3.2 Moisture Content for Establishments Waste

The results for moisture content for the different Establishment sectors is shown in Table A5.4.15 and Fig A5.4.13.d. The markets had the highest moisture content for the samples analysed.

Table A5.4.15 Moisture Content by Establishment Type

	Schools	Kiosks	Supermarkets	Factories	Markets
Minimum (%)	6.36	5.73	19.08	2.54	35.62
Maximum (%)	27.99	20.36	52.16	31.81	59.8
Average (%)	16.72	15.23	37.1	23.1	50.38

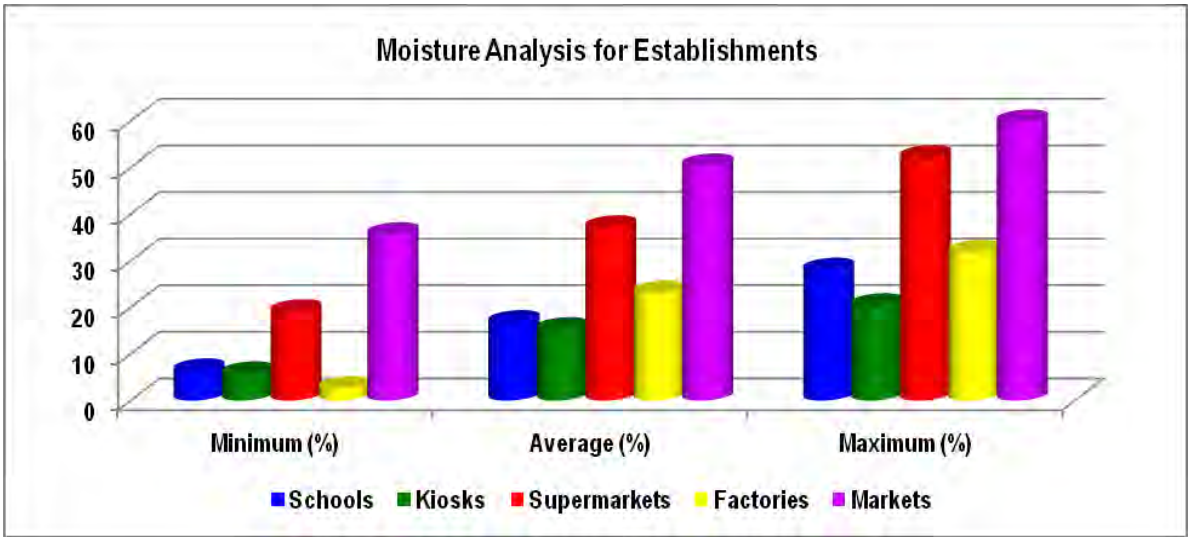

Fig. A5.4.13. d Moisture Content by Establishment Type

5.0 Illegal Dumping Waste Survey

5.1. Methodology

The survey was carried out in order to identify the illegal waste dumping areas within the jurisdictional area of Chitungwiza city. The survey was initially supposed to take 5 days but later took more days as the dumps were numerous in each of the areas. The survey began on 26 July 2012 and ended on 18 August 2012. The survey team went around the municipality area to locate the illegal waste dumping areas and recorded the coordinates as well as measuring the area and volume of the waste. The sites that were mapped were those that held up to 10 m^3 per place. The area and volume of the sites was found by measuring the length, width and height using a measuring tape and by visual inspection. The location of dumping areas was measured by a GPS and the sites were plotted on the map(s). Photographs were also taken in order to show the features of the dumping area. In addition, the general information of the dump sites was collected from the residents regarding such information as when the dumping started, who dumps waste, when the municipality cleanup the waste and why the dumping does not end.

5.2 Illegal Dumps mapping findings

5.2.1 Site Characteristics

The completed survey resulted in the identification of three hundred and ninety (390) illegal dumpsites throughout the municipality. The majority of the sites are in St Mary's and Zengeza district with Seke North and South not being very prominent. The majority of the sites were visible to the public right-of-way. A great majority of the sites documented in this report were located in close proximity to streams. Fig. AN7.1.1 in Annex 7 shows the illegal dumping sites in Chitungwiza Municipality.

To show the extend of dumping in each of the residential area Table A5.4.16 show the total area and volumes of illegal dump sites in Chitungwiza municipality by residential area while and Figure A5.4.14 shows the graphical representation of area covered by illegal dump sites in the same municipality. Among the areas most affected by illegal dumping of waste in Chitungwiza Municipality are St Mary's, Zengeza 4, Manyame and Unit D with such new areas as Rockview and Riverside not having large volumes of waste because most of them have refuse pits at their homestead as a result of availability of space. However, illegal dumping by residents in these areas cannot be ruled out as it is possible for them to go and dump in surrounding areas.

Table A5.4.16 Total Estimated Area and Volume of Illegal Dumps in Chitungwiza municipality

District	Residential Area	Number of illegal dumping sites	Area covered by waste (m^2)	Volume of waste (m^3)
Zengeza	Zengeza 1	19	4,837	2,952
	Zengeza2	13	3,570	1,893
	Zengeza 3	22	4,625	3,398
	Zengeza 3 Ext	22	2,316	1,291
	Zengeza 4	46	11,088	7,643
	Zengeza 5	15	2,635	1,482
	Zengeza 5 Ext	8	4,448	3,158
	Rockview	0	0	0
	Sub Total	**145**	**33,519**	**21,817**
St Mary's	St Mary's	28	13,130	8,763
	Manyame	35	8,489	4,271
	Sub Total	**63**	**21,619**	**13,034**
Seke North	Unit A	7	568	406
	Unit B	24	5,240	3,343
	Unit C	4	428	289
	Unit F	4	406	159
	Unit G	23	6,272	3,197
	Unit N	12	1,490	971
	Unit O	6	663	302
	Unit P	6	535	304
	Riverside	2	195	92
	Sub Total	**88**	**15,797**	**9,063**
Seke South	Unit D	21	11,169	7,576
	Unit E	4	244	115
	Unit H	16	8,008	4,845
	Unit J	14	1,883	992
	Unit K	14	1,713	1,004
	Unit L	7	834	422
	Unit M	18	2,252	1,258
	Sub Total	**94**	**26,103**	**16,212**
Total		**390**	**97,038**	**60,126**

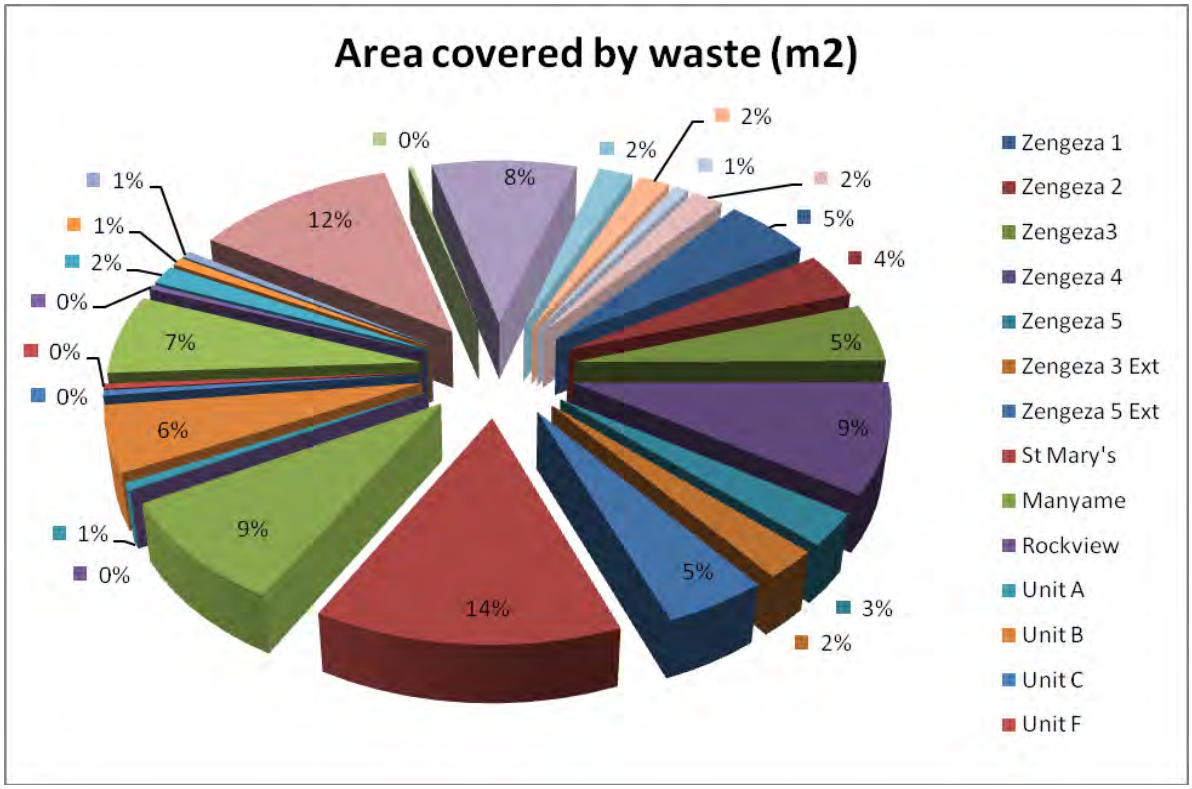

Fig. A5.4.14 Area Covered by Illegal Dump Sites in Chitungwiza Municipality

An analysis of the illegal dump sites according to district shows that Zengeza district has the largest area covered by illegal dump sites as well as large volumes followed by Seke South district. The least area covered by illegal dump sites and volume of waste is in Seke North district (Fig. A5.4.15). As indicated in Fig. A5.4.16, St Mary's, Manyame and Zengeza 4 have the largest volumes of waste that has been dumped. Other areas where large volumes of waste have been dumped include Zengeza 5 Extension, Zengeza 3, Unit B, Unit G, Unit D and Unit H. Of particular interest is the Unit B, area which the municipality classifies as a high income area. Unit B has the second highest volume of waste dumped in Seke North district may be because Makoni supermarkets illegal dumping sites were included under its jurisdiction. In the other two high income areas (Rockview and Riverside), not much waste was recorded because the majority of residents had dug refuse pits in their yards. An interesting observation was also made in the majority of the new areas where very little waste was mapped yet the residents do not have big stands that would allow them to dig refuse pits as was observed in Riverside and Rockview.

It was observed that in areas where there are not enough open spaces, a lot of dumping was done along school durawalls/ perimeter fences, clinics perimeter fences, shopping centres (those affected a lot included Chigovanyika, Huruyadzo, Makoni, Zengeza 5 supermarkets, area opposite Chikwanha shopping centre and Town Centre). Areas along the road and storm water drains also proved favourite places were illegal dumping is carried out. As the Illegal Dumping Waste Survey was underway,

Chitungwiza Municipality had engaged people who were removing waste from the storm water drains and this further created a lot of waste in some areas like Zengeza 1 (CA) of which if it is not removed early enough, may find its way back into the drains again.

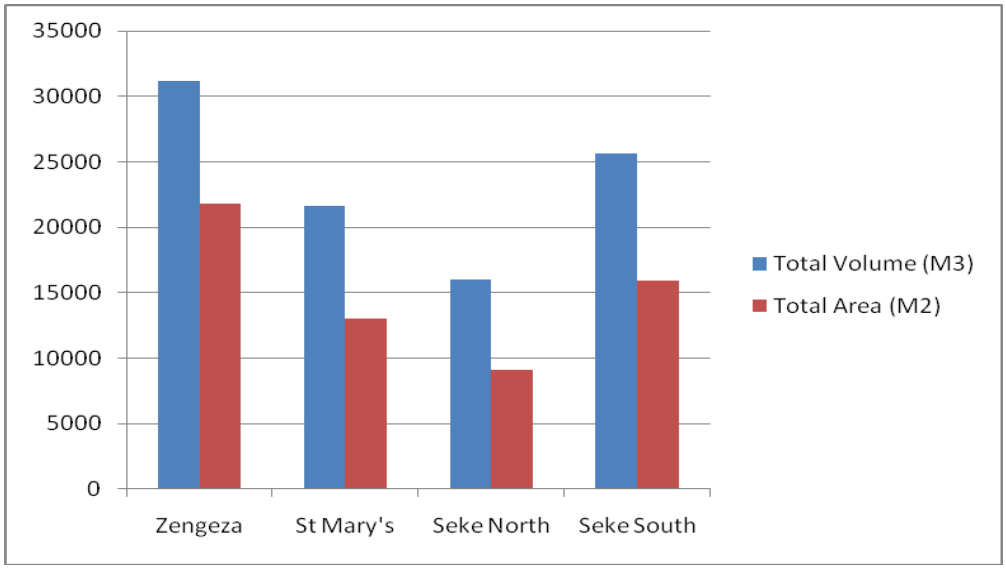

Fig. A5.4.15 Area Covered and Volume by Illegal Dump Sites in Chitungwiza Municipality

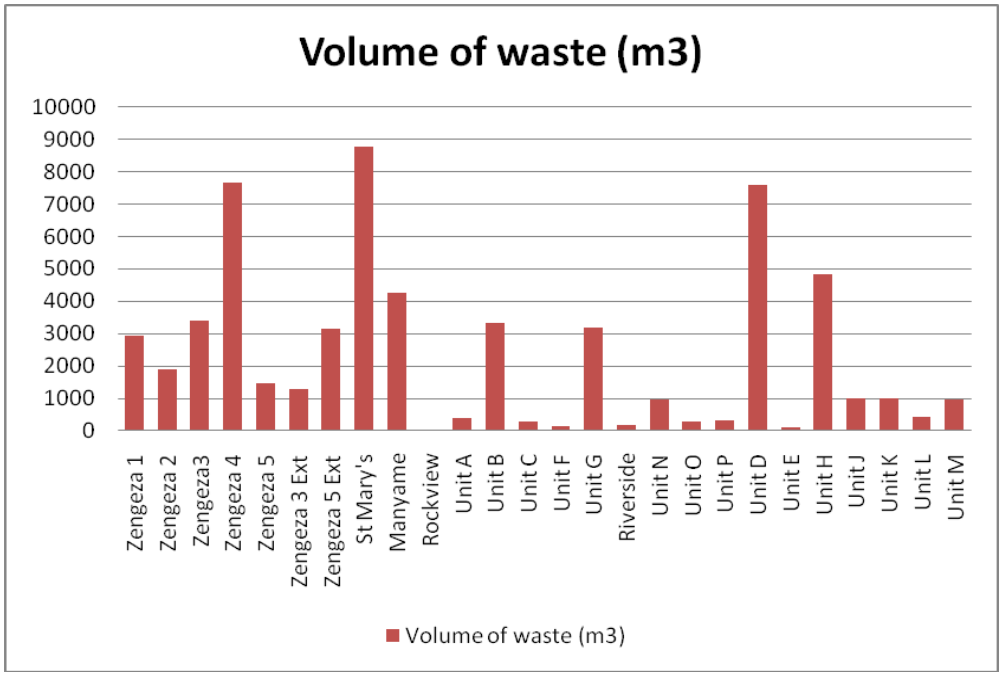

Fig. A5.4.16 Volume of Illegal Dumping Sites in Chitungwiza Municipality

5.2.2 Waste characteristics

Area dump sites contained a variety of wastes including common household wastes, household hazardous wastes, construction and demolition debris, scrap metal, and household appliances. Plastics, beverage cans, pet bottles, diapers and sanitary pads were the most frequently found items, perhaps due to their durability and perceived difficulty of disposal. Food or kitchen waste was also quiet

prominent. Other types of waste streams of concern in the context of an urban lifestyle are construction and demolition waste and end-of-life vehicles. The construction and demolition types of waste were prominent in areas where construction of houses is underway while the end of life vehicles were associated with areas that were being used as makeshift garages.

6.0 Conclusions

The following facts can be concluded

- The waste generation per capita per day for the residential waste was 0.43 kg/day/person. This compares well with documented typical values for developing countries where it is estimated to range between 0.2-0.4 kg/day/person. The low income area generated more waste than other income areas as a result of a lot of yard waste that is produced. The figure ranged from 0.21 kg/day/person to1.54 kg/day/person with a mean of 0.49 kg/day/person. However, when yard waste is excluded, the high income area has the highest per capita waste generation of 0.31 kg/day/person and the low income area has the lowest per capita waste generation of 0.29 kg/day/person.
- The survey estimated waste amount generated by the municipality to be at 176.6 tons/day excluding yard waste. The residential waste was the highest contributor (85.4%) to the waste generated. However when yard waste is excluded, the residential areas contribute about 73.9% of the total municipal waste produced in Chitungwiza.
- From the survey composition of waste generated comprised of high organic content.
- The moisture analysis of the municipality ranged from 15.23- 50.58% with an average of 29.64%. The survey showed that the medium income area and the markets had significantly high content levels compared to others. This indicates that there was considerable organic matter in the waste.
- The majority of waste included food/ kitchen waste, diapers, sanitary pads, end of life vehicles, construction and demolition waste, paper, plastics, scrap metals and household appliances.
- The majority of illegal dump site are found in low income areas which could be attributed to the high population densities in such areas
- Zengeza and Seke North districts had the largest area of waste in illegal dump sites as well as volume with the least area and volume being in Seke South district
- Substantial amounts of waste were also observed at major shopping centres in the city such as Huruyadzo, Chigovanyika, Zengeza 5 supermarkets, Makoni, Town Centre and the area opposite Chikwanha shopping centre. In areas where there were no open spaces, waste was dumped along school perimeter fences/durawalls and along roads as well as in storm water drains.

7.0 References

1. Coffey M and Coad A, 2010, Collection of the Municipal Solid Waste in Developing Countries. www.unhabitat.org. Accessed 31/08/2012
2. Medina, M. 2002. Globalization, Development and Municipal Solid Waste Management in Third World Cities. Institute of Advance Studies, Mexico. pp 1-23.
3. Visvanathan, C. and Trankler, J. 2003. Municipal Solid Waste Management in Asia: A Comparative Analysis. Proceedings of Workshop on Sustainable Landfill Management, 3-5 December, 2003, Chennai. pp 3-15.
4. Yuan G. 2002. Amounts and composition of Municipal solid waste. http://www.eolss.net/Sample-Chapters/C09/E4-11-03-02.pdf. Accessed 28/08/2012

Annex 1- Authorization letter.

