DOMESTIC RAINWATER HARVESTING: EXPLORING USER PERCEPTIONS, ATTITUDES AND WATER USES AT ENKANINI INFORMAL SETTLEMENT, STELLENBOSCH

Quality and treatment of harvested rainwater

Report to the
WATER RESEARCH COMMISSION

by

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EXECUTIVE SUMMARY

This social research project was aimed at investigating household perceptions associated with domestic rainwater harvesting (DRWH) in the Enkanini informal settlement as an alternative water supply. Additionally, the primary uses, approximate daily volume of water utilised, as well as community members' opinion on the prime location of communal DRWH stations were determined. Enkanini is currently the largest informal settlement in the town of Stellenbosch (Western Cape, South Africa) with approximately 4 449 residents living in the settlement. A total of 95 households were sampled in Enkanini Settlement and one respondent per household was interviewed. The socio-economic data revealed that Enkanini, in terms of the population's age, is relatively young, with 55% of the population being between the ages of 20-34. In addition, the average household size of the respondents interviewed was 2 to 3 occupants per household, with the average person using 40 L of water per day (20 L bucket to collect water, and walks at least twice a day). All of the respondents (100%) reported using municipal water for daily bathing, drinking and cooking, while 97% use it for cleaning the house, 94% to wash clothes and 25% use it to water their garden. Results from the social perceptions study indicated that approximately 61% of the respondents were familiar with the concept of rainwater harvesting, while 32% were unfamiliar with the concept. About 67% of the respondents indicated that they would utilise harvested rainwater for their daily water needs. Among the respondents, 77% indicated that they would utilise the rainwater for cleaning the house and bathing, 65% would utilise the rainwater for cooking, while 46% would use it for potable or drinking purposes. Additionally, 67% perceived rainwater to be clean and safe to drink. This revealed a general lack of awareness of the potential health risks of consuming untreated rainwater. Moreover, most of the respondents (68) confirmed that they would use the rainwater instead of municipal water should the tanks be close to their homes.

Once preliminary information on the perceptions was obtained, a stakeholder workshop was convened. The aim of the workshop was to collaborate with co-researchers in the Enkanini community (identified by the Sustainability Institute, Stellenbosch), architects and researchers of the Sustainability Institute, delegates from the local municipality and community on the design of the pilot domestic rainwater harvesting (DRWH) treatment station for optimum space utilisation. As 32 communal taps are located throughout Enkanini settlement, with each tap servicing 139 individuals, Enkanini was selected for the establishment of the pilot small- and large-scale DRWH solar pasteurisation treatment systems. Workshop attendees were taken on a field trip to Enkanini informal settlement, to locate possible sites for the rainwater harvesting systems. It was decided that the Enkanini Research Centre was the ideal location for the large-scale system and that the small-scale solar pasteurisation rainwater treatment systems should be installed at the church grounds and at a household neighbouring Enkanini Research Centre (ERC). The sizes of the tanks, to be installed at the respective sites, were determined using the SamSamWater Rainwater Harvesting Tool (2014), where the volume of water which could be harvested from the roof (surface area) was calculated for each household. The primary objective was to have all of the treatment systems installed and up and running before the rainy season of April 2015.

Prior to commissioning the rainwater harvesting systems, a user pamphlet guide (English and isiXhosa) and user manual were developed. These documents outlined general information on DRWH, the identified primary uses per tank and advice on water storage. In addition, members from each of the ten households utilising the systems at the three sites were trained on the continuous maintenance and repair of the treatment systems. After commissioning the systems, another workshop was hosted. During the workshop it was explained that while untreated harvested rainwater could be utilised for activities such as gardening, the pasteurised rainwater from the treatment systems could be used for domestic purposes including cooking, bathing and washing clothes and dishes. However, it was clearly stated that the rainwater, although treated, should not be utilised for drinking. Participating representatives from each household were provided with keys to the locks of the

systems and 20 L containers to be utilised for rainwater collection only. It was indicated that if treated rainwater was collected from the small-scale systems (temperatures >72°C), the water could be stored for approximately one week in the 20 L containers. The key tags and 20 L containers were then marked in different colours for each of the sites so as to easily identify the users of a particular system and so that each household could be responsible for their own 20 L container and set of keys. Additionally, one of the users was provided with logbooks to record the water usage per household from the solar pasteurisation system located at Sites 1 and 2, respectively, and the 1 500 L storage tank located at Site 3. A logbook was also provided to record the municipal standpipe water usage of each household. Regular workshops will continue to be conducted for recommendations to be communicated to the members of the participating households, and households will also be granted the opportunity to provide feedback to the research group as to how the systems can be improved.

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ACRONYMS AND ABBREVIATIONS

ADWG	Australian Drinking Water Guidelines
CBD	Central Business District
CORC	Community Organisation Resource Centre
CSIR	Council for Scientific and Industrial Research
DRWH	Domestic Rainwater Harvesting
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
EGM	Expert Group Meeting
ERC	Enkanini Research Centre
GPS	Global Positioning System
HAD	Housing Development Agency
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
SABS	South African Bureau of Standards
SANS	South African National Standards
SASSA	South African Social Security Agency
SI	Sustainability Institute
SU	Stellenbosch University
UN	United Nations
V-PCR	Viability Polymerase Chain Reaction
WHO	World Health Organisation

CHAPTER 1: BACKGROUND

1.1 INTRODUCTION

The United Nations (UN) Habitat (2011) report revealed that about 14 million people migrate each year to urban centres in sub-Saharan Africa. Of this number, approximately 70% reside in informal settlement housing, while 30% live in formal housing (United Nations Habitat, 2011). The projection is that by the year 2030, "developing countries will probably account for about 80 percent of the world's urban population" (United Nations Population Division, 2008). Resultantly, there are around 2 700 informal settlements across South Africa, containing approximately 1.2 million households. This statistic represents a remarkable increase, when considering that in 1994 there were about 300 informal settlements in South Africa (Mistro and Hensher, 2009; Bennett and Fieuw, 2012). Consequently, rapid urbanisation has produced considerable challenges in South Africa, such as an increased urban housing deficit, high rates of unemployment, increasing income inequalities, low wages, extreme poverty, living without basic social services, while having intermittent access to water and sanitation facilities (Ziblim, 2013).

Rainwater harvesting involves the collection and storage of water from rooftops and diverse surfaces. The previous Water Research Commission's Project No. K5/2124//3 social research deliverable titled, "Domestic Rainwater Harvesting: Survey of perceptions of users in Kleinmond" was conducted in 2012-2013 in Kleinmond's new housing scheme, located in the Western Cape of South Africa. The study concluded that the community members accepted rainwater harvesting as an additional water source. Most of the respondents in Kleinmond used the rainwater for washing clothes and for general cleaning inside and outside their houses. When the municipal tap water was unavailable to the community due to municipal repairs, some respondents reported using the harvested rainwater for bathing, cooking, and drinking, and a few residents also used it to irrigate their gardens. The study further revealed the importance of training in order to maintain the water tanks, and recommended appointing one or two individuals in the community to supervise the functioning, operation, maintenance and repair of the rainwater harvesting tanks.

1.2 PROJECT AIMS

The following were the aims of the project:

1. To investigate the social perception of implementing a pilot domestic rainwater harvesting (DRWH) multi-tank station in the Enkanini informal settlement as an alternative water supply, and to determine the primary uses, approximate daily volume of water utilised as well as community members' opinion on the prime location of the DRWH multi-tank station.
2. To collaborate with co-researchers in the Enkanini community (identified by the Sustainability Institute, Stellenbosch) as well as architects and researchers of the Sustainability Institute, on the design of the pilot DRWH multi-tank treatment station for optimum space utilisation.
3. To investigate the effect of environmental factors on locally produced and utilised shack building materials and on the chemical and microbial quality of the harvested rainwater at the laboratory and pilot plant scale level, in order to identify which material should be utilised for the construction of the pilot DRWH station.
4. On-site construction of the pilot DRWH multi-tank station and the implementation of multi-purpose treatment systems to produce water for domestic and potable purposes, respectively.
5. To compile a pamphlet guide (isiXhosa, English and Afrikaans) containing general information on domestic rainwater harvesting, the identified primary uses per tank and advice on water storage.

6. To train one or two individuals in the community to supervise the major and continuous maintenance and repair of the DRWH tanks and treatment systems and to compile a manual on the maintenance of the DRWH tanks and treatment systems.
7. To monitor the operational sustainability and the capacity of the tanks to service numerous households daily water needs. In addition to assess the seasonal effect on the microbial and chemical quality of rainwater at the on-site DRWH multi-tank station.

The current report addresses aim one as outlined above. The primary aim was thus to investigate the social perception of residents regarding the implementation of a pilot DRWH multi-tank station in Enkanini as an additional, alternative water supply. It also aims to determine the primary water uses and approximate daily water usage of residents, as well as community members' opinion on the ideal location of the DRWH multi-tank station.

1.3 GENERAL RESEARCH APPROACH

This social research forms part of the Water Research Commission project K5/2368/3. The research was conducted in accordance with the 2009 Framework Policy for the Assurance and Promotion of Ethically Accountable Research at Stellenbosch University. Ethical clearance (protocol number: DESC/Mannel/2014) was granted via Stellenbosch University's Research Ethics Committee, Human Research (Faculty of Humanities), which was provided before fieldwork commenced. Post-fieldwork confidentiality is maintained by means of safeguarding the questionnaires at the researcher's residence. Each questionnaire was assigned a unique questionnaire number; however, these numbers are not linked to the homes of respondents, and identifiable personal details of respondents were not collected during the study. The researcher followed the ethical principle of voluntary consent and the participants explicitly agreed and signed a consent form to participate in the study. The consent form described the purpose, procedure and expected duration of the interview, it guaranteed confidentiality of the records and that the participants would remain anonymous. It also guaranteed that the participant can withdraw from the research without penalty. In addition, the respondents were informed that no benefits or compensation will be provided for participating in the study. See Appendices A, B and C for a copy of the consent form in English, isiXhosa and Afrikaans, respectively. Only the researcher, the translator and supervisors have direct access to the questionnaires.