CHITUNGWIZA MUNICIPALITY

All Correspondence to be addressed to the Town Clerk

The Municipality of CHITUNGWIZA

P.O BOX CZA70
CHITUNGWIZA

If Calling, Please Ask for A. Tinofa

TELEPHONES: (0270) 21053
23000-4; 23009; 23022/3;
24994 – FAX: 23337

OUR REF:

YOUR REF:

DATE: 25th July 2012

To whom it may concern

RE: AUTHORITY TO CONDUCT A WASTE GENERATION SURVEY FOR NCUBE BARROW CONSULTANCY IN CHITUNGWIZA CITY FROM THE 25TH OF JULY TO THE 3RD OF SEPTEMBER 2012

This letter serves to confirm the above mentioned consultancy company has been cleared to conduct a waste generation survey in Chitungwiza from the 25th of July to the 3rd of September 2012. This survey serves to help the City of Chitungwiza to improve waste collection services.

Any assistance accorded to them is greatly appreciated.

Thank you.

CHITUNGWIZA MUNICIPALITY
RECEIVED
THROUGH REGISTRY
30 JUL 2012
P.O. BOX CZA70, CHITUNGWIZA

A. TINOFA
DIRECTOR OF WORKS
For: TOWN CLERK

Annex 2- Equipment list

The following equipment was used for the survey

Waste Amount and Composition	**Illegal dumping Waste Survey**
Gloves and Face Masks	2 tap measures (50M)
Black Plastic disposables bins	2 GPS
Data sheets, pencils, note book,	Note Books and Pencils
Masking tape and markers	Gloves and face masks
75L container for bulk density measurement	Work suits
3 scales (one electrical (30Kg), 2 non electrical (50Kg))	
60m Black polythene sheets	
Blades	
Liquid soap and bar of antiseptic soap	
2 vehicles	
Work suits	
Chemical analysis- laboratory facility, envelops, incubators, 5kg scale –non electrical	

Annex 3-Survey Team members

The survey team members are as follows:

Name	**Designation**	**Gender**
Regina Pawaringira	Team leader (Researcher)	Female
Belladonah Muzavazi	Co- Leader (Researcher)	Female
Lydiate Magura	Research Assistant	Female
Tatenda Manyau	Research Assistant	Female
Liliosa Pahwaringira	Research Assistant	Female
Mary	Research Assistant	Female
Chipo Manyau	Research Assistant	Female
Faith	Research Assistant	Female
Tariro Chisvu	Research Assistant	Female
Luke Mukanyimaho	Research Assistant	Male
Wisdom Masakure	Research Assistant	Male
Talent Tandi	Research Assistant	Male
Webster Vambe	Research Assistant	Male
Washington Vambe	Research Assistant	Male
Wonder Mangwendeza	Research Assistant	Male

Annex 4 Data Collection Sheets

Data Sheet for illegal dump site

Sheet No.	**Date:**	**Name:**
Location:		
GPS Coordinates:		
Area (m^2) Volume (m^3)		
Conditions		
Smell:		
Waste Quantity:		
Others:		
Memo:		

Waste Amount Survey Interview Sheet (Residential)

Name of recorder Date

District Suburb

Name of Respondent Name of House Owner
Relationship to HO

Age of respondent Sex of respondent

Education Level of respondent

Household Information

1	Number of families on the premises			
2	Number of members in each family		Male	Female
		0-5yrs		
		6-12yrs		
		13-17yrs		
		18-50yrs		
		51-65yrs		
		>65yrs		
		Total		
3	Type of House			
4	Floor Area of House			
5	Estimated monthly income			
6	Estimated monthly expenditure			

Waste Amount Survey Interview Sheet (Establishments)

Name of recorder Date

District Suburb

Name of Respondent

Age of respondent Sex of respondent

Education Level of respondent

Establishments Information

1.	Number of employees on t he premises			
2.	Number of employees/children at school		Male	Female
		0-5yrs		
		6-12yrs		
		13-17yrs		
		18-50yrs		
		51-65yrs		
		>65yrs		
		Total		
3.	Floor Area of for the business activity			
4.	Approximate monthly numbers of customers/users/guests			
5.	Type of activity			

Components of Waste Composition Survey

Sampling area: **TOTAL** **Date:**

	Waste Composition		**Bruto weight, kg**	**Bin's weight, kg**	**Net Weight (Kgs)**	**Composition ratio (Average for 8 days)??? Not 7**
1	Food Waste					
2	Paper	Recyclable Paper				
3		Recyclable Cardboard				
4		Mixed Paper				
5		Diapers				
		Subtotal-Paper				
6	Plastics	Plastic Sheet				
7		Recyclable Plastics				
8		PET Bottles				
9		Other Plastics				
		Subtotal-Plastics				
10	Rubber & Leather					
11	Textiles					
12	Yard Waste					
13	Lumber & Logs					
14	Other Org. Waste					
	Organic Waste - Subtotal					
	Inorganic Waste					
15	Glass	Returnable Bottles				
16		Other Live Bottles				
17		Glass bins				
18		Broken Glass				
		Glass-Subtotal				
19	Metals	Tin Cans (steel cans)				
20		Aluminum cans				
21		Copper				
22		Other Metals				
		Metal-subtotal				
23	Dirt, Ash, Stone, Sand					
	Inorganic Waste - Subtotal					
24	**Unclassified residual waste**					
	Domestic Hazardous Waste					
25	Batteries - Dry Cells					
26	Other Domestic Hazardous Waste					
	Average Weight					
	Average volume:					
	Bulk density					

Annex 5 Waste Amount Survey Data

Table AN5.1. 1 Daily and Average Waste Generation rate per capita (Kg/capita/day) per day for each House in Rockview (High Income Area)

Household	Number of Persons in HH	Day 1	Day 2	Day3	Day 4	Day 5	Day 6	Day7	Day8	Total	Average for the 8 days
H1	5	0.62	1.54	1.75	0.26	1.03	0.13	0.04	0.62	5.99	0.75
H2	8	1.06	0.32	0.06	0.86	0.42	0.16	0.02	0.62	3.53	0.44
H3	7	0.27	0.23	0.29	0.43	0.46	0.37	0.00	0.19	2.23	0.28
H4	6	0.15	0.34	0.61	0.13	0.09	0.68	1.32	0.49	3.80	0.47
H5	13	0.00	0.02	0.09	0.78	0.30	0.18	0.39	0.15	1.90	0.24
H6	5	0.00	3.60	0.19	0.33	0.82	0.08	0.60	0.25	5.87	0.73
H7	11	0.00	0.94	0.06	0.08	0.57	0.62	0.00	0.02	2.29	0.29
H8	5	0.11	2.38	0.45	0.08	0.53	0.86	1.06	0.25	5.69	0.71
H9	5	0.31	0.10	0.56	0.85	0.28	0.88	0.10	0.34	3.41	0.43
H10	4	0.06	0.06	2.32	0.46	0.40	0.78	0.00	0.71	4.79	0.60
H11	11	0.00	0.27	0.14	0.19	0.61	0.07	0.26	0.05	1.59	0.20
H12	7	0.09	0.20	0.12	0.39	0.83	0.10	0.19	0.39	2.31	0.29
H13	3	0.00	0.34	0.55	0.81	2.85	0.32	0.18	1.05	6.09	0.76
H14	9	0.00	0.44	0.66	0.13	0.25	0.04	0.00	0.70	2.22	0.28
H15	5	0.00	0.04	0.17	0.46	0.53	0.36	0.24	0.25	2.05	0.26
H16	6	1.47	0.07	0.59	0.07	0.25	1.00	0.00	0.30	3.75	0.47
H17	3	0.99	0.12	0.16	0.12	2.30	0.11	0.25	0.51	4.55	0.57
H18	7	0.00	0.06	0.73	0.02	0.06	0.09	0.20	0.20	1.36	0.17
H19	6	0.00	0.20	0.28	0.07	2.57	0.00	0.07	0.60	3.79	0.47
H20	5	0.28	1.21	0.32	1.62	3.21	0.16	0.00	0.06	6.86	0.86
Total	**131**	**0.23**	**0.56**	**0.42**	**0.39**	**0.75**	**0.32**	**0.23**	**0.34**	**3.25**	**0.41**

Table AN5.1. 2 Daily and Average Waste Generation rate per capita (Kg/capita/day)) per day for each House in Zengeza 4 (Middle Income Area)

Household	Number of Persons in HH	Day 1	Day 2	Day3	Day 4	Day 5	Day 6	Day7	Day8	Total	Average for the 8 days
H1	7	0.62	0.46	0.45	0.04	0.64	1.42	0.17	0.72	4.51	0.56
H2	8	0.43	0.17	0.20	0.78	0.28	0.57	0.04	0.35	2.83	0.35
H3	10	1.38	0.13	0.34	0.30	0.12	0.17	0.13	0.34	2.91	0.36
H4	7	1.03	0.15	0.35	0.24	0.13	0.63	0.02	0.13	2.68	0.34
H5	4	1.67	0.12	0.84	0.29	1.67	1.33	0.56	0.97	7.46	0.93
H6	5	4.02	0.00	0.29	0.43	0.50	1.09	0.50	0.86	7.68	0.96
H7	7	1.66	0.35	0.30	0.17	0.25	0.35	0.12	0.20	3.38	0.42
H8	18	0.02	0.29	0.06	0.22	0.10	1.10	0.11	0.50	2.40	0.30
H9	19	0.08	0.41	0.27	0.15	0.44	0.24	0.24	0.15	1.98	0.25
H10	9	0.64	0.34	0.22	0.43	0.09	1.34	0.53	0.06	3.66	0.46
H11	14	0.05	0.74	0.26	0.15	0.10	0.02	0.05	0.11	1.47	0.18
H12	18	0.04	0.04	0.03	0.61	0.03	0.22	0.02	0.04	1.01	0.13
H13	10	0.59	0.16	0.32	0.12	0.14	1.23	0.15	0.25	2.95	0.37
H14	9	0.03	0.68	0.01	0.26	0.10	0.42	0.81	0.00	2.30	0.29
H15	7	0.60	0.52	0.28	0.24	0.21	1.19	0.46	0.06	3.56	0.44
H16	8	1.98	0.20	0.59	0.28	0.28	1.23	0.51	0.33	5.39	0.67
H17	17	0.61	0.03	0.19	0.22	0.36	0.45	0.45	0.58	2.88	0.36
H18	9	0.35	0.64	0.10	0.03	0.11	0.13	0.91	1.15	3.43	0.43
H19	9	0.63	0.14	0.00	0.14	0.45	0.64	1.48	0.39	3.88	0.48
H20	8	0.00	0.89	0.65	0.76	0.41	1.31	1.42	0.06	5.51	0.69
Total	**203**	**0.60**	**0.32**	**0.24**	**0.29**	**0.26**	**0.66**	**0.38**	**0.33**	**3.07**	**0.38**

Table AN5.1. 3 Daily and Average Waste Generation rate per capita (Kg/capita/day)) per day for each House in St Mary‘s (Low Income Area)

Household	Number of Persons in HH	Day 1	Day 2	Day3	Day 4	Day 5	Day 6	Day7	Day8	Total	Average for the 8 days
H1	12	1.04	0.19	1.26	0.86	0.89	0.37	0.13	0.48	5.22	0.65
H2	5	0.63	0.46	0.32	0.15	0.00	1.11	1.44	0.56	4.65	0.58
H3	12	0.96	0.36	0.35	0.24	1.18	0.19	0.19	0.22	3.69	0.46
H4	13	0.06	0.43	0.57	0.48	0.50	0.19	0.13	0.58	2.94	0.37
H5	21	0.04	0.08	0.02	0.36	0.39	0.38	0.28	0.14	1.69	0.21
H6	18	0.33	0.24	0.09	0.19	0.11	0.09	0.45	0.43	1.93	0.24
H7	6	1.00	0.07	0.59	0.35	1.15	1.82	1.69	1.88	8.55	1.07
H8	14	0.03	0.37	0.13	0.22	0.45	0.35	0.67	0.13	2.36	0.29
H9	5	1.05	1.00	1.89	0.10	2.49	1.34	0.76	0.84	9.46	1.18
H10	10	0.01	0.64	0.21	0.78	0.56	0.71	0.14	0.94	3.99	0.50
H11	8	0.29	0.07	0.04	0.32	1.10	0.31	0.00	0.22	2.33	0.29
H12	5	0.23	0.00	0.49	1.08	1.45	1.57	0.40	1.30	6.51	0.81
H13	4	0.30	0.23	0.54	0.91	2.21	1.21	2.64	1.79	9.84	1.23
H14	16	0.22	0.20	0.24	0.20	0.96	0.45	0.12	0.11	2.50	0.31
H15	7	0.06	0.79	0.42	0.39	1.32	0.66	0.78	0.69	5.10	0.64
H16	10	0.00	0.59	0.11	0.03	0.29	0.29	0.14	0.24	1.69	0.21
H17	12	0.32	0.49	0.40	0.16	0.40	0.06	0.62	0.26	2.72	0.34
H18	10	1.02	0.30	0.11	0.35	0.22	0.53	0.96	0.62	4.11	0.51
H19	9	0.09	1.01	0.68	1.17	1.41	0.55	0.28	0.24	5.42	0.68
H20	7	0.00	3.14	0.87	1.67	3.69	1.12	1.21	0.63	12.33	1.54
Total	**204**	**0.34**	**0.46**	**0.38**	**0.44**	**0.84**	**0.51**	**0.49**	**0.47**	**3.93**	**0.49**

Table AN5.1. 4 Average per capita waste generation (inclusive and exclusive of yard waste)

Area	Total amount of waste(kg)	Total amount of Yard waste(kg)	Total population	Total waste excluding yard waste (kg)	Average Per capita/day/person (yard waste excluded)	Average Per capita/day/person (yard waste included)	Average Kg/ household/day (yard waste excluded)	Average Kg/ household/day (yard waste included)
High Income	425.06	101.8	131	323.26	0.31	0.41	2.02	2.66
Middle Income	623.65	150.06	203	473.59	0.29	0.38	2.96	3.90
Low Income	802.731	500.41	204	302.321	0.19	0.49	1.89	5.02

Table AN5.1. 5 Total waste generated by the high income area (Rockview)

WASTE AMOUNT		31-Jul-12		1-Aug-12		2-Aug-12		3-Aug-12		6-Aug-12		7-Aug-12		8-Aug-12		9-Aug-12		
		Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		Day 8		Total
Household	Bin's weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Net weight (kg)
H1	0.035	3.15	3.115	7.75	7.715	8.785	8.75	1.31	1.275	5.205	5.17	0.7	0.665	0.21	0.175	3.12	3.085	**29.95**
H2	0.035	8.5	8.465	2.625	2.59	0.515	0.48	6.94	6.905	3.365	3.33	1.32	1.285	0.228	0.193	5.03	4.995	**28.243**
H3	0.035	1.895	1.86	1.62	1.585	2.06	2.025	3.05	3.015	3.275	3.24	2.605	2.57	0.05	0.015	1.33	1.295	**15.605**
H4	0.035	0.925	0.89	2.07	2.035	3.69	3.655	0.81	0.775	0.565	0.53	4.105	4.07	7.95	7.915	2.95	2.915	**22.785**
H5	0.035	0	0	0.355	0.32	1.15	1.115	10.145	10.11	3.87	3.835	2.315	2.28	5.065	5.03	2.045	2.01	**24.7**
H6	0.035	0	0	18.025	17.99	0.96	0.925	1.695	1.66	4.135	4.1	0.455	0.42	3.04	3.005	1.275	1.24	**29.34**
H7	0.035	0	0	10.41	10.375	0.64	0.605	0.92	0.885	6.27	6.235	6.895	6.86	0	0	0.295	0.26	**25.22**
H8	0.035	0.565	0.53	11.91	11.875	2.275	2.24	0.41	0.375	2.66	2.625	4.31	4.275	5.32	5.285	1.275	1.24	**28.445**
H9	0.035	1.56	1.525	0.515	0.48	2.84	2.805	4.265	4.23	1.42	1.385	4.455	4.42	0.52	0.485	1.735	1.7	**17.03**
H10	0.035	0.27	0.235	0.29	0.255	9.325	9.29	1.89	1.855	1.615	1.58	3.155	3.12	0	0	2.86	2.825	**19.16**

WASTE AMOUNT		31-Jul-12		1-Aug-12		2-Aug-12		3-Aug-12		6-Aug-12		7-Aug-12		8-Aug-12		9-Aug-12		
		Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		Day 8		Total
Household	Bin's weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Net weight (kg)
H11	0.035	0	0	3.015	2.98	1.625	1.59	2.075	2.04	6.73	6.695	0.845	0.81	2.86	2.825	0.555	0.52	**17.46**
H12	0.035	0.66	0.625	1.465	1.43	0.865	0.83	2.73	2.695	5.845	5.81	0.735	0.7	1.35	1.315	2.775	2.74	**16.145**
H13	0.035	0	0	1.05	1.015	1.69	1.655	2.47	2.435	8.57	8.535	0.98	0.945	0.577	0.542	3.175	3.14	**18.267**
H14	0.035	0	0	3.955	3.92	5.98	5.945	1.195	1.16	2.27	2.235	0.4	0.365	0	0	6.35	6.315	**19.94**
H15	0.035	0	0	0.25	0.215	0.9	0.865	2.31	2.275	2.705	2.67	1.845	1.81	1.225	1.19	1.27	1.235	**10.26**
H16	0.035	8.86	8.825	0.455	0.42	3.58	3.545	0.47	0.435	1.515	1.48	6.015	5.98	0	0	1.86	1.825	**22.51**
H17	0.035	3.01	2.975	0.4	0.365	0.52	0.485	0.38	0.345	6.925	6.89	0.35	0.315	0.79	0.755	1.55	1.515	**13.645**
H18	0.035	0	0	0.455	0.42	5.17	5.135	0.156	0.121	0.42	0.385	0.64	0.605	1.465	1.43	1.425	1.39	**9.486**
H19	0.035	0	0	1.255	1.22	1.7	1.665	0.44	0.405	15.475	15.44	0	0	0.44	0.405	3.63	3.595	**22.73**
H20	0.035	1.44	1.405	6.065	6.03	1.63	1.595	8.145	8.11	16.1	16.065	0.82	0.785	0.055	0.02	0.31	0.275	**34.285**
Total		**30.835**	**30.45**	**73.935**	**73.235**	**55.9**	**55.2**	**51.806**	**51.106**	**98.935**	**98.235**	**42.945**	**42.28**	**31.145**	**30.585**	**44.815**	**44.115**	**425.206**

NB 0 indicates that no sample was collected for that household on the day. Reasons have been articulated in the limitation section.