CHAPTER 2: STUDY APPROACH

2.1 DESCRIPTION OF THE STUDY AREA – ENKANINI INFORMAL SETTLEMENT

The term slum or informal settlement was defined in November 2002 by the UN Habitat Expert Group Meeting (EGM) in Nairobi as follows: “a group of individuals living under the same roof, [and lacking] one or more of the following conditions: (1) access to improved water; (2) access to improved sanitation; (3) access to secure tenure; (4) durability of housing and (5) sufficient living area” (UN Habitat 2007). In South Africa, the Department of Human Settlements established its own benchmarks for identifying informal settlements, under the Housing Code, which is based on the following characteristics: “(a) illegality and informality; (b) inappropriate locations; (c) restricted public and private sector investment; (d) poverty and vulnerability; and (e) social stress” (Housing Development Agency 2012). Therefore, any settlement that exhibits one or more of the above features can be qualified as an informal settlement, as per the 2009 National Housing Code (HDA, 2012).

Enkanini is currently the largest informal settlement in the town of Stellenbosch, situated in the Western Cape, South Africa (Community Organisation Resource Centre], 2012). The background information on Enkanini is that in 2006, 47 families moved to an open area next to Kayamandi (indicated as “K” in Figure 2.1). Kayamandi is a suburb of Stellenbosch and it was established and expanded in 1941-1953 when predominantly black African families and single black male workers were brought to Kayamandi specifically to work on the farms or factories in Stellenbosch (Rock, 2011).

Figure 2.1. Outline of Enkanini Informal Settlement, Stellenbosch (GPS Coordinates: 33°54' 28.42″S 18°25' 03.56″E).

After battles with usual demolition responses to remove the 47 families, Stellenbosch Municipality intervened with a court order stating that the families could stay within a demarcated area for three months. Over weekends and during the night time however, people broke through the fence from Kayamandi's side to build their houses outside the marked area. The new settlement was named "Enkanini", which means 'force', as the people built their houses outside of the demarcated area (indicated as "E" in Figure 2.1). The settlement is located on the steep slope of Onder Papegaaiberg mountain, 1.8 km from the Central Business District (CBD) of Stellenbosch and less than one kilometre from the Stellenbosch Railway Station (indicated as "S" in Figure 2.1). Enkanini is situated above the Plankenburg Industrial area (indicated as "I" in Figure 2.1) which is connected to the R44 road that links three major towns in the area: Somerset West, Franschhoek and Paarl.

As indicated in Table 2.1, Enkanini has an estimated population of 4 449 residents with 32 communal taps (139 individuals per tap) dispersed throughout this settlement (CORC, 2012). According to the standards set by the Department of Water Affairs and Forestry (DWAF), a maximum of 100 people should be served per standpipe (DWAF, 2004). Sharing one tap with 139 people results in overcrowded taps, people standing in long queues to collect water, being exposed to the hot sun in the summer and cold wet days in the winter, and adds pressure on the pumps as they are being used excessively. It becomes apparent, therefore, that infrastructure systems need to be reconceptualised in order to meet service delivery shortfalls and the growing demand for water.

Table 2.1. Demographic Profile of Enkanini Informal Settlement (CORC, 2012).

Age of settlement	8 years
Type of structures	All shacks
No. of shacks	2494
Population	4 449 (females comprise 46%)
No. of community taps	32. All functional and maintained.
Ratio per tap/population	1:139
Land ownership	Municipality

2.2 SAMPLING METHOD

This research is being conducted in collaboration with researchers at the Sustainability Institute (SI), and Stellenbosch University (SU). Random sampling technique was applied to select homes within a 100 m radius of the Enkanini Research Centre. The Enkanini Research Centre (referred to as the ERC) is a prototype ecologically designed house with passive energy flows, which produces biogas from five micro flush toilets and is fitted with a 1.3 kW Solar Photovoltaic Micro grid that powers a computer, television, lights, fridge and spotlights. Mr Yondela Tyawa (Enkanini resident, co-researcher and translator for this study) is the in-house custodian, who also runs a catering business for visitors (academics, government officials, delegates and tourists). Current projects in Enkanini are the Sanitation Project, which entails the introduction of the five micro flush toilets and biogas digester, the Bokashi Project which entails organic waste management through fermenting bacteria to produce garden compost and the Art Project which uses art, such as photos, paintings and crochet as a communications device for residents to depict their aspirations. The iShack project operates independently but originated within this group of researchers and the sanitation project (Boix-Mansilla et al., 2010). The ERC is located on the border of section E and F and homes in section E and F were thus selected to participate in the study (Figure 2.2). There are 144 homes in section E and 243 homes in section F. A total of 95 households were sampled and one respondent per household was interviewed (Figure 2.2). Mr Yondela Tyawa was employed for five days to assist the researcher with the interviews. As a local resident he provided easy access to respondents, which made the recruitment of respondents straightforward and easy.