Table AN5.1. 6 Total waste generated by the medium income area (Zengeza 4)

WASTE AMOUNT		30-Jul		31-Jul-12		1-Aug-12		2-Aug-12		3-Aug-12		6-Aug-12		7-Aug-12		8-Aug-12		
		Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		Day 8		Total
Household	Bin's weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Net weight (kg)
H1	0.035	4.355	4.32	3.28	3.245	3.15	3.115	0.32	0.285	4.48	4.445	9.99	9.955	1.225	1.19	5.05	5.015	**31.57**
H2	0.035	3.51	3.475	1.375	1.34	1.645	1.61	6.285	6.25	2.275	2.24	4.585	4.55	0.37	0.335	2.835	2.8	**22.6**
H3	0.035	13.875	13.84	1.355	1.32	3.45	3.415	3.08	3.045	1.235	1.2	1.7	1.665	1.33	1.295	3.4	3.365	**29.145**
H4	0.035	7.25	7.215	1.075	1.04	2.51	2.475	1.73	1.695	0.935	0.9	4.42	4.385	0.175	0.14	0.97	0.935	**18.785**

WASTE AMOUNT		30-Jul		31-Jul-12		1-Aug-12		2-Aug-12		3-Aug-12		6-Aug-12		7-Aug-12		8-Aug-12		
		Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		Day 8		Total
Household	Bin's weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Net weight (kg)
H5	0.035	6.73	6.695	0.51	0.475	3.4	3.365	1.21	1.175	6.73	6.695	5.36	5.325	2.27	2.235	3.91	3.875	**29.84**
H6	0.035	20.12	20.085	0	0	1.505	1.47	2.16	2.125	2.53	2.495	5.465	5.43	2.55	2.515	4.325	4.29	**38.41**
H7	0.035	11.62	11.585	2.45	2.415	2.1	2.065	1.245	1.21	1.79	1.755	2.465	2.43	0.85	0.815	1.4	1.365	**23.64**
H8	0.035	0.48	0.445	5.335	5.3	1.1	1.065	4.01	3.975	1.845	1.81	19.78	19.745	2.025	1.99	8.965	8.93	**43.26**
H9	0.035	1.55	1.515	7.89	7.855	5.13	5.095	2.85	2.815	8.435	8.4	4.615	4.58	4.62	4.585	2.845	2.81	**37.655**
H10	0.035	5.815	5.78	3.105	3.07	2.015	1.98	3.915	3.88	0.85	0.815	12.075	12.04	4.79	4.755	0.615	0.58	**32.9**
H11	0.035	0.665	0.63	10.365	10.33	3.61	3.575	2.075	2.04	1.495	1.46	0.335	0.3	0.74	0.705	1.6	1.565	**20.605**
H12	0.035	0.69	0.655	0.685	0.65	0.59	0.555	10.975	10.94	0.625	0.59	3.92	3.885	0.31	0.275	0.715	0.68	**18.23**
H13	0.035	5.95	5.915	1.59	1.555	3.205	3.17	1.275	1.24	1.445	1.41	12.29	12.255	1.545	1.51	2.5	2.465	**29.52**
H14	0.035	0.31	0.275	6.145	6.11	0.095	0.06	2.375	2.34	0.92	0.885	3.8	3.765	7.315	7.28	0	0	**20.715**
H15	0.035	4.26	4.225	3.655	3.62	1.96	1.925	1.68	1.645	1.525	1.49	8.37	8.335	3.23	3.195	0.485	0.45	**24.885**
H16	0.035	15.9	15.865	1.64	1.605	4.73	4.695	2.26	2.225	2.25	2.215	9.865	9.83	4.09	4.055	2.68	2.645	**43.135**
H17	0.035	10.46	10.425	0.55	0.515	3.185	3.15	3.82	3.785	6.1	6.065	7.645	7.61	7.63	7.595	9.895	9.86	**49.005**
H18	0.035	3.15	3.115	5.83	5.795	0.905	0.87	0.295	0.26	1.05	1.015	1.23	1.195	8.24	8.205	10.41	10.375	**30.83**
H19	0.035	5.735	5.7	1.265	1.23	0	0	1.32	1.285	4.08	4.045	5.76	5.725	13.39	13.355	3.57	3.535	**34.875**
H20	0.035	0	0	7.18	7.145	5.27	5.235	6.09	6.055	3.29	3.255	10.55	10.515	11.365	11.33	0.545	0.51	**44.045**
Total		**122.425**	**121.76**	**65.28**	**64.615**	**49.555**	**48.89**	**58.97**	**58.27**	**53.885**	**53.185**	**134.22**	**133.52**	**78.06**	**77.36**	**66.715**	**66.05**	**623.65**

NB 0 indicates that no sample was collected for that household on the day. Reasons have been articulated in the limitations section

Table AN5.1. 7 Total waste generated by the Low income area (St Mary's)

WASTE AMOUNT		31-Jul-12		1-Aug-12		2-Aug-12		3-Aug-12		6-Aug-12		7-Aug-12		8-Aug-12		9-Aug-12		Total
		Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		Day 8		

Household	Bin's weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Gross weight (kg)	Net weight (kg)	Net weight (kg)
H1	0.035	12.49	12.455	2.305	2.27	15.135	15.1	10.34	10.305	10.77	10.735	4.455	4.42	1.595	1.56	5.815	5.78	**62.625**
H2	0.035	3.17	3.135	2.34	2.305	1.61	1.575	0.78	0.745	0	0	5.565	5.53	7.215	7.18	2.82	2.785	**23.255**
H3	0.035	11.53	11.495	4.365	4.33	4.235	4.2	2.92	2.885	14.23	14.195	2.27	2.235	2.285	2.25	2.725	2.69	**44.28**
H4	0.035	0.79	0.755	5.645	5.61	7.46	7.425	6.28	6.245	6.59	6.555	2.505	2.47	1.695	1.66	7.52	7.485	**38.205**
H5	0.035	0.805	0.77	1.815	1.78	0.485	0.45	7.625	7.59	8.205	8.17	7.92	7.885	5.825	5.79	3.015	2.98	**35.415**
H6	0.035	6.03	5.995	4.31	4.275	1.62	1.585	3.535	3.5	1.955	1.92	1.64	1.605	8.045	8.01	7.85	7.815	**34.705**
H7	0.035	6.055	6.02	0.47	0.435	3.55	3.515	2.15	2.115	6.955	6.92	10.955	10.92	10.16	10.125	11.29	11.255	**51.305**
H8	0.035	0.515	0.48	5.27	5.235	1.785	1.75	3.175	3.14	6.305	6.27	4.99	4.955	9.435	9.4	1.8	1.765	**32.995**
H9	0.035	5.265	5.23	5.055	5.02	9.49	9.455	0.535	0.5	12.465	12.43	6.725	6.69	3.81	3.775	4.24	4.205	**47.305**
H10	0.035	0.18	0.145	6.385	6.35	2.165	2.13	7.88	7.845	5.64	5.605	7.135	7.1	1.425	1.39	9.405	9.37	**39.935**
H11	0.035	2.325	2.29	0.575	0.54	0.315	0.28	2.605	2.57	8.815	8.78	2.5	2.465	0	-0.035	1.8	1.765	**18.655**
H12	0.035	1.17	1.135	0	0	2.49	2.455	5.41	5.375	7.28	7.245	7.87	7.835	2.045	2.01	6.515	6.48	**32.535**
H13	0.035	1.25	1.215	0.95	0.915	2.21	2.175	3.675	3.64	8.89	8.855	4.875	4.84	10.595	10.56	7.175	7.14	**39.34**
H14	0.035	3.525	3.49	3.225	3.19	3.87	3.835	3.18	3.145	15.46	15.425	7.26	7.225	2.015	1.98	1.77	1.735	**40.025**
H15	0.035	0.44	0.405	5.57	5.535	2.985	2.95	2.74	2.705	9.255	9.22	4.66	4.625	5.525	5.49	5	4.8	**35.73**
H16	0.035	0	0	5.96	5.925	1.1	1.065	0.33	0.295	2.915	2.88	2.91	2.875	1.45	1.415	2.465	2.43	**16.885**
H17	0.035	3.865	3.83	5.97	5.935	4.835	4.8	1.955	1.92	4.87	4.835	0.8	0.765	7.45	7.415	3.135	3.1	**32.6**
H18	0.035	10.27	10.235	2.99	2.955	1.12	1.085	3.535	3.5	2.22	2.185	5.3	5.265	9.68	9.645	6.25	6.215	**41.085**
H19	0.035	0.83	0.795	9.116	9.081	6.12	6.085	10.53	10.495	12.75	12.715	5.01	4.975	2.54	2.505	2.175	2.14	**48.791**
H20	0.035	0	0	21.98	21.945	6.135	6.1	11.755	11.72	25.85	25.815	7.88	7.845	8.505	8.47	4.465	4.43	**86.325**
Total		**70.505**	**69.875**	**94.296**	**93.631**	**78.715**	**78.015**	**90.935**	**90.235**	**171.42**	**170.755**	**103.225**	**103.225**	**101.295**	**100.595**	**97.065**	**96.365**	**802.696**

NB 0 indicates that no sample was collected for that household on the day. Reasons have been articulated in the limitation section.

Table AN5.1. 8 Daily and Average Waste Generation rate per capita (Kg/capita/day)) per day for each Establishment

Sector	Sampled establishment	Day 1	Day 2	Day 3	Day 4	Day 5	Total Waste generated	Ave waste/day	Estimate amount/month
School	Zengeza 4 Primary School	13.97	38.72	27.14	31.42	18.99	130.23	26.05	729.29
	Zengeza 2 High School	11.59	12.72	3.39	2.53	5.72	35.94	7.19	201.24
	Dudzai Primary School	35.42	18.62	22.10	12.81	29.09	118.02	23.60	660.91
	Total	**60.97**	**70.05**	**52.63**	**46.75**	**53.80**	**284.19**	**56.84**	**1,591.44**
Kiosk	Zengeza 4 shop7	1.10	3.15	0.00	0.98	1.27	6.49	1.30	36.34
	Zengeza 5 Matandi Enterprise	0.56	0.25	0.58	0.02	0.05	1.44	0.29	8.06
	Unit F	1.02	0.26	0.66	0.28	0.82	3.02	0.60	16.91
	Total	**2.67**	**3.65**	**1.23**	**1.27**	**2.14**	**10.95**	**2.19**	**61.32**
Supermarkets	T M Zengeza 2	9.91	7.64	10.39	8.32	5.63	41.88	8.38	234.53
	FCG Makoni	13.44	19.17	8.62	21.05	14.31	76.59	15.32	428.89
	OK Makoni	1.22	14.60	0.00	8.39	18.08	42.28	8.46	236.77
	Total	**24.57**	**41.41**	**19.01**	**37.75**	**38.02**	**160.75**	**32.15**	**900.19**
Factories	Chibuku Breweries	55.64	5.91	56.33	26.08	75.22	219.18	43.84	1,227.43
	National Bakeries	397.02	373.71	64.22	326.72	84.47	1,246.13	249.23	6,978.33
	Dairibord Nutriplus	7.39	11.48	14.88	11.83	6.99	52.56	10.51	294.31
	Total	**460.04**	**391.09**	**135.43**	**364.63**	**166.67**	**1,517.87**	**303.57**	**8,500.06**
Market	Jambaja	3.07	10.36	5.55	4.21	4.62	27.79	5.56	155.62
	Makoni	3,000.00	3,000.00	3,000.00	2,250.00	3,000.00	14,250.00	2,850.00	79,800.00
	Chigovanyika	3,000.00	3,000.00	3,750.00	5,250.00	3,000.00	18,000.00	3,600.00	100,800.00
	Total	**6,003.07**	**6,010.36**	**6,755.55**	**7,504.21**	**6,004.62**	**32,277.79**	**6,455.56**	**180,755.62**
GRAND TOTAL		6,551.31	6,516.55	6,963.84	7,954.60	6,265.23	34,251.54	6,850.31	191,808.63

Table AN5.1. 9 Waste amount/capita/month vs. estimated household income and expenditure for High income households

Household	Estimated income	Estimated expenditure	Waste generation per capita rate
H1	$ 300.00	$ 300.00	2.6
H2	$ 1,000.00	$ 700.00	1.5
H3	$ 350.00	$ 300.00	1.0
H4	$ 5,000.00	$ 3,000.00	1.7
H5	$ 310.00	$ 170.00	0.8
H6	$ 500.00	$ 500.00	2.6
H7	$ -	$ -	1.0
H8	$ 400.00	$ 400.00	2.5
H9	$ 450.00	$ 450.00	1.5
H10	$ -	$ -	2.1
H11	$ 600.00	$ 600.00	0.7
H12	$ -	$ -	1.0
H13	$ -	$ -	2.7
H14	$ 400.00	$ 400.00	1.0
H15	$ 250.00	$ 200.00	0.9
H16	$ 500.00	$ 350.00	1.6
H17	$ 150.00	$ 200.00	2.0
H18	$ 250.00	$ 250.00	0.6
H19	$ 500.00	$ 350.00	1.7
H20	$ 200.00	$ 200.00	3.0

Table AN5.1. 10 Waste amount/capita/month vs Estimated household income and expenditure for Middle income households

Household	Estimated income	Estimated expenditure	Waste generation per capita rate
H1	$ 150.00	$ 100.00	2.0
H2	$ 350.00	$ 150.00	1.2
H3	$ 100.00	$ 100.00	1.3
H4	$ 150.00	$ 183.00	1.2
H5	$ 2,750.00	$ 2,800.00	3.3
H6	$ 1,800.00	$ 1,450.00	3.4
H7	$ 100.00	$ 50.00	1.5
H8	$ 250.00	$ 150.00	1.1
H9	$ 500.00	$ 500.00	0.9
H10	$ 300.00	$ 300.00	1.6
H11	$ 200.00	$ 170.00	0.6
H12	$ 325.00	$ 100.00	0.4
H13	$ -	$ -	1.3
H14	$ -	$ -	1.0
H15	$ -	$ -	1.6
H16	$ -	$ -	2.4
H17	$ 300.00	$ 200.00	1.3
H18	$ 500.00	$ 500.00	1.5
H19	$ 250.00	$ 300.00	1.7
H20	$ 300.00	$ 400.00	2.4

Table AN5.1. 11 Waste amount/capita/month vs Estimated household income and expenditure for Low income households

Household	Estimated income	Estimated expenditure	Waste generation per capita rate
H1	$ 150.00	$ 150.00	2.3
H2	$ -	$ -	2.0
H3	$ 200.00	$ 100.00	1.6
H4	$ 500.00	$ 270.00	1.3
H5	$ 200.00	$ 50.00	0.7
H6	$ 100.00	$ 60.00	0.8
H7	$ -	$ -	3.7
H8	$ 790.00	$ 1,000.00	1.0
H9	$ 1,080.00	$ 500.00	4.1
H10	$ 110.00	$ 110.00	1.7
H11	$ 25.00	$ 100.00	1.0
H12	$ 405.00	$ 304.00	2.8
H13	$ 100.00	$ 150.00	4.3
H14	$ 450.00	$ 300.00	1.1
H15	$ -	$ -	2.2
H16	$ -	$ -	0.7
H17	$ -	$ -	1.2
H18	$ -	$ -	1.8
H19	$ -	$ 200.00	2.4
H20	$ -	$ -	5.4

Table AN5.1. 12 Field Notes for Waste amount calculations for Establishments

Establishments			Waste Amount Status during sampling				
Sector	**Sampled establishment**	**Waste amount information**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**
School	Zengeza 4 Primary School	7 80L black bins, usually burn their waste	collected all waste	collected all waste	collected all waste	collected all waste	collected all waste
	Zengeza 2 High School	7 80L black bins, usually burn their waste, mulch yard waste	collected all waste	collected all waste	collected some as school had burnt some of its waste	collected some as school had burnt some of its waste	collected some as school had burnt some of its waste
	Dudzai P rimary School	4 200L bins , usually burn their waste	collected all waste	collected all waste	collected all waste	collected all waste	collected all waste
Kiosks	Zengeza 4 shop7	5L box emptied everyday	collected all waste	collected all waste	collected all waste	collected all waste	collected all waste
	Zengeza 5 Matandi Enterprise	5L box emptied everyday	collected all waste	collected all waste	collected all waste	collected all waste	collected all waste
	Unit F	5L box emptied everyday	collected all waste	collected all waste	did not collect a sample the owner forgot and disposed the waste	collected all waste	collected all waste
Supermarkets	T M Zengeza 2	6 80Lblack bins, on daily base 1 g ets filled with paper from till, while the rest are usually halfway filled with food waste	collected some of the waste most had been disposed	collected all waste	collected all waste	collected all waste	collected all waste
	FCG Makoni	4 80L Black bins, fill on daily base	collected some of the waste most had been disposed- 1/2 a bin	collected all waste	collected all waste	collected all waste	collected all waste
	OK Makoni	4 80L Black bins, emptied on daily base, 2 bins are usually full food waste and papers, card boxes and pet bottles are collected twice daily by community members	collected some of the waste most had been disposed- 1/2 a bin	collected all waste	no waste collected bins were emptied	collected all waste	collected all waste
Factories	Chibuku Breweries	5 80L Black bins fill on daily base and emptied into their skip bin, Waste Away collects skip twice weekly	4 bins full collected 1bin	3 bins full collected 1.5bins	4 bins full collected 1.75 bins	4 bins full collected 1 bin	4 bins full collected 1 bin