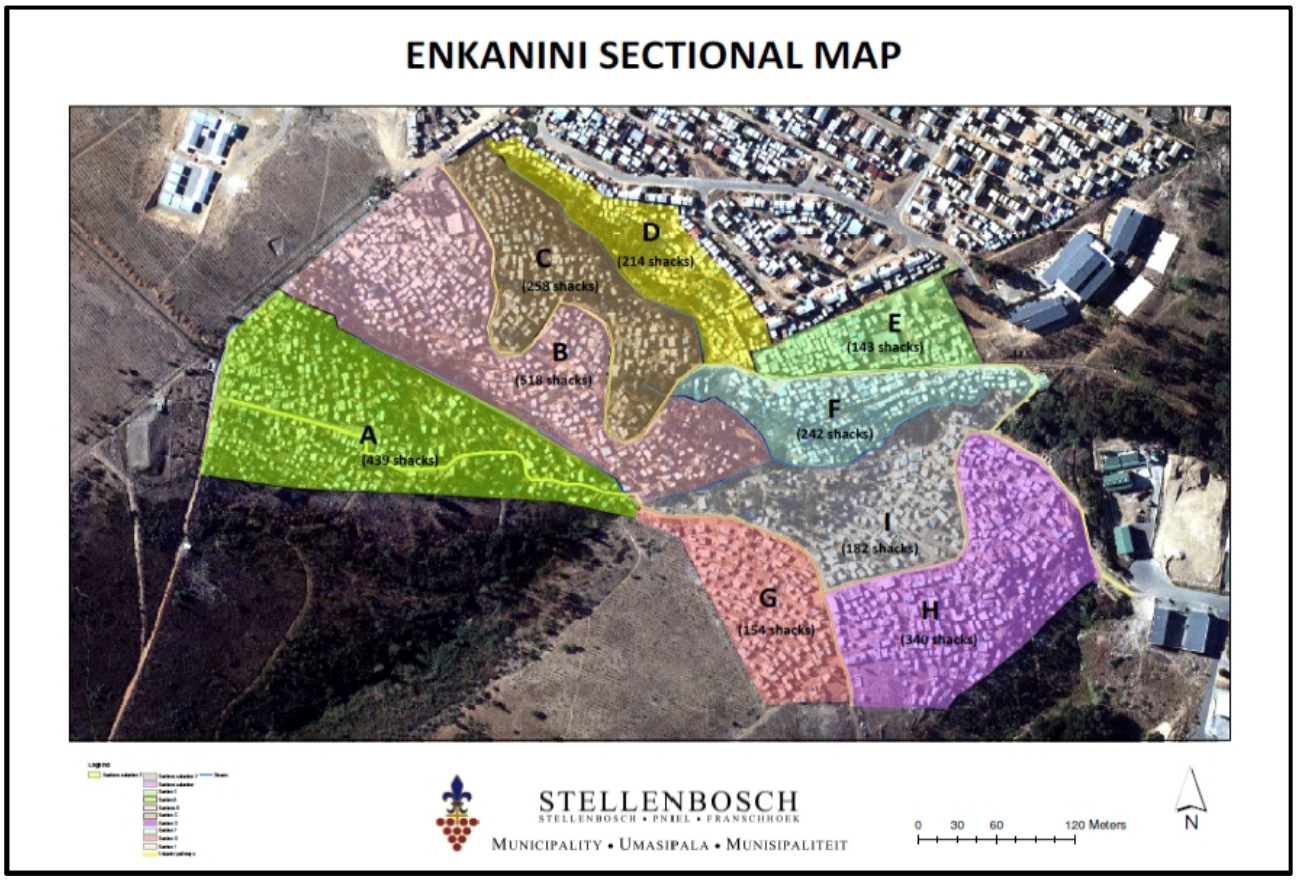

Figure 2.2. Outline of Enkanini Informal Settlement Sectional Map, Stellenbosch (GPS Coordinates: 33°54' 28.42″S 18°25' 03.56″E) (CORC, 2012).

2.3 DATA COLLECTION AND ANALYSIS

Data were gathered by means of face-to-face interviews. Due to the relatively low level of literacy and education in South Africa, "face-to-face interviews are the most common method to collect survey data" (Babbie et al., 2001). The interviews were guided by a semi-structured questionnaire (see Appendices A, B and C), and were conducted over a period of five days (24, 25, 26, 27 and 28 April 2014) by the researcher, with the help of the translator. Each interview took 10 to 20 minutes.

2.3.1 Questionnaire Design

The questionnaire was designed primarily to gather quantitative data but included open-ended questions in order to determine respondents' subjective understanding of the topic and explore reasons for certain responses. The principal language spoken in Enkanini is isiXhosa. This was confirmed by the translator and by a postgraduate student from the Sustainability Institute who has worked in Enkanini for the last three years. The questionnaire was originally designed in English and then translated into Afrikaans and isiXhosa. In the field, the isiXhosa questionnaire was used by the translator. On the first day, the translator asked the questions in isiXhosa and then translated the responses to the researcher, who then completed an English version of the questionnaire. As the translator works as a co-researcher and has assisted the Sustainability Institute postgraduate students with various questionnaires, the researcher and translator worked independently during the rest of the data collection days and conducted interviews separately, in order to speed up the process of collecting the data. The researcher and co-researcher were however, always conducting interviews in homes next to or opposite each other and as a local resident, the translator was able to identify residents who would

be able to communicate in English. Additionally he arranged for a local young woman to assist the researcher in case the respondents did not understand the English questions.

The aim of the first section of the questionnaire was to gain an overview of municipal water usage in Enkanini: what is the water used for, the distance residents have to walk to collect water, how often they have to walk per day and the volume of water they use per day. The second part of the questionnaire was aimed at understanding whether respondents are familiar with the principle of rainwater harvesting, whether they would be willing to use harvested rainwater, what they would use the rainwater for, and their opinion on the most suitable location for the DRWH multi-tank station. The last part of the questionnaire was to determine the size of the household and to establish if they are generally concerned about water availability as well as to elicit their opinion on municipal water.