Establishments			Waste Amount Status during sampling				
Sector	**Sampled establishment**	**Waste amount information**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**
	National Bakeries	14 Black plastics and many yeast boxes emptied everyday into their skip bin, skip bin emptied twice every week	14 bins full collected 3 bins	14 bi ns full collected 3 bins	12 bins full collected 3 bins	12 bins full collected 3 bins	14 bins full collected 3 bins
	Dairibord Nutriplus	12 200L bins categorized into organic, plastics, paper and glass, there are two skip bins to which the bins are emptied, the bins take 2 to three days to fill up, the skip bin is collected every Friday by Waste Away	collected some of the waste as bins had waste from previous week	collected some of the waste as bins had waste from previous week	The bins were emptied of previous week waste and all waste generated on the was collected	collected all waste	collected all waste
Markets	Jambanja	skip bin emptied every Tuesday but mostly used by households, market place uses 2 pits, current pit 4 months old full during time of study, the other pit was not full but hardly used, a bit far from the vegetable market	collected all waste that seemed to be fresh waste for the day from pit	collected all waste that seemed to be fresh waste for the day from pit	collected all waste that seemed to be fresh waste for the day from pit	collected all waste that seemed to be fresh waste for the day from pit	collected all waste that seemed to be fresh waste for the day from pit
	Makoni	2 skip bins collected Monday to Friday	full skip bin, collected sample for composition	full skip bin, collected sample for composition	full skip bin, collected sample for composition	0.75 full skip bin, collected sample for composition	full skip bin, collected sample for composition
	Chigovanyika	often market place has 1 skip emptied everyday but always full as residents also come to dump their waste	full skip bin, collected sample for composition	full skip bin, collected sample for composition	over flowing skip bin, collected sample for composition	1.75 full skip bins, collected sample for composition	full skip bin, collected sample for composition

Table AN5.1. 13 Background information for sampled Establishments

Establishments						
Sector	**Sampled establishment**	**Number of employees/ Children**	**Floor Area of business(m2)**	**Approximate monthly customers/users**	**Activity**	**Waste amount information**
School	Zengeza 4 Primary School	2,253	2,500		Primary School	7, 80L black bins, usually burn their waste
	Zengeza 2 High School	1,612	13,000		High School	7 80L black bins, usually burn their waste, mulch yard waste
	Dudzai Primary School	2,153	2,000		Primary School	4 200L bins , usually burn their waste
Kiosks	Zengeza 4 shop7	1	no information	100	retail groceries	5L box emptied everyday

Establishments						
Sector	**Sampled establishment**	**Number of employees/ Children**	**Floor Area of business(m2)**	**Approximate monthly customers/users**	**Activity**	**Waste amount information**
	Zengeza 5 Matandi Enterprises	2	12.5	168	retail groceries	5L box emptied everyday
	Unit F	4	no information	100	retail groceries and butchery	5L box emptied everyday
Supermarkets	T M Zengeza 2	46	7,000	90 000	Retail Shop	6 80Lblack bins ,on daily base 1 gets filled with paper from till, while the rest are usually halfway filled with food waste
	FCG Makoni	14	no information	no information	Retail Shop	4 80L Black bins, fill on daily base
	OK Makoni	65	no information	3,000	Retail Shop	4 80L Black bins, emptied on daily base, 2 bins are usually full food waste and papers, card boxes and pet bottles are collected twice daily by community members
Factories	Chibuku Breweries	150	no information	no information	Beer Brewing	5 80L Black bins fill on daily base and emptied into their skip bin, Waste Away collects skip twice weekly
	National Bakeries	90	1,200	customers come for less than 15 minutes	Bakery	14 Black plastics and many yeast boxes emptied everyday into their skip bin, skip bin emptied twice every week
	Dairibord Nutriplus	45	40,000	no information	Dairy drink production	12 200L bins categorized into organic, plastics, paper and glass, there are two skip bins to which the bins are emptied, the bins take 2 to three days to fill up, the skip bin is collected every Friday by Waste Away
Markets	Jambanja	1,000	no information	no information	Market for vegetable and other non-food items e.g. clothes, kitchen ware	skip bin emptied every Tuesday but mostly used by households, market place uses 2 pits, current pit 4 months old full during time of study, the other pit was not full but hardly used, a bit far from the vegetable market
	Makoni	3,000	no information	no information	Market for vegetable and other non-food items e.g. clothes ,kitchen ware	2 skip bins collected Monday to Friday
	Chigovanyika	>100	no information	no information	Market for vegetable and other non-food items e.g. clothes, kitchen ware	often market place has 1 skip emptied everyday but always full as residents also come to dump their waste

Annex 6-Waste Composition Survey Data

Table AN6.1. 1 Bulk density for Residential areas

	High income Area			Middle income area			Low income area		
	weight for bulk density (kg)	**volume of container (m^3)**	**Bulk density (Kg/m3)**	**weight for bulk density (kg)**	**volume of container (m^3)**	**Bulk density (Kg/m3)**	**weight for bulk density (kg)**	**volume of container (m^3)**	**Bulk density (Kg/m3)**
Day1	10.184	0.075	135.79	34.99	0.075	466.51	11.24	0.075	149.85
Day2	3.76	0.075	50.13	14.86	0.075	198.17	12.68	0.075	169.09
Day 3	14.4	0.075	192.00	5.60	0.075	74.72	28.07	0.075	374.23
Day4	12.744	0.075	169.92	7.01	0.075	93.48	9.89	0.075	131.82
Day5	9.336	0.075	124.48	18.01	0.075	240.12	9.95	0.075	132.69
Day6	15.216	0.075	202.88	8.07	0.075	107.59	11.88	0.075	158.34
Day7	6.44	0.075	85.87	17.49	0.075	233.16	10.45	0.075	139.27
Day8	11.52	0.075	153.60	6.58	0.075	87.68	14.82	0.075	197.60
Average	**10.45**	**0.075**	**139.33**	**14.08**	**0.075**	**187.68**	**13.62**	**0.075**	**181.61**

Table AN6.1. 2 Bulk density Analysis for Establishments

	School			Kiosks			Supermarkets			Factories			Markets		
	weight for bulk density (kg)	**volume of container (m^3)**	**Bulk density (Kg/m3)**	**weight for bulk density (kg)**	**volume of container (m^3)**	**Bulk density (Kg/m3)**	**weight for bulk density (kg)**	**volume of container (m^3)**	**Bulk density (Kg/m3)**	**weight for bulk density (kg)**	**volume of container (m^3)**	**Bulk density (Kg/m3)**	**weight for bulk density (kg)**	**volume of container (m^3)**	**Bulk density (Kg/m3)**
Day 1	2.64	0.075	35.2	1.17	0.075	15.60	2.38	0.075	31.79	21.78	0.075	290.35	4.31	0.075	57.46
Day 2	2.92	0.075	38.9	0.73	0.075	9.71	7.81	0.075	104.11	9.94	0.075	132.48	7.54	0.075	100.53
Day 3	1.97	0.075	26.27	0.96	0.075	12.74	9.26	0.075	123.52	5.74	0.075	76.59	2.96	0.075	39.43
Day 4	4.25	0.075	56.7	0.62	0.075	8.23	2.26	0.075	30.19	18.12	0.075	241.60	5.86	0.075	78.17
Day 5	6.69	0.075	89.2	0.75	0.075	9.97	8.42	0.075	112.32	7.46	0.075	99.41	6.86	0.075	91.43
Average	**3.69**	**0.075**	**49.3**	**0.84**	**0.075**	**11.25**	**6.03**	**0.075**	**80.38**	**12.61**	**0.075**	**168.09**	**5.51**	**0.075**	**73.41**

Table AN6.1. 3 Moisture Content for Residential Waste

	High income Area			Middle income area			Low income area		
	Dry weight sample	Wet sample weight (kg)	Moisture Content (%)	Dry weight sample	Wet sample weight (kg)	Moisture Content (%)	Dry weight sample	Wet sample weight (kg)	Moisture Content (%)
Day1	1.50	1.97	23.54	1.44	1.97	26.72	1.32	1.97	33.08
Day2	1.50	1.97	23.54	1.22	1.97	38.17	1.49	1.97	24.17
Day 3	1.64	1.97	16.54	1.44	1.97	26.72	0.87	1.97	55.98
Day4	1.24	1.97	36.90	1.27	1.97	35.62	1.64	1.97	16.54
Day5	1.29	1.97	34.35	1.14	1.97	41.98	1.32	1.97	33.08
Day6	1.34	1.97	31.81	1.27	1.97	35.62	1.29	1.97	34.61
Day7	0.97	1.97	50.89	1.08	1.97	45.17	1.27	1.97	35.62
Day8	1.29	1.97	34.35	0.77	1.97	61.07	0.97	1.97	50.89
Average	**1.35**	**1.97**	**31.49**	**1.20**	**1.97**	**38.88**	**1.27**	**1.97**	**35.50**

Table AN6.1. 4 Moisture Content for Establishments Waste

	Schools			Kiosks			Supermarkets			Factories			Markets		
	Dry weight sample	Wet sample weight (kg)	Moisture Content (%)	Dry weight sample	Wet sample weight (kg)	Moisture Content (%)	Dry weight sample	Wet sample weight (kg)	Moisture Content (%)	Dry weight sample	Wet sample weight (kg)	Moisture Content (%)	Dry weight sample	Wet sample weight (kg)	Moisture Content (%)
Day1	1.65	1.97	16.16	1.85	1.97	5.73	1.52	1.97	22.90	1.92	1.97	2.54	0.87	1.97	55.98
Day2	1.59	1.97	19.08	1.59	1.97	19.08	1.59	1.97	19.08	1.34	1.97	31.81	0.92	1.97	53.44
Day 3	1.84	1.97	6.36	0.97	1.15	15.72	0.94	1.97	52.16	1.45	1.97	26.46	0.79	1.97	59.80
Day4	1.42	1.97	27.99	0.92	1.08	15.28	1.19	1.97	39.44	1.49	1.97	24.17	1.27	1.97	35.62
Day5	1.69	1.97	13.99	1.57	1.97	20.36	0.95	1.97	51.91	1.37	1.97	30.53	1.04	1.97	47.07
Average	**1.64**	**1.97**	**16.72**	**1.38**	**1.62**	**15.23**	**1.24**	**1.97**	**37.10**	**1.51**	**1.97**	**23.10**	**0.98**	**1.97**	**50.38**

Annex 7 Map of Illegal Dumping Sites in Chitungwiza Municipality

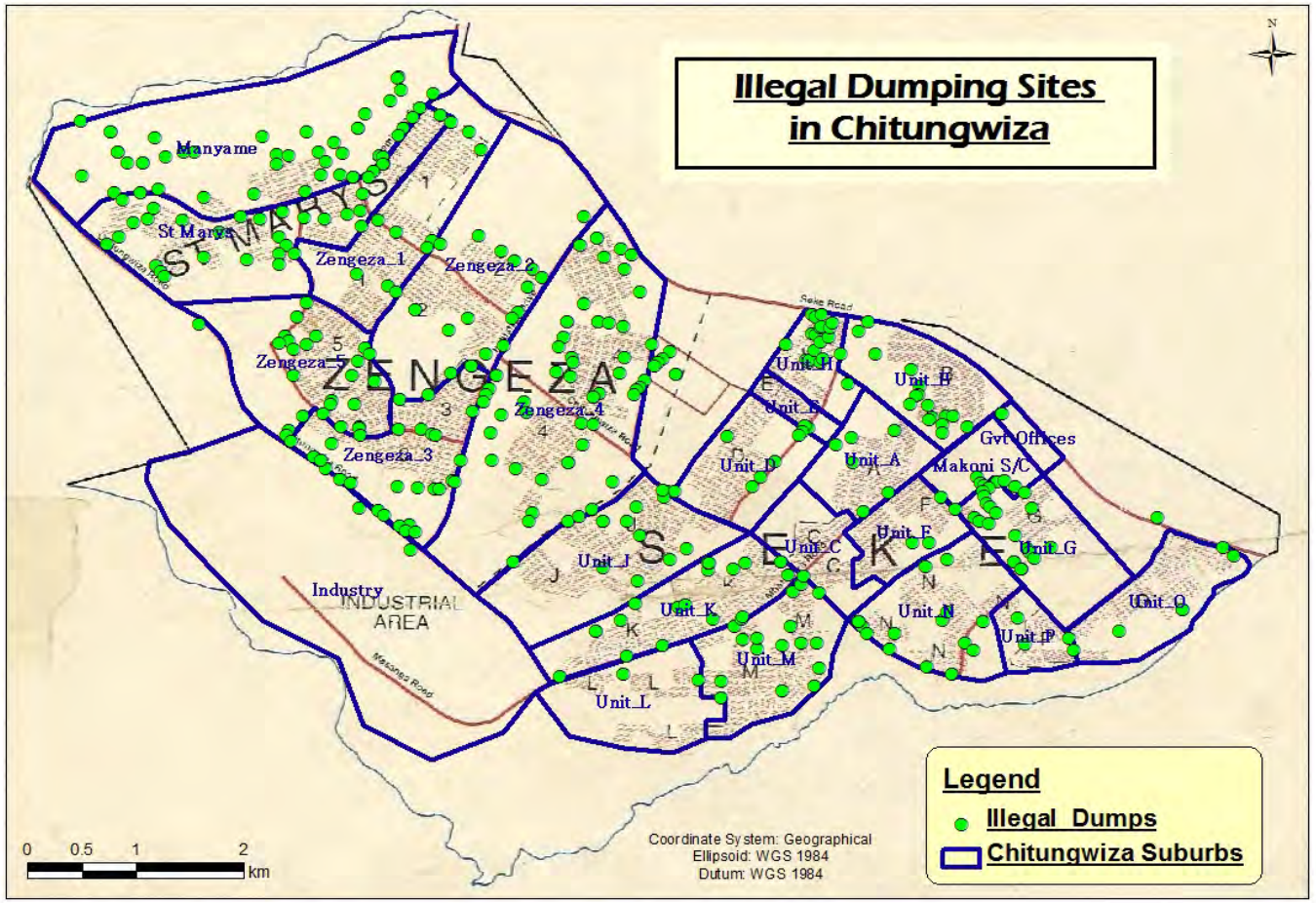

Fig. AN7.1. 1 Illegal dumping sites in Chitungwiza Municipality

APPENDIX 5.5

The Water Quality Survey for the Implementation of the Water Supply, Sewerage and Solid Waste Management in Chitungwiza

WATER QUALITY SURVEY
FINAL RESULTS REPORT

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February 2013

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1 Introduction

1.1 Purpose of Sampling Survey

The purpose of this sampling and analysis survey was to grasp the pollution conditions of the catchment area of Manyame River, lake water quality of Manyame and Chivero Lake, the raw water quality of Zengeza STP (sewage treatment plant) and well water quality located in Chitungwiza Municipality. The pollution condition survey was carried out both dry and wet season.

(i) Microbiological quality: Refers to the presence of organisms that cannot be individually seen by the naked eye, such as protozoa, bacteria and viruses. Many of these microbes are associated with the transmission of infectious water-borne diseases such as gastroenteritis and cholera. faecal and total coliform bacteria are commonly used as indicator organisms to determine the microbiological status and safety of water supplies.

(ii) Physical quality: Refers to water quality properties (such as conductivity, pH and turbidity) that may be determined by physical methods. The physical quality mainly affects the aesthetic quality (taste, odour and appearance) of water.

(iii) Chemical quality: Refers to the nature and concentration of dissolved substances (such as organic and inorganic chemicals including metals). Many chemicals in water are essential as part of a person's daily nutritional requirements, but unfortunately above a certain concentration most chemicals (e.g. iron, manganese) may have negative health effects.

1.2 Representative Water Sample

Samples were taken from locations that are representative of water flow, lakes and the inflow point of STP. The sampling points used for the purpose of the study were points that are currently being used by the City of Harare and ZINWA for collecting their samples.

1.3 Analysis performed

Numerous water quality analyses were chosen based upon the objective of the sampling. General categories of constituents include bacteria, metals, nutrients and other constituents (such as total suspended sediments). Table 1 below shows a list of water quality parameters that were being tested and their relevance to the user. These Parameters differ according to the purpose of the sampling and the results are also dependent on the type of samples. An analysis of the parameters found from the sampling results will be done in the later chapters and interpretation and conclusions derived from them.

Each category of analysis is briefly discussed below.

1.3.1 Bacteria

Current water quality testing methodologies relies on the usage of indicator organisms- Total Bacteria, coliform and faecal coliform- as a measure of the potential for human pathogens to be present in the sampled waters. Their presence in the water has a relationship to public health risk (e.g. skin rashes, respiratory infections, gastro-intestinal illness and other diseases). *E.Coli* bacteria is the most prevalent form of faecal coliform bacteria.

1.3.2 Nutrients

Nutrients are vital to the health of an aquatic environment. However, they can be detrimental to aquatic life in high concentrations. Nitrogen and phosphorus tend to be the most commonly problematic nutrients because homeowners and agricultural operations add these nutrients to their lawns and gardens in vast quantities to increase productivity. The presence of nutrients can accelerate growth and preponderance of water plants such as algae. When water becomes stagnant and temperatures increase, algal growth greatly increases, leading to the formation of large patches of thick green algal mats. These mats are not harmful to humans, but reduce light and oxygen availability in the water and may lead to anaerobic conditions, odours, and severe impacts to other aquatic life.

1.3.3 Other Constituents

Other constituents sampled for include turbidity, total suspended solids, hardness, and specific conductance, among others. While many of these physical parameters are expected to be present and may not be toxic in the aquatic environment, their concentrations may be indicative of other problems, or useful for general characterization of the water sources. Hardness is a measure of the level of dissolved carbonates in the water bodies.

Table 1.1: Water Quality Parameters

KEY SUBSTANCES	RELEVANCE TO THE DOMESTIC USER
Microbiological quality	
Faecal coliforms	Indicates recent faecal pollution, and the potential risk of contracting infectious diseases
Total coliforms	indicates the general hygienic quality of the water
Physical quality	
Electrical conductivity Total dissolved salts	Serves as a general indicator of change in water quality and affects the taste and "freshness" of the water.
pH	Affects the taste and corrosivity of the water
Turbidity	Indicates the cloudiness of the water, and affects the risk of infectious disease transmission.
Colour	Indicate pollution by water's colour
BOD (biochemical oxygen demand)	Indicates pollution degree by organic materials
COD (chemical Oxygen demand)	Indicates pollution degree by organic and/or chemical materials
SS(Suspended Solid)	Indicates pollution by floating solid
Chemical Quality	
Sodium and Chloride	May impart a salty taste to the water
Fluoride	Excessive amounts stain teeth and cause Crippling skeletal deformities.
Iron and Manganese	May discolour water; excessive amounts may be toxic
Total Hardness	Affects the scaling and foaming quality of the water
Magnesium	Excessive amounts make bitter and may cause diarrheorea
Nitrate and Nitrite	may be toxic to infants

1.4 Report Structure

The report follows the following structure:

- Sampled Areas covering;
  - Lakes,
  - Rivers, and
  - Aquifers/Ground Water.
- Sampling Equipment,
- Sampling Methodology,
- Testing Laboratories, and
- Discussion of Sampling Results.

1.5 Terms of Reference (TOR)

The terms of reference specified that for Water Quality Survey;

- The sampling points will be determined as the same points for The Study for Prevention of Water Pollution in Upper Stream Area of Manyame River by JICA in 1996,
- The following Water Quality Indices were requested to be examined; pH, BOD_5(for river and others), COD(for lake, sampled after filtration), SS, DO, Escherichia coli, T-N and T-P,
- Method and accuracy to be as included in the Drinking Water Standard of Zimbabwe and Environmental Standard for Water Quality and those not covered to conform to WHO Drinking Water Quality Guidelines measurement methods, and
- Number of sampling; one during the dry season and one during the wet season.

For The Vertical Direction Water Quality Survey;

- Sampling at 1m and 5m depth intervals and at the bottom to the perpendicular direction at the same location with the horizontal measurement in Lake Chivero,
- The following Water Quality Indices were requested to be examined; pH, BOD5(for river and others), COD(for lake, sampled after filtration), SS, DO, Escherichia coli, T-N and T-P,
- Method and accuracy to be as included in the Drinking Water Standard of Zimbabwe and Environmental Standard for Water Quality and those not covered to conform to WHO Drinking Water Quality Guidelines measurement methods, and
- Number of sampling; one during the dry season and one during the wet season.

The report was to include;

- Summary table of investigation results according to location and time of samples including sampling location photos, and
- Detailed investigation results of all works conducted, presented in a systematic manner.

2 Sampling

2.1 Sampling Area, Points and the Dates

The samples area and points for river and lake water are shown in Figure 2.1 which includes below river and lakes;

- Marimba River
- Mukuvisi River
- Nyatsime River
- Manyame River
- Lake Chivero
- Lake Manyame
- Harava dam

The sampling point of raw sewage and well water are shown Figure 2.2.
Well sampling points were shown from W1 to W6.

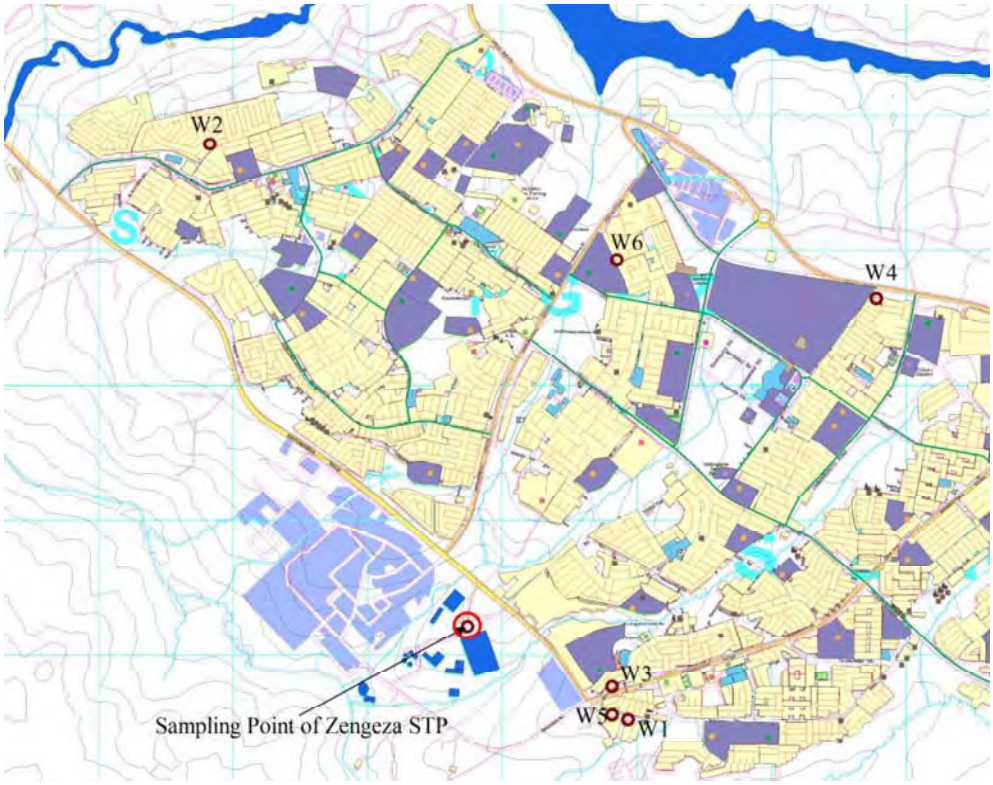

Figure 2.2 Sampling Points of Raw Sewage and Well Water

Table 2.1 shows the dates of sampling.

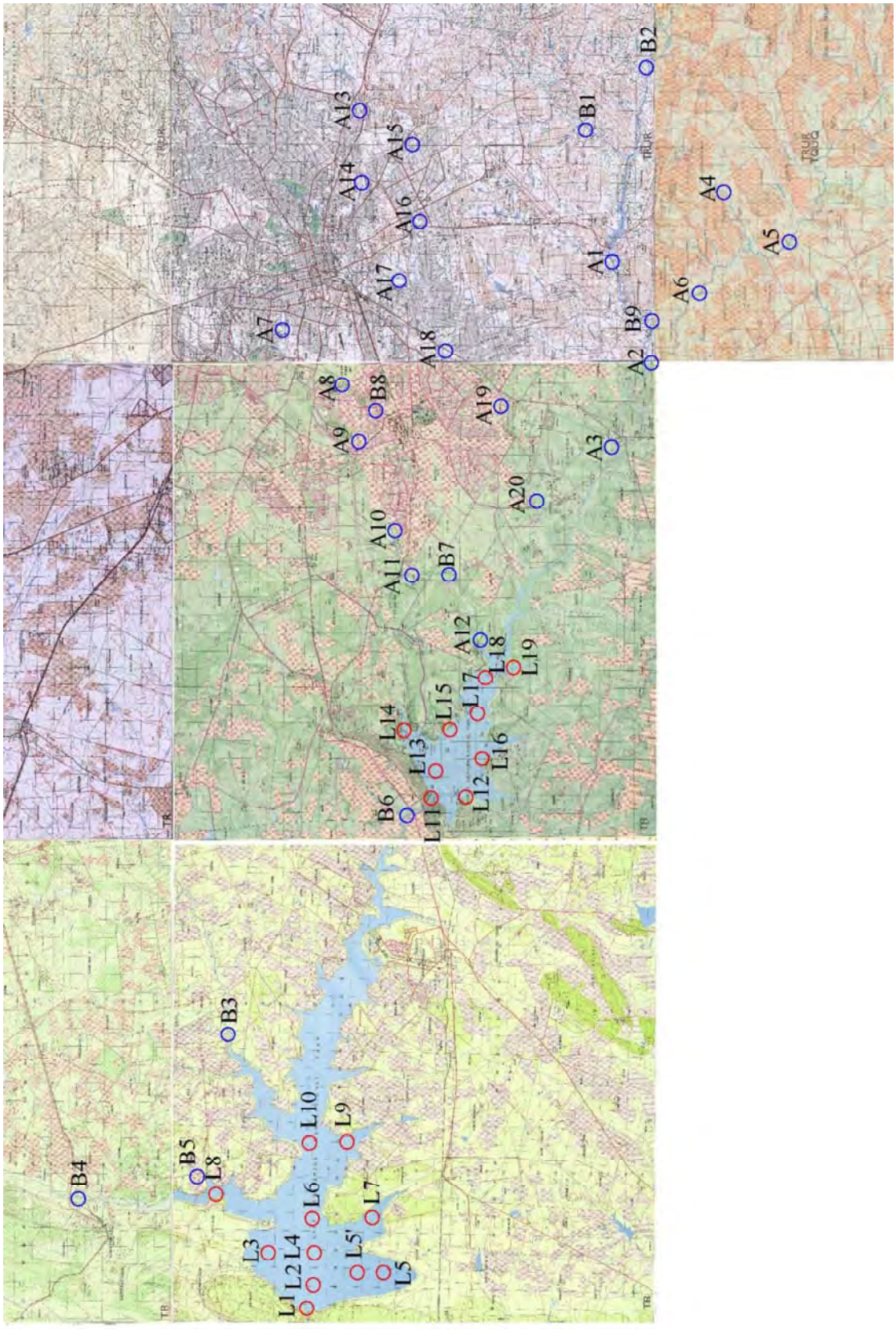

Figure 2.1 Sampling Area and Points

Table 2.1 Date of Sampling

Sample Items		Sampling Date	
Flow Water	Previous JICA Study	17th Aug. 2012	21th Jan. 2013
	ZINWA Points	18th Aug. 2012	22th Jan. 2013
Lake Water		29-31th Aug 2012	
STP Raw Water		27th Sep. 2012	
Well Water		13th Sep. 2012	

Table 2.2 shows coordination of sampling points, which were previous sampling points of JICA Study, which is numbered from A1 toA20.
Points of ZINWA sampling, which were numbered from B1 to B9, were not shown because these were specified by ZINWA.

Table 2.2 Coordination of- Sampling Points

Sampled Point		**Coordination**		**Elevation (m)**
Mark	**Place**	**E**	**N**	
	Seke Area			
A1	Below Harava Dam	0294412	8011102	1412
A2	Zengeza Stream	0294347	8006062	1415
A3	Nyastime River (Above ZSW)	0294199	8003754	1390
A4	Nyastime River (Below ZSW)	0293313	8005200	1388
A5	St Mary's Stream	0291336	8008881	1407
A6	New Bridge	0290637	8009576	
A7	Skyline	0284187	8010711	1386
	Mukuvisi River			
A8	Amalinda Rd (Bridge)	0284640	8017172	1403
A9	Beatrice Rd (Bridge)	0288899	8020901	1426
A10	Borshoff Rd (Bridge)	0292555	8022645	1451
A11	Seke Rd (Near ABC)	0293312	8026213	1453
A12	Chiremba (OK Mart)	0295411	8026847	1478
A13	Mutare Rd	0302920	8025629	1526
A14	Little Kariba	0302249	8025514	1523
A15	Msasa Rail Bridge	0301322	8025569	1517
	Marimba River			
A16	Bulawayo Rd	0288085	8027811	1444
A17	Westwood	0286510	8025719	1441
A18	Kambuzuma	0283321	8025067	1422
A19	Upstream of Crowborough Works	0278806	8023262	1404
A20	Downstream of Crowborough Works	0277388	8023230	1394

Table 2.3 shows coordination of sampling points of Manyame and Chivero Lake.

Table 2.3 Sampling Points of Lakes

Manyame Lake			Chivero Lake		
Point	Coordination		Point	Coordination	
	E	N		E	N
L1	Outflow Gate		L11	Intake Tower	
L2	235 960,84	8027 990,86	L12	264 004,00	8020 012,00
L3	238 991,68	8031 006,54	L13	264 959,76	8021 004,30
L4	238 980,77	8027 979,12	L14	267 044,28	8022 872,94
L5	237 490,17	8023 485,25	L15	268 024,32	8020 018,08
L7	240 500,79	8025 008,82	L16	265 991,37	8018 950,04
L6	240 466,82	8027 991,04	L17	268 963,07	8019 048,98
L8	242 010,47	8033 985,79	L18	271 018,83	8017 998,97
L9	244 989,92	8026 491,58	L19	271 023,30	8017 002,70
L10	244 963,44	8028 018,07			

2.2 Photographs

Below are some photographic evidence for some of the rivers and lakes where samples were taken.

Harava 2 Inlet

Darwendale Manyame River

C1

3 Sampling Methodology

3.1 Sampling Equipment

The following sampling equipment was used for sampling purposes;

(i) Water

- Water depth sampler,
- Sterilized bottles,
- Ice, and
- Protective clothing, hand gloves, and work suite.

(ii) Waste Water

- Two litre plastic bottles,
- Cooler box,
- Ice, and
- Protective clothing, hand gloves, mask, and work suite.

(iii) Sample bottles

Sterile sample bottles collected from the testing laboratory were used for microbiological samples and clean plastic or bottles were used for chemical and physical samples. The samples were kept in a cooler box with ice before they were delivered to the laboratory within 24 hours.

(iv) Sample labels

Labels printed on special water-resistant paper were used with each sample bottle having a clearly identifiable label with a sample point description including date and time of sampling.

3.2 Collection of Water Samples

At the sampling point the cap of sample bottle was removed but without contaminating inner surface of cap and neck of sample bottle with hands. Samples were collected by dipping water depth sampler into the river or lake and fill sample bottle without rinsing and replacing cap immediately. Before closing the sample bottle it was ensured to leave ample air space in the bottle (at least 2.5 cm) to facilitate mixing by shaking before examination.

Photographs Showing Sampling Equipment- Location Marimba Stagnant

3.2.1 Water

Sampling points were determined, covering streams, rivers and lakes as highlighted on the map in Appendix B and C in line with the TOR. At these chosen points, 1 sample was taken from streams; 2 samples from rivers and 3 samples from lakes at varying depths to accommodate depth variations in the water quality. Difficult points in lakes were accessed by boat with the navigation aid of surveyors.

3.2.2 Waste Water

Sampling was carried out at Zengeza Sewage Treatment Works. Samples were collected three times a day. At 9 am, 1pm and 6pm. Two litre sterilised plastic bottles were filled up with raw sewage and then stored in a cooler box filled with ice. Each bottle was labelled with the date and time of when it was taken and then the samples were immediately taken to the laboratory soon after sampling. Sampling was conducted on the following days; Sundays, Wednesdays, and Fridays, to come up with representative results.

4 Analysis of Results

The Laboratory "Agrianalysis Centre Pvt Ltd; AgLabs" was used to analyze the samples;

4.1 Flow water Analysis

(1) Dry season
The analysis results of sampling points for flow water, A1-A20 and B1-B9 in dry season is shown in Table 4.1, of which samplings were carried out 17th and 18th August 2012.
From the result, it was clear that river water were heavily contaminated. The parameters are outside the acceptable levels of standards accepted by Environmental Management (Effluent and So lid Waste Disposal) Regulations, 2007.

- Microbiological indicators

  Coliform
  The values of coliform count in most of the rivers and streams is above 1600number /100ml.

  Escherichia coli (E. coli)
  E-coli is present in some of the rivers and stream indicating contamination from sewage spillages.

- Physical Indicators

  Total Suspended Solids (TSS)
  The values for TSS in Table 4.1 range from 3.5mg/l at Darwandale Manyame River to 532mg/l for Marimba stagnant.

  Turbidity
  The values for Turbidity in Table 4.1 range from 2.5NTS to 87NTS for Lower Nyatsime.

  Conductivity
  The values for Conductivity in Table 4.1 range from 143 for Gwebi River to 1278 for Marimba stagnant

- Chemical Indicators

  Dissolved Oxygen (DO)
  The values for Dissolved Oxygen in Table 4.1 range a low of 0.2 for Marimba stagnant to 6.8 for Seke below Hre.

  BOD
  Most pristine rivers will have a 5-day carbonaceous BOD below 1 mg/L. moderately polluted rivers may have a BOD value in the range of 2 to 8 mg/L. (Wikipedia). The value of BOD from Table 4.1 range from 1.5mg/l for Gwebi River to 460mg/l for Marimba Stagnat. The graph below show the BOD value of the rivers. Indicating the riv ers around Ha rare and Chitungwiza are heavily polluted.

  COD
  The value of COD from Table 4.1 range from 5.3mg/l for Gwebi river to 3360mg/l for Marimba Stagnant. The graph below show the COD value of the rivers.

PH
The normal pH value in rivers is 6.5 to 8.5. The pH value from Table 4.1 range from 5.92 for MJ Bridge to 7.7 for Beatrice Bridge. The most rivers and streams pH value are within acceptable values.

Total Hardness
The United States Geological Survey Classify hardness as shown below:

Classification	**hardness in mg/L**
Soft	0–60
Moderately hard	61–120
Hard	121–180
Very hard	≥ 181

From the results Table 4.1 most of the rivers sampled have hard to very hard water.

(2) Wet Season
The analysis in wet season was carried out to the samples taken 21st and 22nd January 2013 and the results were shown in Table 4.2.
Though the quality was slightly improved by dilution by rain water, the contamination was serious. The parameters are outside the acceptable levels of standards accepted by Environmental Management (Effluent and Solid Waste Disposal) Regulations, 2007.