The researcher asked each participant 32 questions. All the respondents were asked the same questions, which were carefully recorded by the researcher and translator. Numerical codes were assigned to the response options for closed-ended questions, to simplify data entry and analysis.

2.3.2 Data analysis

The qualitative data that was collected was “transcribed and a method of open coding was used where phrases or key words are coded using theoretical themes to organise the texts”, using SPSS (Statistical Package for Social Sciences) (Goldin, 2005). The SPSS was then used to; (1) summarise the data, (2) compile appropriate tables and graphs and (3) examine relationships between variables. Although self-administered questionnaires would have been less time-consuming, administering the questionnaire during interviews ensured that the questions were understood by the respondents. This increased the accuracy and reliability of the data collected.

CHAPTER 3: WATER USES, USER PERCEPTIONS AND ATTITUDES TOWARDS DOMESTIC RAINWATER HARVESTING

3.1 INTRODUCTION

This section reports on the social perceptions of residents regarding the implementation of a pilot domestic rainwater harvesting (DRWH) system at Enkanini as an additional, alternative water supply. It also aims to determine the primary water uses and approximate daily water usage of residents, as well as community members' opinion on the ideal location of the DRWH system.

3.2 SOCIO-DEMOGRAPHIC PROFILE OF THE ENKANINI RESIDENTS

One person per household was interviewed and 95 interviews were conducted. Referring to Table 3.1, the "Frequency," column simply reports the total number of cases. For instance, 28 households (or cases) reported to have two members in their homes, while 27 individuals (or cases) reported to have three occupants (Table 3.1). The third column, labelled "Percent," provides a percentage of the total cases. In other words, the data can further be analysed by stating that 20% of the respondents reported to have four occupants in their homes. Based on the information obtained through the interviews it was also determined that there was only one case (or 1%) with 10 members in one household, while 6% reported they had six members residing in their house.

Table 3.1. Reported household sizes in Enkanini Settlement.

No of people per household	Frequency	Percent
1	9	9.5
2	28	29.5
3	27	28.4
4	19	20.0
5	4	4.2
6	6	6.3
7	1	1.1
10	1	1.1
Total	95	100.0

The population of Enkanini is divided into the age groups as depicted in Figure 3.1 (Adapted from CORC, 2012). Enkanini residents are relatively young, and a significant proportion of the people residing in the settlement are of working age. The working age in South Africa is from 16 years, which implies that approximately 70% of the residents in Enkanini are eligible for employment (Figure 3.1). As indicated, 23% of Enkanini's entire population is aged between 25 and 29 years, while 19% are aged between 30 and 34 years. Thirteen percent (13%) are in the range of 20 to 24 years of age, while 10% are between the ages of 35 and 39 years. The categories 0-4 and 5-9 years represented approximately 8% of the population, respectively, while 5% of the Enkanini population are between the ages of 15 to 19 years and 40 to 44 years, respectively. When the CORC (2012) collected the data on the residents' age, they reported that 22% of the respondents in Enkanini did not provide their age, indicated as "no response" in Figure 3.1.

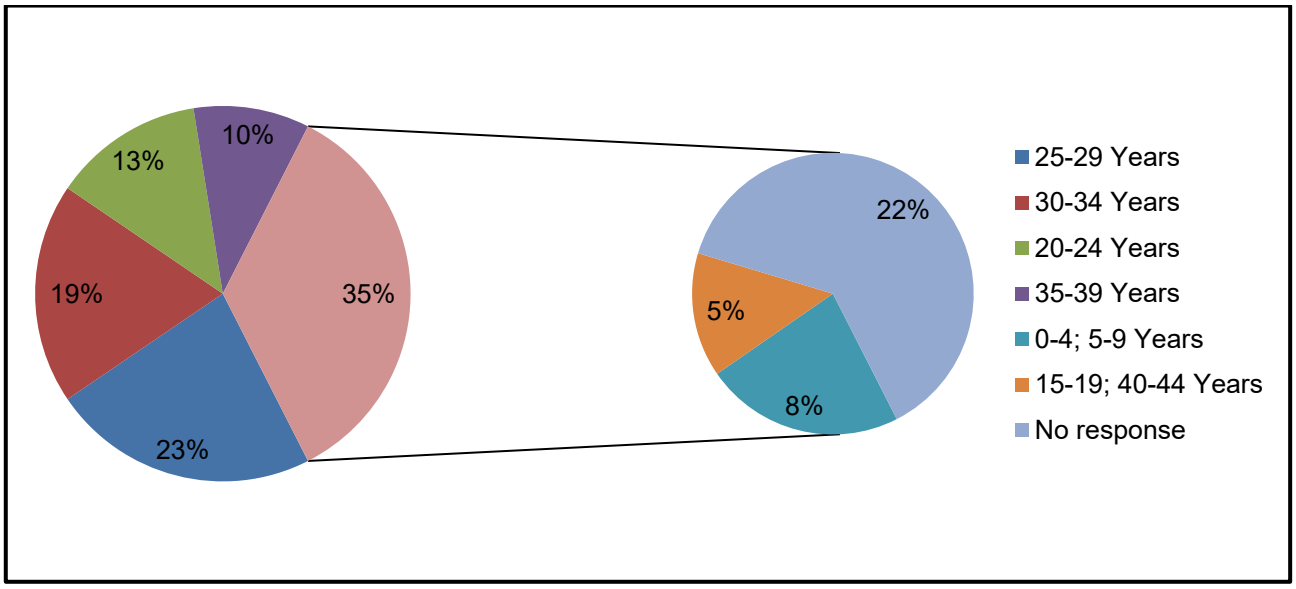

Figure 3.1. Age group categories of Enkanini residents (CORC, 2012).