- Microbiological indicators

  Coliform
  The values of coliform count in most of the rivers and streams are between 100number /100ml and 1000number/100ml.

  Escherichia coli (E. coli)
  E-coli is present in some of the rivers and stream indicate contamination from sewage spillages.

- Physical Indicators

  Total Suspended Solids (TSS)
  The values for TSS in Table 4.5 range from 2.1mg/l at Before Lake Mukubishi to 210mg/l for Marimba stagnant.

  Turbidity
  The values for Turbidity in Table 4.5 range from 2.2NTS to 56.2NTS for Lower Nyatsime.

  Conductivity
  The values for Conductivity in Table 4.5 range from 132 for Gwebi River to 1211 for Marimba stagnant

- Chemical Indicators

Dissolved Oxygen (DO)
The values for Dissolved Oxygen in Table 4.5 range a low of 3.8 for Marimba flowing to 6.8 for Seke below Hre.

BOD
Most pristine rivers will have a 5-day carbonaceous BOD below 1 mg/L. moderately polluted rivers may have a BOD value in the range of 2 to 8 mg/L. (Wikipedia). The value of BOD from Table 4.5 range from 1mg/l for Amalinda Bridge to 250mg/l for Marimba Stagnat. The graph below show the BOD value of the rivers. Indicating the rivers around Harare and Chitungwiza are heavily polluted.

COD
The value of COD from Table 4.5 range from 6.5mg/l for Darwandale Manyame River to 850mg/l for Marimba Stagnat.

PH
The pH value in rivers is 6.5 to 8.5. The pH value from Table 4.5 range from 6.89 at several sampling points to 7.35 for Seke below Hre.

4.2 Lake Water Analysis

The sampling of lake water was carried out simultaneously with the water depth survey of Manyame and Chivero Lake. Basically water was taken from 1m depth but deep points of water were taken at some points, the results were shown in Table 4.2.
The results showed that both lakes' contamination was very serious but that of Manyame Lake seemed more serious than Chivero. The parameters are outside the acceptable levels of standards accepted by Environmental Management (Effluent and Solid Waste Disposal) Regulations, 2007.

4.3 Raw Water Quality of Zengeza Sewage Treatment Plant (STP)

To confirm the raw sewage quality of Zengeza STP, samples were carried out three time a day on Sunday, Wednesday and Friday. The results were shown in Table 4.4. The qualities were typical in Zimbabwe STP's raw water.

4.4 Well Water Quality

Well water for two boreholes and four shallow wells were analyzed. Water quality of shallow wells were did not meet the World Health Organisation (WHO) standard, especially to with regards to Total bacteria and coliform. However all the samples tested negative for E-coli. The boreholes were better than shallow wells but the quality does not meet with the WHO standard.

Table 4.1 Flow Water Quality in Dry Season

Mark	Nayalysis Item/Sample point	pH	Dessolved Oxigen (mg/l)	Conductivity (cond.mrg/l)	Total Alkalinity (mg/l)	Chloride (mg/l)	Colour Hazen (mg/l)	Turbidity (NTS)	Total Hardness (mg/1)	Iron (mg/l)	Manganese (mg/l)	Suspended Solid (mg/l)	BOD (mg/l)	COD (mg/l)	Total Nitrogen (mg/l)	Kj Nitrogen (mg/l)	Nitrate (mg/l)	Nitrite (mg/1)	Fluoride (mg/l)	Total Phosphate (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)	E-coli(--)
A1	Seke Below Hre	7.49	6.5	255	120	35	10	10.0	94	0.87	0.16	25	56.1	125	12.5		2.1		0.01	0.21	60	>1600	Negative
A2	New Bridge	7.36	6.2	322	128	89	10	18.0	82	2.46	0.54	52	45	95	13.5		1.2		0.08	0.12	100	>1600	Negative
A3	Skyline	7.55	6.2	422	242	78	5	3.7	76	<0.01	0.04	12	65	86	23.1		1.3		<0.01	0.15	200	>1600	Positive
A4	Zengeza Stream	7.58	4.5	555	206	63	10	23.0	132	1.74	0.26	35	32	102	25.1		0.9		<0.01	0.23	1000	>1600	Negative
A5	Loewr Nyatsime	7.68	4.6	652	460	72	20	87.0	102	1.93	0.12	94	55	112	12.8		0.6		0.02	0.33	1000	>1600	Positive
A6	Upper Nyatsime	7.7	5.5	568	68	68	10	20.0	58	1.45	0.01	35	45	109	15.2		1.5		0.01	0.42	500	>1600	Negative
A7	Byo Road	6.94	3.5	653	200	69	5	7.8		0.3	0.07	15	56	108	14.2		1.2		0.04	0.25	300	>1600	Negative
A8	Westwood	6.89	5.4	755	98	53	5	6.9		0.29	0.08	12	65	102	9.8		1.2		0.01	0.15	200	2	Negative
A9	Kambuzuma	6.88	4.8	598	98	78	5	33		0.81	0.12	22	75	121	20.1		2.5		0.03	0.19	500	>1600	Positive
A10	Upper Crowborough	7.09	5.5	632	134	69	5	3.4		0.11	0.08	58	45	89	12.5		1.2		0.01	0.25	1000	>1600	Negative
A11	Lower Crowborough	6.64	3.2	655	198	88	15	3.3		0.18	0.2	192	53	95	13		1.5		0.02	0.12	1000	>1600	Negative
A12	Marimba stagnant	6.77	0.2	1278	422	104	50	30		2.55	0.59	532	460	3360	75.1		10.5		7.72	2.19	1000	>1600	Posetive
A13	Mutare Rd	7.41	6.5	552	94	75	10	25.0	126	0.61	0.44	32	89	230	20.1		1.2		0.02	0.12	120	>1600	Positive
A14	Msasa RB	7.36	6.8	523	55	56	5	2.2	214	<0.01	0.61	8.2	52	135	12.5		2.5		0.01	0.23	60	23	Positive
A15	OK Mart	5.25	4.8	498	65	78	15	29.0	284	2.35	1.74	42	65	145	18.2		3.2		0.1	0.25	40	6	Positive
A16	Gienara Mbare	7.34	5.6	436	80	89	5	3.5	168	<0.01	0.03	7.5	14	35	5.2		1.2		0.02	0.32	1000	>1600	Negative
A17	Bochoff	7.52	5.7	553	100	66	5	3.7	194	0.17	0.08	9.2	13	42	7.8		0.8		0.02	0.12	1000	>1600	Positive
A18	Beatrice Bridge	7.77	6.7	566	114	56	5	2.5	168	<0.01	0.03	5.2	14	35	6.5		0.9		0.04	0.32	500	>1600	Negative
A19	Amalinda Bridge	7.6	6.2	621	93	85	5	2.9	172	<0.01	<0.01	6.2	23	45	4.5		1.2		0.01	0.38	200	>1600	Negative
A20	Before Lake Mukubishi	7.65	6.3	523	125	75	10	3.5	182	0.02	0.02	7.2	19	32	3.5		0.2		0.02	0.29	250	>1600	Positive
B2	Harava 11	7.14	6.5	165	40	37	10	5.2		0.43	<0.01	4.2	3.2	12.2	6.5		0.2	<0.01	0.09	0.22	150	240	Posetive
B3	Gwebi R	7.16	6.2	143	232	45	10	3		0.26	0.03	3.5	1.5	5.3	4.5		1.2	<0.01	0.89	0.32	100	34	Posetive
B4	Darwendale manyame R	7.55	5.2	250	152	88	10	18		0.01	0.03	3.5	3.2	15.5	8.3		2.3	<0.01	0.46	0.55	20	28	negative
B5	C1	6.62	3.5	663	246	78	40	20		0.23	0.04	55	12.92	484	65.5	38.7	2.5	<0.01	0.19	1.59	1000	>1600	Posetive
B6	MJ bridge	5.92	4.2	516	64	76	50	2.5		0.25	0.03	20	35	80	58.2	40.9	5.2	<0.01	0.79	0.72	1000	1>1600	Posetive
B7	Marimba flowing	7.10	4.5	858	820	102	40	9		0.46	0.02	6	55	120	55.4	42.1	3.5	<0.01	0.82	1.68	1000	>1600	Posetive
B8	Little Kariba	7.38	5.2	450	366	55	20	34.0		0.5	0.68	20	62	102	42	35.2	2	<0.01	0.08	0.05	500	>1600	Negative
B9	St.Marys	7.23	5.6	456	312	28	25	23		0.2	0.02	12.1	43	105	32	15.5	3.5	<0.01	0.02	0.12	700	120	Negative

Table 4.2 Lake Warter Qaulity

Mark	Nayalysis Item/Sample point	pH	Dessolved Oxigen(mg/l)	Conductivity (cond.mrg/l)	Total Alkalinity (mg/l)	Total Hardness	Chloride (mg/l)	Colour Hazen(mg/l)	Turbidity (NTS)	Iron(mg/l)	Manganese (mg/l)	Suspended Solid (mg/l)	COD(mg/l)	Total Nitrogen (mg/l)	Ammonia (mg/l)	Nitrate(mg/l)	Fluoride (mg/l)	Total Phosphate (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)	E-coli(--)
L1(12m)	Manyame L	8.82	4.1		132	114		20	17	0.44	<0.01	20	21			0.12	<0.01		500	Nil	Negative
L2(1m)	Manyame L	8.99	6.4	250	148	120	125	20	22	0.34	<0.01	4	18	0.64	0.11	0.12	<0.01	0.042	500	Nil	Negative
L3(2m)	Manyame L	7.96	5.7	189	148	126	102	20	18	0.49	<0.01	48	25			0.25	0.01		80	9	Positive
L4(1m)	Manyame L	8.42	6.5	222	132	122	89	20	16	0.52	<0.01	4	17	0.75	0.10	0.23	0.02	0.055	80	Nil	Negative
L5(1m)	Manyame L	8.62	7.5	210	146	120	95	20	25	0.92	0.02	4.4	15	0.65	0.15	0.18	0.01	0.051	500	Nil	Negative
L5(2m)	Manyame L	7.78	6.5	231	144	144	102	10	14	0.32	<0.01	156	28			0.15	<0.01		120	47	Positive
L5'(7m)	Manyame L	7.76	6.5		122	136	113	10	15	0.4	<0.01	578	25			0.11	0.04		60	22	Negative
L6(2m)	Manyame L	8.53	7.2	213	146	132	89	10	16	0.31	<0.01	<0.01	16	0.67	0.12	0.15	0.01	0.058	60	180	Negative
L6(5m)	Manyame L	9.02	5.1		120	120		20	24	0.32	<0.01	54	17			0.43	<0.01		500	Nil	Negative
L7(2m)	Manyame L	7.73	6.5	223	164	142	99	10	19	0.38	<0.01	212	16	0.87	0.16	0.23	0.02	0.061	300	22	Negative
L8(2m)	Manyame L	8.49	6.5	224	158	140	102	10	15	0.49	<0.01	<0.01	15			0.12	0.1		60	13	Negative
L9(1m)	Manyame L	8.08	7.5	222	138	140	112	10	15	0.44	0.08	216	25	0.88	0.15	0.09	<0.01	0.078	150	14	Negative
L9(8m)	Manyame L	8.52	4.5		142	132		10	15	0.3	<0.01	38	23			0.08	<0.01		80	70	Negative
L10(2m)	Manyame L	8.16	6.7	213	142	122	113	10	15	0.31	<0.01	10	15			0.13	<0.01		40	210	Negative
L11(1m)	Chivero L	6.72	5.5	182	120	102	102	5	5	<0.01	<0.01	<0.01	13	0.55	0.25	0.11	0.08	0.25	1000	>1600	Positive
L12(1m)	Chivero L	6.77	5.2	198	112	104	98	5	4.5	<0.01	0.03	<0.01	12	0.33	0.15	0.15	0.08	0.32	300	6	Positive
L13(1m)	Chivero L	6.84	5.3	234	120	106	102	5	7	<0.01	0.01	<0.01	15	0.35	0.13	0.11	0.08	0.31	200	4	Positive
L14(1m)	Chivero L	6.82	5.1	189	104	108	105	10	15	0.3	0.26	146	18	0.42	0.15	0.13	0.08	0.28	150	10	Positive
L15(1m)	Chivero L	6.64	5.8	156	118	116	113	5	5	0.01	0.05	<0.01	12	0.55	0.17	0.14	0.08	0.29	120	5	Negative
L16 (4m)	Chivero L	6.92	5.2	132	106	100	135	5	6.3	<0.01	0.04	<0.01	11			0.09	<0.01		150	6	Positive
L16 (8m)	Chivero L	7.59	4.5		114	116		5	8.5	<0.01	0.02	<0.01	15			0.08	<0.01		60	4	Positive
L17 (4m)	Chivero L	7.07	4.2		120	104		5	4	<0.01	0.02	<0.01	16			0.13	<0.01		200	7	Positive
L18(8m)	Chivero L	7.32	3.5		114	104		5	3.8	<0.01	0.02	<0.01	12			0.09	<0.01		300	>1600	Positive
L19(1m)	Chivero L	7.55	5.8	123	112	108		5	4.5	<0.01	0.02	<0.01	11	0.35	0.12	0.12	<0.01	0.25	300	>1600	Positive
L19(5m)	Chivero L	7.34	4.5		120	116		30	70	3.14	0.78	462	18			0.11	0.03		1000	>1600	Positive

Table 4.3 Raw Water Quality of Zenegaza STP

Mark		Analysis item/sample point	ph	Dissolved oxygen (mg/l)	Conductivi (cond.mrg/	Toatal alkalinity (mg/l)	Colour Hazen (mg/l)	Turbidity (NTS)	Chloride (mg/l)	Suspended Solid(mg/l)	BOD (mg/l)	COD (mg/l)	Total Nitrogen (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	Total Phosphate (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)	E-coli(-)
Sunday	9:00	Zengeza in	6.62	0.6	1.33	396	40	410	142	855	750	1.854	59.9	12.5	2.5	1.61	1,000	>1600	Positive
	13:00	Zengeza in	6.56	0.2	1.449	376	60	460	158	795	355	327	62.8	8.2	1.2	0.3	1,000	>1600	Positive
	18:00	Zengeza in	6.56	0.5	1.519	310	40	420	170	655	832	2.082	50.8	7.2	2.3	1.39	1,000	>1600	Positive
Wednesday	9:00	Zengeza in	7.39	0.3	1.455	322	40	400	290	980	755	2.707	49.7	2.5	1.5	0.84	1,000	>1600	Positive
	13:00	Zengeza in	6.69	0.2	1.635	320	40	440	184	850	655	3.475	53.4	10.5	3.2	1.38	1,000	>1600	Positive
	18:00	Zengeza in	7.61	0.15	1.362	406	40	310	158	980	740	1.083	48.1	9.8	1.2	1.67	1,000	>1600	Positive
Friday	9:00	Zengeza in	6.93	0.3	1.066	220	60	370	114	532	560	1.294	39.1	7.5	0.8	1.86	1,000	>1600	Positive
	13:00	Zengeza in	7.6	0.2	1.122	264	60	330	114	655	650	1.554	68.7	3.6	2.3	1.09	1,000	>1600	Positive
	18:00	Zengeza in	7.2	0.3	1.355	350	60	380	156	970	750	1.598	75.3	5.6	0.5	2.55	1,000	>1600	Positive

Table 4.2 Well Water Quality

Mark	Analysis Item/Sample point	pH	Total Alkalinity (mg/l)	Colour Hazen(mg/l)	Turbidity (NTS)	Iron(mg/l)	Manganese (mg/l)	Suspended Solid(mg/l)	Fluoride (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)	E-coli(--)	Note
---	WHO	6.5 - 8.9	Not Given	15	5	0.3	0.1	100	15	<100	Nil/100	Negative/100ml	Shallow well
W1	Unit L Ext	6.43	52	5	2.7	<0.01	<0.01	<0.01	0.08	200	17	Negative	Shallow well
W2	Manyame Park	6.15	164	5	2.4	<0.01	<0.01	<0.01	0.09	200	7	Negative	Shallow well
W3	Zanoremba Shallow	6.24	102	5	2	<0.01	0.07	<0.01	0.08	500	26	Negative	Shallow well
W4	B Unit H	5.87	82	5	2.5	0.07	<0.01	<0.01	0.07	27	2	Negative	Borehole
W5	Zanoremba B/Hole	6.45	100	5	2.2	<0.01	<0.01	<0.01	0.1	1	2	Negative	Borehole
W6	14051C	5.51	56	5	2	<0.01	<0.01	<0.01	0.1	33	7	Negative	Shallow well

Table 4.5 Flow Water Quality in Wet Season

Mark	Nayalysis Item/Sample point	pH	Dessolved Oxigen (mg/l)	Conductivity (cond.mrg/l)	Total Alkalinity (mg/l)	Chloride (mg/l)	Colour Hazen (mg/l)	Turbidity (NTS)	Suspended Solid (mg/l)	BOD (mg/l)	COD (mg/l)	Total Nitrogen (mg/l)	Kj Nitrogen (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	Total Phosphate (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)
A1	Seke Below Hre	7.35	6.8	223	105	32	5	7.5	12	23	45	11.2		2.1	0.02	0.13	40	1000
A2	New Bridge	7.23	5.5	322	102	56	10	8.9	25	21	52	10.5		1.2	0.02	0.11	50	800
A3	Skyline	7.25	6.5	687	189	85	5	5.5	12	15	88	13.2		0.8	0.01	0.08	150	>1600
A4	Zengeza Stream	7.15	5.2	552	108	86	10	21.5	23	42	96	13.5		0.6	0.03	0.12	250	800
A5	Loewr Nyatsime	6.89	5.2	1211	125	32	10	56.2	56	52	93	14.2		0.5	0.02	0.13	600	>1600
A6	Upper Nyatsime	7.23	4.8	918	65	100	15	12.5	23	42	73	13.8		0.9	0.01	0.11	600	600
A7	Byo Road	7.41	6.2	520	125	61	5	5.6	12	13	33	8.9		0.9	<0.01	0.21	600	>1600
A8	Westwood	7.25	5.4	454	95	74	5	6.5	11.3	32	63	10.2		1.2	<0.01	0.13	300	800
A9	Kambuzuma	7.11	4.5	444	99	78	5	5.6	10.2	52	90	12		1.3	<0.01	0.15	200	>1600
A10	Upper Crowborough	6.95	5.8	522	120	96	5	7.8	14.5	69	125	15.5		4.1	<0.01	0.09	200	>1600
A11	Lower Crowborough	6.98	5.3	450	112	99	10	4.5	12	45	88	10.2		1.2	0.03	0.21	500	800
A12	Marimba stagnant	7.22	4.5	390	320	102	30	25	210	250	850	88.1		5.2	0.03	1.2	1000	700
A13	Mutare Rd	7.31	6.5	366	82	72	10	15	28	4.4	87.4	15.2		1.3	<0.01	0.55	600	600
A14	Msasa RB	7.11	6.5	405	53	76	5	3	26	7.1	55.6	10.2		1.6	<0.01	0.56	400	200
A15	OK Mart	7.13	5.8	610	62	52	10	25	15	49.2	120	13.2		0.6	<0.01	0.32	300	300
A16	Gienara Mbare	7.55	6.2	552	85	75	5	3.2	13	35.2	76.2	5.5		0.8	0.01	0.12	500	500
A17	Bochoff	7.23	5.4	473	120	78	5	2.2	5.4	3.8	65.3	3.4		0.5	<0.01	0.85	400	1000
A18	Beatrice Bridge	6.99	5.5	511	110	82	5	2.5	6.5	2.4	61.1	3.7		0.6	0.02	0.26	200	800
A19	Amalinda Bridge	7.22	6.2	475	53	76	5	3.2	4.3	1	103	2.8		0.4	0.01	0.12	200	600
A20	Before Lake Mukubishi	7.12	5.2	422	88	65	10	3.2	2.1	16	45	2.9		0.5	0.03	0.22	250	1200
B1	Harava 1	7.05	5.3	103	52	32	5	8.2	10.2	3.2	9.8	4.5	2.8	1.2	<0.01	0.15	200	80
B2	Harava 11	7.16	6.8	125	42	28	5	6.2	6.5	2.8	8.9	5.6	3.2	0.2	<0.01	0.22	100	90
B3	Gwebi R	7.13	6.3	132	189	35	5	3.5	3.2	2.1	5.2	3.8	2.8	1.2	<0.01	0.32	50	35
B4	Darwendale manyame R	7.45	5.5	320	123	72	5	12.2	4.2	3.2	6.5	7.3	3.5	2.3	<0.01	0.55	40	80
B5	C1	6.89	4.5	452	211	71	30	18.2	42	12.8	4.8	32.1	24.5	2.5	<0.01	1.59	800	600
B6	MJ bridge	7.01	5.2	358	98	69	30	2.8	19	21.5	53	38.1	32.1	5.2	<0.01	0.72	600	500
B7	Marimba flowing	6.89	3.8	288	689	89	30	9.5	5.5	45.2	52	45.1	35.3	3.5	<0.01	1.68	800	>1600
B8	Little Kariba	6.99	5.8	299	312	111	10	25.5	18.9	32.1	45	22.6	21.5	2.2	<0.01	1.25	500	500
B9	St Marys	7.01	5.7	324	230	131	10	24.2	25.5	35.5	35	35.2	26.1	1.5	<0.01	1.33	400	400

5. Appendices

5.1 Water analysis results for points A1-A20 sampled 17th August 2012

5.2 Water analysis results for points B1-B9 sampled 18th August 2012

5.3 Water analysis results for lake water sampled 29th -31st August 2012

5.4 Water Analysis results for raw water of Zengeza STP sampled 27th September 2012

5.5 Water analysis results for well water sampled 3rd September 2012

5.6 Water analysis results for points A1-A20 sampled 21th January 2013

5.7 Water analysis results for points B1-B9 sampled 22th January 2013

5.8 Environmental Management (Effluent and Solid Waste Disposal) Regulations, 2007.

5.1 Water analysis results for points A1-A20 sampled 17th August 2012

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TEST CERTIFICATE

For River Water previous JICA Study

Client: BCHOD
Address:5th Dloor Gold Bridge Harare

Report No.306
Date Sampled: 17/Aug/2012
Date in: 17/Aug/2012
Date out: 27/Aug/2012
Tested By: Paruwanel & Makoma

Mark	Nayalysis Item/Sample point	pH	Dessolved Oxigen (mg/l)	Conductivity (cond.mrg/l)	Total Alkalinity (mg/l)	Chloride (mg/l)	Colour Hazen (mg/l)	Turbidity (NTS)	Total Hardness (mg/1)	Iron (mg/l)	Manganese (mg/l)	Suspended Solid (mg/l)	BOD (mg/l)	COD (mg/l)	Total Nitrogen (mg/l)	Kj Nitrogen (mg/l)	Nitrate (mg/l)	Nitrite (mg/1)	Fluoride (mg/l)	Total Phosphate (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)	E-coli(--)
A1	Seke Below Hre	7.49	6.5	255	120	35	10	10.0	94	0.87	0.16	25	56.1	125	12.5		2.1		0.01	0.21	60	>1600	Negative
A2	New Bridge	7.36	6.2	322	128	89	10	18.0	82	2.46	0.54	52	45	95	13.5		1.2		0.08	0.12	100	>1600	Negative
A3	Skyline	7.55	6.2	422	242	78	5	3.7	76	<0.01	0.04	12	65	86	23.1		1.3		<0.01	0.15	200	>1600	Positive
A4	Zengeza Stream	7.58	4.5	555	206	63	10	23.0	132	1.74	0.26	35	32	102	25.1		0.9		<0.01	0.23	1000	>1600	Negative
A5	Loewr Nyatsime	7.68	4.6	652	460	72	20	87.0	102	1.93	0.12	94	55	112	12.8		0.6		0.02	0.33	1000	>1600	Positive
A6	Upper Nyatsime	7.7	5.5	568	68	68	10	20.0	58	1.45	0.01	35	45	109	15.2		1.5		0.01	0.42	500	>1600	Negative
A7	Byo Road	6.94	3.5	653	200	69	5	7.8		0.3	0.07	15	56	108	14.2		1.2		0.04	0.25	300	>1600	Negative
A8	Westwood	6.89	5.4	755	98	53	5	6.9		0.29	0.08	12	65	102	9.8		1.2		0.01	0.15	200	2	Negative
A9	Kambuzuma	6.88	4.8	598	98	78	5	33		0.81	0.12	22	75	121	20.1		2.5		0.03	0.19	500	>1600	Positive
A10	Upper Crowborough	7.09	5.5	632	134	69	5	3.4		0.11	0.08	58	45	89	12.5		1.2		0.01	0.25	1000	>1600	Negative
A11	Lower Crowborough	6.64	3.2	655	198	88	15	3.3		0.18	0.2	192	53	95	13		1.5		0.02	0.12	1000	>1600	Negative
A12	Marimba stagnant	6.77	0.2	1278	422	104	50	30		2.55	0.59	532	460	3360	75.1		10.5		7.72	2.19	1000	>1600	Posetive
A13	Mutare Rd	7.41	6.5	552	94	75	10	25.0	126	0.61	0.44	32	89	230	20.1		1.2		0.02	0.12	120	>1600	Positive
A14	Msasa RB	7.36	6.8	523	55	56	5	2.2	214	<0.01	0.61	8.2	52	135	12.5		2.5		0.01	0.23	60	23	Positive
A15	OK Mart	5.25	4.8	498	65	78	15	29.0	284	2.35	1.74	42	65	145	18.2		3.2		0.1	0.25	40	6	Positive
A16	Gienara Mbare	7.34	5.6	436	80	89	5	3.5	168	<0.01	0.03	7.5	14	35	5.2		1.2		0.02	0.32	1000	>1600	Negative
A17	Bochoff	7.52	5.7	553	100	66	5	3.7	194	0.17	0.08	9.2	13	42	7.8		0.8		0.02	0.12	1000	>1600	Positive
A18	Beatrice Bridge	7.77	6.7	566	114	56	5	2.5	168	<0.01	0.03	5.2	14	35	6.5		0.9		0.04	0.32	500	>1600	Negative
A19	[illegible]	7.6	6.2	621	93	85	5	2.9	172	<0.01	<0.01	6.2	23	45	4.5		1.2		0.01	0.38	200	>1600	Negative
A20	Before Lake Mukubishi	7.65	6.3	523	125	75	10	3.5	182	0.02	0.02	7.2	19	32	3.5		0.2		0.02	0.29	250	>1600	Positive
	Test method		CTMO13	CTM010	CTM012	CTM077	CTM007	CTM031	CTM022	CTM027	CTM019	CTM028	CTM076	CTM003	CTM006	CTM021	CTM023	CTM022	CTM025	CTM039	CTM028	MTM013	MTM015	MIM016

Checked by C.Zaranyika

Authorised by N.Karonga

5.2 Water analysis results for points B1-B9 sampled 18th August 2012

Aglabs

TEST CERTIFICATE

For River Water ZINWA sampling points

Colcom Complex
1 Country Road Workington
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Client: BCHOD
Address:5th Dloor Gold Bridge Harare

Report No.307
Date Sampled: 18th/Aug/2012
Date in: 18th/Aug/2012
Date out: 27th/Aug/2012
Tested By: Paruwanel & Makoma

Mark	Nayalysis Item/Sample point	pH	Dessolved Oxigen (mg/l)	Conductivity (cond.mrg/l)	Total Alkalinity (mg/l)	Chloride (mg/l)	Colour Hazen (mg/l)	Turbidity (NTS)	Total Hardness (mg/1)	Iron (mg/l)	Manganese (mg/l)	Suspended Solid (mg/l)	BOD (mg/l)	COD (mg/l)	Total Nitrogen (mg/l)	Kj Nitrogen (mg/l)	Nitrate (mg/l)	Nitrite (mg/1)	Fluoride (mg/l)	Total Phosphate (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)	E-coli(--)
B1	Harava 1	7.10	5.2	152	44	25	5	7.2		0.69	0.01	5.5	2.2	10.2	5.2		1.2	<0.01	0.92	0.15	300	49	Posetive
B2	Harava 11	7.14	6.5	165	40	37	10	5.2		0.43	<0.01	4.2	3.2	12.2	6.5		0.2	<0.01	0.09	0.22	150	240	Posetive
B3	Gwebi R	7.16	6.2	143	232	45	10	3		0.26	0.03	3.5	1.5	5.3	4.5		1.2	<0.01	0.89	0.32	100	34	Posetive
B4	Darwendale manyame R	7.55	5.2	250	152	88	10	18		0.01	0.03	3.5	3.2	15.5	8.3		2.3	<0.01	0.46	0.55	20	28	negative
B5	C1	6.62	3.5	663	246	78	40	20		0.23	0.04	55	12.92	484	65.5	38.7	2.5	<0.01	0.19	1.59	1000	>1600	Posetive
B6	MJ bridge	5.92	4.2	516	64	76	50	2.5		0.25	0.03	20	35	80	58.2	40.9	5.2	<0.01	0.79	0.72	1000	1>1600	Posetive
B7	Marimba flowing	7.10	4.5	858	820	102	40	9		0.46	0.02	6	55	120	55.4	42.1	3.5	<0.01	0.82	1.68	1000	>1600	Posetive
B8	Little Kariba	7.38	5.2	450	366	55	20	34.0		0.5	0.68	20	62	102	42	35.2	2	<0.01	0.08	0.05	500	>1600	Negative
B9	St.Marys	7.23	5.6	456	312	28	25	23		0.2	0.02	12.1	43	105	32	15.5	3.5	<0.01	0.02	0.12	700	120	Negative
	Test method	CTMO13	CTM010	CTM012	CTM077	CTM007	CTM031	CTM022	CTM027	CTM019	CTM028	CTM076	CTM003	CTM006	CTM021	CTM023	CTM022	CTM025	CTM039	CTM028	MTM013	MTM015	MIM016

Checked by C.Zaranyika

Authorised by N.Karonga

5.3 Water analysis results for lake water sampled 29th -31st August 2012

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TEST CERTIFICATE

For Lake water of Chivero and Manyame

Client: BCHOD
Address:5th Dloor Gold Bridge Harare

Report No.310
Date Sampled: 29-31/Aug/2012
Date in: 29-31/Aug/2012
Date out: 7/Sep/2012
Tested By: Paruwanel & Makoma

Mark	Nayalysis Item/Sample point	pH	Dessolved Oxigen(mg/l)	Conductivity (cond.mrg/l)	Total Alkalinity (mg/l)	Total Hardness	Chloride (mg/l)	Colour Hazen(mg/l)	Turbidity (NTS)	Iron(mg/l)	Manganese (mg/l)	Suspended Sclid (mg/l)	BOD(mg/l)	COD(mg/l)	Total Nitrogen (mg/l)	Ammonia (mg/l)	Nitrate(mg/l)	Fluoride (mg/l)	Total Phosphate (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)	E-coli(--)
L1(12m)	Manyame L	8.82	4.1		132	114		20	17	0.44	<0.01	20		21			0.12	<0.01		500	Nil	Negative
L2(1m)	Manyame L	8.99	6.4	250	148	120	125	20	22	0.34	<0.01	4		18	0.64	0.11	0.12	<0.01	0.042	500	Nil	Negative
L3(2m)	Manyame L	7.96	5.7	189	148	126	102	20	18	0.49	<0.01	48		25			0.25	0.01		80	9	Positive
L4(1m)	Manyame L	8.42	6.5	222	132	122	89	20	16	0.52	<0.01	4		17	0.75	0.10	0.23	0.02	0.055	80	Nil	Negative
L5(1m)	Manyame L	8.62	7.5	210	146	120	95	20	25	0.92	0.02	4.4		15	0.65	0.15	0.18	0.01	0.051	500	Nil	Negative
L5(2m)	Manyame L	7.78	6.5	231	144	144	102	10	14	0.32	<0.01	156		28			0.15	<0.01		120	47	Positive
L5'(7m)	Manyame L	7.76	6.5		122	136	113	10	15	0.4	<0.01	578		25			0.11	0.04		60	22	Negative
L6(2m)	Manyame L	8.53	7.2	213	146	132	89	10	16	0.31	<0.01	<0.01		16	0.67	0.12	0.15	0.01	0.058	60	180	Negative
L6(5m)	Manyame L	9.02	5.1		120	120		20	24	0.32	<0.01	54		17			0.43	<0.01		500	Nil	Negative
L7(2m)	Manyame L	7.73	6.5	223	164	142	99	10	19	0.38	<0.01	212		16	0.87	0.16	0.23	0.02	0.061	300	22	Negative
L8(2m)	Manyame L	8.49	6.5	224	158	140	102	10	15	0.49	<0.01	<0.01		15			0.12	0.1		60	13	Negative
L9(1m)	Manyame L	8.08	7.5	222	138	140	112	10	15	0.44	0.08	216		25	0.88	0.15	0.09	<0.01	0.078	150	14	Negative
L9(8m)	Manyame L	8.52	4.5		142	132		10	15	0.3	<0.01	38		23			0.08	<0.01		80	70	Negative
L10(2m)	Manyame L	8.16	6.7	213	142	122	113	10	15	0.31	<0.01	10		15			0.13	<0.01		40	210	Negative
L11(1m)	Chivero L	6.72	5.5	182	120	102	102	5	5	<0.01	<0.01	<0.01		13	0.55	0.25	0.11	0.08	0.25	1000	>1600	Positive
L12(1m)	Chivero L	6.77	5.2	198	112	104	98	5	4.5	<0.01	0.03	<0.01		12	0.33	0.15	0.15	0.08	0.32	300	6	Positive
L13(1m)	Chivero L	6.84	5.3	234	120	106	102	5	7	<0.01	0.01	<0.01		15	0.35	0.13	0.11	0.08	0.31	200	4	Positive
L14(1m)	Chivero L	6.82	5.1	189	104	108	105	10	15	0.3	0.26	146		18	0.42	0.15	0.13	0.08	0.28	150	10	Positive
L15(1m)	Chivero L	6.64	5.8	156	118	116	113	5	5	0.01	0.05	<0.01		12	0.55	0.17	0.14	0.08	0.29	120	5	Negative
L16 (4m)	Chivero L	6.92	5.2	132	106	100	135	5	6.3	<0.01	0.04	<0.01		11			0.09	<0.01		150	6	Positive
L16 (8m)	Chivero L	7.59	4.5		114	116		5	8.5	<0.01	0.02	<0.01		15			0.08	<0.01		60	4	Positive
L17 (4m)	Chivero L	7.07	4.2		120	104		5	4	<0.01	0.02	<0.01		16			0.13	<0.01		200	7	Positive
L18(8m)	Chivero L	7.32	3.5		114	104		5	3.8	<0.01	0.02	<0.01		12			0.09	<0.01		300	>1600	Positive
L19(1m)	Chivero L	7.55	5.8	123	112	108		5	4.5	<0.01	0.02	<0.01		11	0.35	0.12	0.12	<0.01	0.25	300	>1600	Positive
L19(5m)	Chivero L	7.34	4.5		120	116		30	70	3.14	0.78	462		18			0.11	0.03		1000	>1600	Positive
Test method		CTMO13	CTM010	CTM012	CTM077	CTM019	CTM007	CTM031	CTM022	CTM027	CTM028	CTM076	CTM003	CTM006	CTM021	CTM022	CTM023	CTM039	CTM023	MTM013	MTM015	MIM016

Checked by C.Zaranyika
Authorized by N.Karonga

5.4 Water Analysis results for raw water of Zengeza STP sampled 27th September 2012

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TEST CERTIFICATE

For Zengeza STP inflow water

Client: BCHOD
Address:5th Dloor Gold Bridge Harare

Report No.325
Date Sampled: 27th/Sep/2012
Date in: 27th/Sep/2012
Date out: 5th/Oct/2012
Tested By: Paruwanel & Makoma