In terms of gender, 54% of the residents are male, while 46% are female (CORC, 2012). Based on results obtained from previous studies (He et al., 2007; Ademun, 2009), the employment status is considered important, as it generally indicates financial stability or instability. Even though approximately 70% of the population of Enkanini is eligible for employment, the CORC reported that the majority of the residents (31%) are unemployed. Of that number, 59% are females and 41% are males. In total, 28% of the population in Enkanini was employed full-time (with 32% being females and 68% males). Sixteen percent (16%) are employed part-time and 2% of the population is self-employed (CORC, 2012).

In terms of income and expenditure the average income per month was calculated as R1 031.11 (CORC, 2012). This average includes 27% of the households that indicated zero income and if this percentage is set aside, the mean rises to R1 421.06 per month. When concentrating on the data available, R1 031.11 is suggested as the household average income for Enkanini population (CORC, 2012).

South Africa has a well-established social welfare system and a large proportion of social spending goes towards social grants (South African Social Security Agency, 2014). Social grants are administered by the South African Social Security Agency (SASSA), and many residents of Enkanini are currently on grant support (Table 3.2).

Table 3.2. Social grants for Enkanini residents (Adapted from CORC, 2012 and www.sassa.gov.za/).

Grant type	Number of Households Receiving Grants	Rand Value
Old age pension	17	R1 350, older than 75 yrs
Disability grant	32	R1 350
Child support (linked to child)	492	R310
Care dependency grant	15	R1 350
Foster care grant	17	R830
Grant in aid	25	R310
Social relief	7 (Granted for maximum 3 months)	Received in vouchers, food parcels or cash.

Grants are targeted at people who are vulnerable to poverty and in need of state support, such as older people, people with disabilities and children. In Enkanini, Child Support (R310 per month per child) is received by 492 households, with the Disability Grant (R1 350 per month per disabled person) received by 32 households. The Social Relief of Distress, which provides immediate temporary assistance to people in dire need of financial support, is the grant with the least dependence in Enkanini and is given to people in the form of vouchers, food parcels or money for a three month period (Table 3.2).

3.3 DAILY USE OF MUNICIPAL WATER

From the 95 interviews conducted, all the respondents (100%) stated that they use municipal water on a daily basis. There are 32 communal taps in Enkanini, which are functional and well maintained (CORC, 2012). Sections E and F (where the interviews were conducted) in Enkanini are located within 1 km of municipal taps and all respondents reported walking less than 1 km to collect water. However, sections A, D and G have the lowest service delivery rates and many residents walk more than 1 km to collect water (Figure 2.2). In order to measure the volume of water used on a daily basis the following two questions were asked: (1) How many times per day do you walk to fetch water for the household and; (2) What bucket size do you use to collect water? However, through observation, the researcher noticed that when some residents do laundry, they let the water run until the soap is rinsed out of the clothes, often letting buckets overflow. It is therefore difficult to measure how much water they use with one washing load. On one occasion the researcher observed two women washing clothes and the water was running for approximately 15 minutes before they closed the tap (Figure 3.2).

Figure 3.2. Photograph of women doing laundry at a standpipe in Enkanini.

According to the translator, it is common practice to leave municipal water running while doing washing. Another lady rinsed her mop with the tap open, while a 20 L bucket was standing next to the tap (Figure 3.3). It was also observed that occasionally the tap would be open even though no one was using the water. Due

to these observations, the researcher included two additional questions into the questionnaire: (1) When doing laundry, do you let the water run continuously when rinsing your clothes and; (2) When doing laundry, do you fill the bucket with water, close the tap and rinse the clothes? If so, how many buckets do you use to rinse the clothes? Based on the interview responses, 66 respondents' use 20 L buckets to collect water, 16 use 25 L buckets and 9 reported using 10 L buckets. Two of the four respondents that use a 5 L bucket live next to the taps and therefore do not use large containers to collect water. Table 3.3 outlines the average number of times the respondents collect water per day from the local standpipe. As indicated, the first column 'Option to answer the following' was part of the questionnaire design where the researcher ticked the corresponding box on the questionnaire after enquiring from the respondents "what bucket size do you use to fetch water".

Figure 3.3. Photograph of woman rinsing her mop at a standpipe in Enkanini.

Table 3.3. Frequency of times per day people collect water from the local standpipe.

How often do you walk per day to collect water?			
Option to answer the following:	**Frequency**	**Percent**	**Cumulative Percent**
Once a day	14	14.7	14.7
Twice a day	40	42.1	56.8
Three times a day	25	26.3	83.2
Four times a day	12	12.6	95.8
Five times a day	3	3.2	98.9
Six times a day	1	1.1	100.0
Total	95	100.0	

The frequency column represents the number of cases and as indicated most of the inhabitants (40 respondents / 40 cases) walk twice a day to collect water (Table 3.3). Twenty five respondents reported that they walk three times a day, 15% (or 14 respondents) walk once a day, while 12.6% walk four times a day. Only one respondent said that she walks about six times per day (Table 3.3). The fourth column, labelled "Cumulative Percent," adds the percentages of each case from the top of the table to the bottom, culminating in 100%.