Mark	Nayalysis Item/Sample point	pH	Dessolved Oxigen (mg/l)	Conductivity (cond.mrg/l)	Total Alkalinity (mg/l)	Chloride (mg/l)	Colour Hazen (mg/l)	Turbidity (NTS)	Chloride (mg/l)	Suspended Solid(mg/l)	BOD (mg/l)	COD (mg/l)	Total Nitrogen (mg/l)	Nitrate (mg/l)	Nitrite (mg/1)	Total Phosphate (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)	E-coli(--)
9:00	Zengeza in	6.62	0.6	1,330	396	142	40	410	142	855	750	1,854	59.9	12.5	2.5	1.61	1,000	>1600	Positive
10:00	Zengeza in	6.56	0.2	1,449	376	158	60	460	158	795	355	327	62.8	8.2	1.2	0.3	1,000	>1600	Positive
11:00	Zengeza in	6.56	0.5	1,519	310	170	40	420	170	655	832	2,082	50.8	7.2	2.3	1.39	1,000	>1600	Positive
12:00	Zengeza in	7.39	0.2	1,455	322	290	40	400	290	980	755	2,707	49.7	2.5	1.5	0.84	1,000	>1600	Positive
13:00	Zengeza in	6.69	0.3	1,635	320	184	40	440	184	850	655	3,475	53.4	10.5	3.2	1.38	1,000	>1600	Positive
14:00	Zengeza in	7.61	0.15	1,362	406	158	40	310	158	980	740	1,083	48.1	9.8	1.2	1.67	1,000	>1600	Positive
15:00	Zengeza in	7.27	0.2	1,366	328	150	40	430	150	799	350	766	62.9	8.7	1.1	1.73	1,000	>1600	Positive
16:00	Zengeza in	6.93	0.3	1,066	220	114	60	370	114	532	560	1,294	39.1	7.5	0.8	1.86	1,000	>1600	Positive
17:00	Zengeza in	7.6	0.2	1,122	264	114	60	330	114	655	650	1,554	68.7	3.6	2.3	1.09	1,000	>1600	Positive
18:00	Zengeza in	7.2	0.3	1,355	350	125	60	380	156	970	750	1,598	75.3	5.6	0.5	2.55	1,000	>1600	Positive
19:00	Zengeza in	7.5	0.1	1,555	320	256	60	420	162	990	721	1,689	68.8	4.2	1.2	3.22	1,000	>1600	Positive
Test method		CTMO13	CTM010	CTM012	CTM077	CTM007	CTM031	CTM022	CTM027	CTM023	CTM028	CTM076	CTM003	CTM023	CTM006	CTM028	MTM013	MTM015	MTM016

Cheched by C.Zaranyika

Authorised by N.Karonga

5.5 Water analysis results for well water sampled 3rd September 2012

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Aglabs

TEST CERTIFICATE

For Well water in Chitungwiza Municipality

Client: BCHOD
Address:5th Dloor Gold Bridge Harare

Report No.321
Date Sampled: 3/Sep/2012
Date in: 13/Sep/2012
Date out: 11/Sep/2012
Tested By: Paruwani & Makoma

Mark	Analysis Item/Sample point	pH	Total Alkalinity (mg/l)	Colour Hazen(mg/l)	Turbidity (NTS)	Iron(mg/l)	Manganese (mg/l)	Suspended Solid(mg/l)	Fluoride (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)	E-coli(--)
----	WHO	6.5 - 8.9	Not Given	15	5	0.3	0.1	100	15	<100	Nil/100	Negative/100ml
W1	Unit L Ext	6.43	52	5	2.7	<0.01	<0.01	<0.01	0.08	200	17	Negative
W2	Manyame Park	6.15	164	5	2.4	<0.01	<0.01	<0.01	0.09	200	7	Negative
W3	Zanoremba Shallow	6.24	102	5	2	<0.01	0.07	<0.01	0.08	500	26	Negative
W4	B Unit H	5.87	82	5	2.5	0.07	<0.01	<0.01	0.07	27	2	Negative
W5	Zanoremba B/Hole	6.45	100	5	2.2	<0.01	<0.01	<0.01	0.1	1	2	Negative
W6	14051C	5.51	56	5	2	<0.01	<0.01	<0.01	0.1	33	7	Negative
Test method		CTMO13	CTM077	CTM031	CTM022	CTM027	CTM028	CTM076	CTM039	MTM013	MTM015	MIM016

Cheched by C.Zaranyika

Authorised by N.Karonga

5.6 Water analysis results for points A1-A20 sampled 21th January 2013

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TEST CERTIFICATE

For River Water previous JICA Study

Client: BCHOD
Address:5th Dloor Gold Bridge Harare

Report No.341
Date Sampled: 21th/Jan/2013
Date in: 21th/Jan/2013
Date out: 1st/Feb/2013
Tested By: Paruwanel & Makoma

Mark	Nayalysis Item/Sample point	pH	Dessolved Oxigen (mg/l)	Conductivity (cond.mrg/l)	Total Alkalinity (mg/l)	Chloride (mg/l)	Colour Hazen (mg/l)	Turbidity (NTS)	Total Hardness (mg/1)	Iron (mg/l)	Manganese (mg/l)	Suspended Solid (mg/l)	BOD (mg/l)	COD (mg/l)	Total Nitrogen (mg/l)	Kj Nitrogen (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	Fluoride (mg/l)	Total Phosphate (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)
A1	Seke Below Hre	7.35	6.8	223	105	32	5	7.5				12	23	45	11.2		2.1	0.02		0.13	40	1000
A2	New Bridge	7.23	5.5	322	102	56	10	8.9				25	21	52	10.5		1.2	0.02		0.11	50	800
A3	Skyline	7.25	6.5	687	189	85	5	5.5				12	15	88	13.2		0.8	0.01		0.08	150	>1600
A4	Zengeza Stream	7.15	5.2	552	108	86	10	21.5				23	42	96	13.5		0.6	0.03		0.12	250	800
A5	Loewr Nyatsime	6.89	5.2	1211	125	32	10	56.2				56	52	93	14.2		0.5	0.02		0.13	600	>1600
A6	Upper Nyatsime	7.23	4.8	918	65	100	15	12.5				23	42	73	13.8		0.9	0.01		0.11	600	600
A7	Byo Road	7.41	6.2	520	125	61	5	5.6				12	13	33	8.9		0.9	<0.01		0.21	600	>1600
A8	Westwood	7.25	5.4	454	95	74	5	6.5				11.3	32	63	10.2		1.2	<0.01		0.13	300	800
A9	Kambuzuma	7.11	4.5	444	99	78	5	5.6				10.2	52	90	12		1.3	<0.01		0.15	200	>1600
A10	Upper Crowborough	6.95	5.8	522	120	96	5	7.8				14.5	69	125	15.5		4.1	<0.01		0.09	200	>1600
A11	Lower Crowborough	6.98	5.3	450	112	99	10	4.5				12	45	88	10.2		1.2	0.03		0.21	500	800
A12	Marimba stagnant	7.22	4.5	390	320	102	30	25				210	250	850	88.1		5.2	0.03		1.2	1000	700
A13	Mutare Rd	7.31	6.5	366	82	72	10	15				28	4.4	87.4	15.2		1.3	<0.01		0.55	600	600
A14	Msasa RB	7.11	6.5	405	53	76	5	3				26	7.1	55.6	10.2		1.6	<0.01		0.56	400	200
A15	OK Mart	7.13	5.8	610	62	52	10	25				15	49.2	120	13.2		0.6	<0.01		0.32	300	300
A16	Gienara Mbare	7.55	6.2	552	85	75	5	3.2				13	35.2	76.2	5.5		0.8	0.01		0.12	500	500
A17	Bochoff	7.23	5.4	473	120	78	5	2.2				5.4	3.8	65.3	3.4		0.5	<0.01		0.85	400	1000
A18	Beatrice Bridge	6.99	5.5	511	110	82	5	2.5				6.5	2.4	61.1	3.7		0.6	0.02		0.26	200	800
A19	Amalinda Bridge	7.22	6.2	475	53	76	5	3.2				4.3	1	103	2.8		0.4	0.01		0.12	200	600
A20	Before Lake Mukubishi	7.12	5.2	422	88	65	10	3.2				2.1	16	45	2.9		0.5	0.03		0.22	250	1200

Test method	CTMO13	CTM010	CTM012	CTM077	CTM007	CTM031	CTM022	CTM019	CTM027	CTM028	CTM076	CTM003	CTM006	CTM021	CTM022	CTM023	CTM039	CTM023	CTM028	MTM013	MTM015

Cheched by C.Zaranyika

Authorised by N.Karonga

5.7 Water analysis results for points B1-B9 sampled 22th January 2013

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TEST CERTIFICATE

For River Water ZINWA sampling points

Client: BCHOD
Address:5th Dloor Gold Bridge Harare

Report No.342
Date Sampled: 22th/Jan/2013
Date in: 22th/Jan/2013
Date out: 1st/Febg/2012
Tested By: Paruwanel & Makoma

Mark	Nayalysis Item/Sample point	pH	Dessolved Oxigen (mg/l)	Conductivity (cond.mrg/l)	Total Alkalinity (mg/l)	Chloride (mg/l)	Colour Hazen (mg/l)	Turbidity (NTS)	Total Hardness (mg/1)	Iron (mg/l)	Manganese (mg/l)	Suspended Solid (mg/l)	BOD (mg/l)	COD (mg/l)	Total Nitrogen (mg/l)	Kj Nitrogen (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	Fluoride (mg/l)	Total Phosphate (mg/l)	Total Bacteria (no/ml)	Coliform (no/100ml)	E-coli(--)
B1	Harava 1	7.05	5.3	103	52	32	5	8.2				10.2	3.2	9.8	4.5	2.8	1.2	<0.01		0.15	200	80	Posetive
B2	Harava 11	7.16	6.8	125	42	28	5	6.2				6.5	2.8	8.9	5.6	3.2	0.2	<0.01		0.22	100	90	Posetive
B3	Gwebi R	7.13	6.3	132	189	35	5	3.5				3.2	2.1	5.2	3.8	2.8	1.2	<0.01		0.32	50	35	Posetive
B4	Darwendale manyame R	7.45	5.5	320	123	72	5	12.2				4.2	3.2	6.5	7.3	3.5	2.3	<0.01		0.55	40	80	negative
B5	C1	6.89	4.5	452	211	71	30	18.2				42	12.8	4.8	32.1	24.5	2.5	<0.01		1.59	800	600	Posetive
B6	MJ bridge	7.01	5.2	358	98	69	30	2.8				19	21.5	53	38.1	32.1	5.2	<0.01		0.72	600	500	Posetive
B7	Marimba flowing	6.89	3.8	288	689	89	30	9.5				5.5	45.2	52	45.1	35.3	3.5	<0.01		1.68	800	>1600	Posetive
B8	Little Kariba	6.99	5.8	299	312	111	10	25.5				18.9	32.1	45	22.6	21.5	2.2	<0.01		1.25	500	500	Negative
B9	St Marys	7.01	5.7	324	230	131	10	24.2				25.5	35.5	35	35.2	26.1	1.5	<0.01		1.33	400	400	Negative

Test method	CTMO13	CTM010	CTM012	CTM077	CTM007	CTM031	CTM022	CTM019	CTM027	CTM028	CTM076	CTM003	CTM006	CTM021	CTM022	CTM023	CTM039	CTM023	CTM028	MTM013	MTM015	MIM016

Cheched by C.Zaranyika

Authorised by N.Karonga

Statutory Instrument 6 of 2007.

[CAP. 20:27

Environmental Management (Effluent and Solid Waste Disposal) Regulations, 2007

ARRANGEMENT OF SECTIONS

PART II

Table 1. *Classification table using effluent standards for discharge. Sensitive areas are as defined in the Fifth Schedule.* (Measurements are mg/l unless otherwise stated).

Parameter	Blue		Green	Yellow	Red	Test Methods		
	Sensitive	Normal				1	2	3
Alkalinity	*	*	*	*	*<500	SAZS 606		
Aluminium	*	*	*	*	≤5			
Ammonia (N)	≤0.5	≤0.5	≤1.0	≤1.5	<2.0	SAZS 582	SAZS 483	IC
Arsenic (As)	≤0.05	≤0.05	≤0.1	≤0.15	<0.3	SAZS 583	SAZS 492	
Barium (Ba)	≤0.1	≤0.5	≤1	≤1.5	<2	SAZS 584	AAS	
BOD	≤15	≤30	≤50	≤100	<120	SAZS 496		
Boron (B)	≤0.5	≤0.5	≤1.0	≤1.5	<2	SAZS 585		
Ca+Mg	*	*	*	*	*	SAZS 579	SAZS 485	IC
Cadmium (Cd)	≤0.01	≤0.01	≤0.05	≤0.1	≤0.3	SAZS 586	SAZS. 488	
Chloride (Cl)	≤200	≤250	≤300	≤400	≤500	SAZS. 587	IC	
Chlorine residual (free Chlorine)	Nil	≤0.1	≤0.2	≤0.3	≤0.5	SAZS 588		
Chromium (Cr (hex))	≤0.05	≤0.05	≤0.1	≤0.2	≤0.5	SAZS. 604		
Chromium, total (Cr)	≤1.0	≤1.0	≤1.2	≤1.6	≤2	SAZS 589	SAZS 494	
Cobalt (Co)	*	*	*	*	≤2	SAZS 488		
COD	≤30	≤60	≤ 90	≤150	≤200	SAZS 574	SAZS 495	
Colour (TCU)	≤15	≤15				SAZS 477		
Conductivity (µS/cm)	≤200	≤1000	≤2000	≤3000	≤3500	SAZS 643		
Copper (Cu)	≤1.0	≤1.0	≤2.0	≤3	≤5 590	SAZS 488	SAZS	

Table 1: *continued*

Parameter	Blue		Green	Yellow	Red	Test Methods		
Cyanides and related compounds (CN)	≤0.07	≤0.07	≤0.1	≤0.15	≤1	SAZS 591		
Cyanide (as free CN)	≤0.07	≤0.07	≤0.1	≤0.15	≤0.3			
Detergents***	≤0.2	≤1.0	≤2	≤3	≤5	SAZS 592/ 593S		
DO % saturation	≥75	≥60	≥50	≥30	≥15	SAZS 573		
Faecal coliforms (No./100ml)**	≤1000	≤1000	>1000	>1500	≤2000	SAZS 629s		
Fluoride (F)	≤1	≤1	≤2	≤4	≤6	SAZS 594	IC	
Grease & oil	Nil	≤2.5	≤5	≤7.5	≤10	SAZS 581		
Helminth eggs (No/100ml)	≤1000	≤1000	>1000	>1000	≤2000			
Iron (Fe)	≤0.3	≤1	≤2	≤5	≤8	SAZS 486	SAZS 626	
Lead (Pb)	≤0.05	≤0.05	≤0.1	≤0.2	≤0.5	SAZS 595	SAZS 488	
Manganese (Mn)	≤0.1	≤0.1	≤0.3	≤0.4	≤0.5	SAZS 626	SAZS 596	
Mercury (Hg)	≤0.01	≤0.01	≤0.02	≤0.03	≤0.05	SAZS 597		
Nickel (Ni)	≤0.3	≤0.3	≤0.6	≤0.9	≤1.5	SAZS 488	SAZS 598	
Nitrite Nitrogen (NO2)	≤3	≤3	≤5	≤8	≤10	SAZS 482	SAZS 599	IC
Nitrogen Total (N)	≤10	≤10	≤20	≤30	≤50	SAZS 599		
Oxygen Absorbed	≤5	≤10	≤15	≤25	≤40	SAZS 575		
pH (pH units)	6.0-7.5	6-9	5-6 9-10	4 -5 10-12	0-4 12-14	SAZS 459		
Phenolic cpds (phenol)	≤0.01	≤0.01	>0.04	>0.06	≤0.1	SAZS 600		
Phosphates Total (P)	≤0.5	≤0.5	≤1.5	≤3	≤5	SAZS 489	SAZS 603	
Potassium (K)	*	*	*	*	≤500	SAZS 628	IC	
Selenium (Se)	≤0.05	≤0.05	≤0.1	≤1.5	≤3	SAZS 605		

Table 1: *continued*

Parameter	Blue		Green	Yellow	Red	Test Methods		
Sodium (Na)	≤200	≤200	≤300	≤500	<1000	SAZS 627	SAZS 722	IC
Sulphate (SO4)	≤100	≤250	≤300	≤400	≤500	SAZS 480	SAZS 578	
Sulphide (S)	≤0.05	≤0.2	≤0.3	≤0.4	≤1	SAZS 601		
TDS	≤100	≤500	≤1500	≤2000	≥3000	SAZS 576	SAZS 577	
Temperature deg.C	<25	<35	<40	≤40	≤45	SAZS 572		
Total heavy metals	≤1.0	≤2.0	≤4	≤10	≤20			
TSS	≤10	≤25	≤50	≤100	≤150	SAZS 576		
Turbidity (NTU)	≤5	≤5				SAZS 478		
Zinc (Zn)	≤0.3	≤0.5	≤4.0	≤5.0	≤15	SAZS 488	SAZS 602	

Notes and abbreviations

* No prescribed limits currently exist for these parameters.

** The faecal coliform limit shall be based on the average of the plate counts of the sample taken.

*** Monaxol–OT=Sodium Dioctyl Sulphosuccinate

AAS = Atomic Absorption Spectrometry; BOD = Biological Oxygen Demand; COD = Chemical Oxygen Demand; DO = Dissolved Oxygen; IC = Ion Chromatography; µS/cm = MicroSiemens per centimetre; NTU = Nephelometric Turbidity Units; TCU = True Colour Units; TDS = Total Dissolved Solids; TSS = Total Suspended Solids.

Table 2: *Blacklisted pesticides and pesticides not registered in Zimbabwe*

Compound	Maximum Concentration (ug/1) (ppb)
Aldrin	0,3
Dieldrin	0,3
Endrin	0,05