Cross tabulation is a way to examine the relationship between two variables. The two variables that were cross tabulated were, "how many times per day do you walk to fetch water for the household" and "what bucket size

do you use to fetch water". This method was used to establish how much water the household needs per day. The "Total" row running horizontally at the bottom of Table 3.4 refers to the number of people using a particular bucket size to collect water. Results collated in Table 3.4 thus indicate that four people use 5 L buckets, nine people use 10 L buckets, 66 use 20 L buckets and 16 use 25 L buckets. From the 66 respondents that use 20 L buckets to collect water, 30 are walking twice a day, while 19 respondents walk three times a day to collect water, and 8 walk four times a day. From the 16 respondents using 25 L buckets, five reported walking once a day, while another five walk two or three times a day. Based on the cross tabulation data, the average person who was interviewed thus uses 40 L of water per day, as they utilise a 20 L bucket at least twice a day to collect the water. These statistics exclude the respondents who confirmed that they do not close the tap when they are rinsing their laundry.

Table 3.4. Relationship between bucket size and water collection frequency.

How many times per day do you walk to fetch water for the household?	What bucket size do you use to fetch water?				Total
	5 litres	10 litres	20 litres	25 litres	
Once a day	0	2	7	5	14
Twice a day	0	5	30	5	40
Three times a day	0	1	19	5	25
Four times a day	3	1	8	0	12
Five times a day	1	0	1	1	3
Six times a day	0	0	1	0	1
Total	4	9	66	16	95

Figure 3.4 outlines the responses regarding water usage from municipal standpipes on laundry days and, as indicated, approximately 36% of the respondents close the tap when rinsing their laundry, while approximately 57% of the respondents firmly established that they do not close the tap when they rinse their laundry and five respondents stated that they sometimes leave the tap open. In other words, nearly two thirds of the sample leaves water running continuously when doing washing. As a result the average person uses more than 40 L of water per day on laundry days.

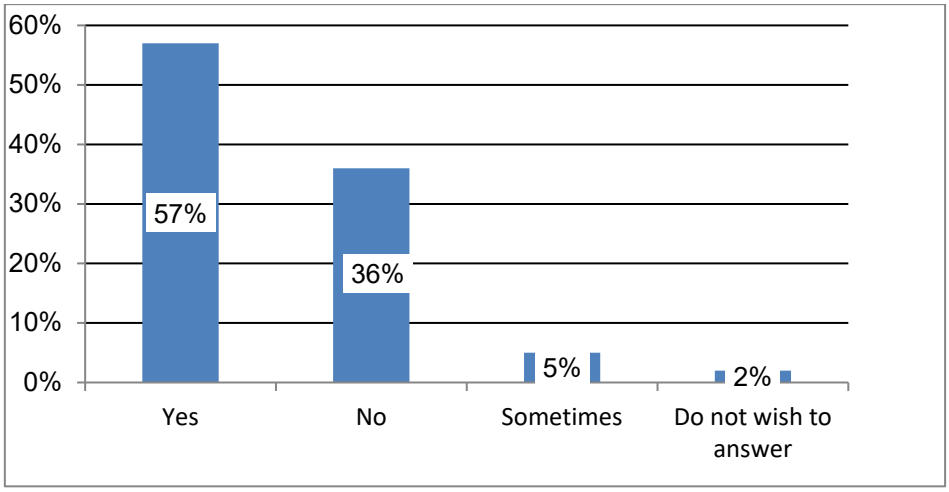

Figure 3.4. Responses regarding water use when doing laundry.

The responses to the question on laundry procedure reveal that 36% (or 34 respondents) reported that they fill the bucket, close the tap and then rinse the clothes in the bucket. Of these 34 respondents, 20 respondents fill the bucket twice to rinse the clothes, while 14 respondents fill it three times. On washing days, these 34 respondents use between 80-100 L of water. Even though it was not part of the questionnaire, through informal

conversation and discussion between the residents and the researcher, it was evident that most of the working women do laundry once a week, mostly over weekends. The taps are thus very busy in the mornings, especially over the weekends, and people have to stand in long queues to use the taps.

In order to understand what the residents of Enkanini use municipal water for, residents were specifically asked whether they use water for gardening, cooking, drinking, washing clothes, cleaning the house and/or bathing. Respondents could choose more than one option. The results, represented in Figure 3.5, indicate that all respondents use the municipal water for daily bathing, cooking and drinking. The second most common municipal water use is general cleaning and laundry, while 25% of the respondents indicated that they use it to water their garden. Land space is very limited in Enkanini and it is thus difficult to procure space for a garden, which partly explains why only 25% use water for gardening purposes.

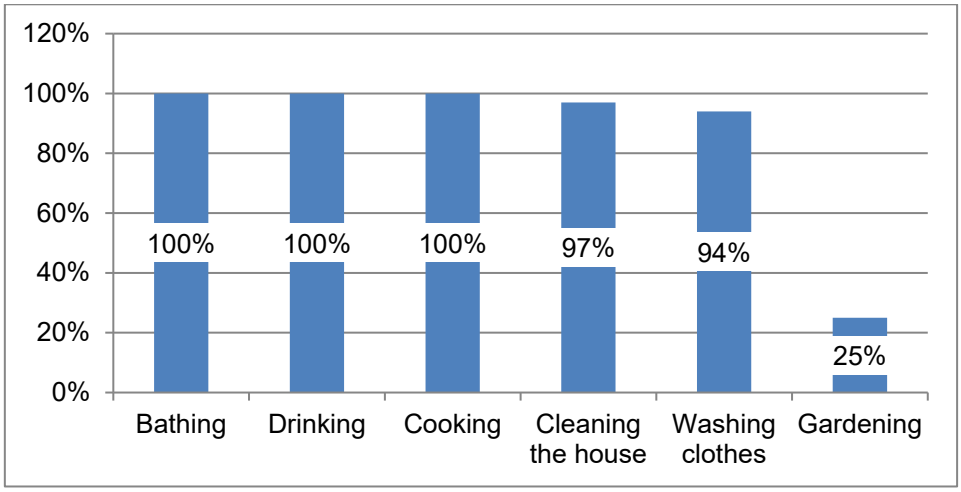

Figure 3.5. Daily uses of municipal tap water.

3.4 KNOWLEDGE ON RAINWATER HARVESTING

From the 95 interviews, 58 respondents (or 61%) indicated that they are familiar with the concept of rainwater harvesting (RWH) (Figure 3.6). Some respondents mentioned that they are familiar with the principle of rainwater harvesting because they originate from the Eastern Cape and in this province they depend on harvested rainwater to fulfil their daily water needs. Seven respondents were unsure what rainwater harvesting is, while 32% did not know what it means to harvest rainwater (Figure 3.6). The “don't know" response category means that the respondent did not know the answer to the question, while “unsure” indicates that people lack opinion or they lack information to form an opinion about the topic.

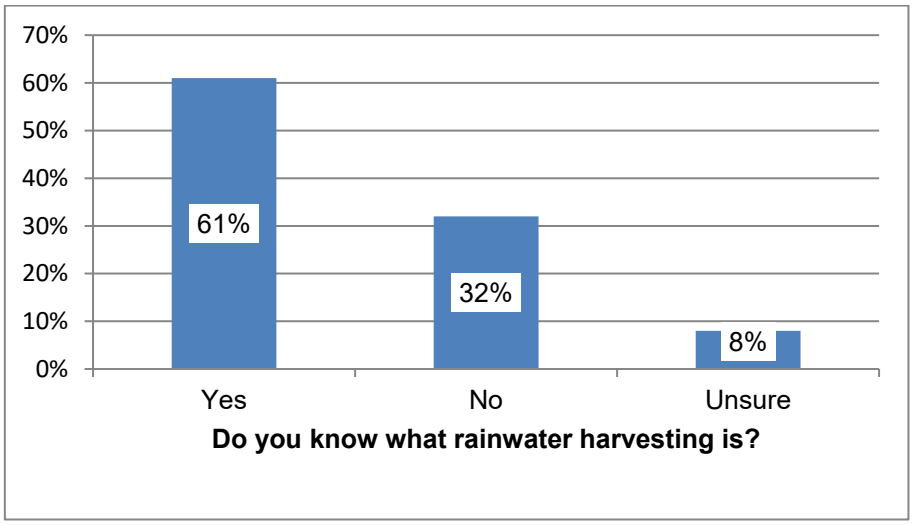

Figure 3.6. Respondents' knowledge on RWH.

Table 3.5 summarises the potential uses of rainwater harvesting as indicated by the respondents and while 67% confirmed that they would use rainwater for their daily needs, approximately 13% said they would not use rainwater and 17% were unsure whether they would use it (Table 3.5). The respondents who indicated that they would use rainwater correlate with those who said that they are familiar with the concept of RWH (Figure 3.6). The data further reflects that respondents who are not familiar with RWH are unsure of whether they would use rainwater and/or will most likely not use it.

Table 3.5. Potential use of RWH for daily needs.

Will you use the rainwater for your daily needs?			
Option to answer the following:	**Frequency**	**Percent**	**Cumulative Percent**
Yes	64	67.4	67.4
No	12	12.6	80.0
Unsure	16	16.8	96.8
Do not wish to answer	3	3.2	100.0
Total	95	100.0	

Referring back to the previous WRC social study in Kleinmond in 2012-2013, the residents' municipal water supply was unavailable for three days due to maintenance and repairs which provided evidence that the harvested rainwater was particularly useful, convenient and important to the respondents, as most of them relied on the tanks to fulfil their daily water needs. Should Enkanini experience a similar situation, one could predict that respondents who reported not to use the rainwater and respondents who were unsure whether they would use the rainwater, will probably do so, as the entire sample confirmed that they use water every day of their lives.

A single table (Table 3.6) was created based on responses to the six variables (gardening, cooking, drinking, washing clothes, cleaning the house and bathing). Respondents could select more than one category and 'N' refers to the number of people who chose a particular variable. The "percent of cases" adds the percentages of each case from the top of the table to the bottom, and not the number of individuals. Cleaning the house and bathing with the rainwater were the most selected responses, with 73 people selecting these categories, while gardening was the least selected response (13 responses). Approximately 46% selected drinking the rainwater, while 65% of cases will use rainwater for cooking. Surveys can measure prospective behaviour and it is important to note that 46 of the sample would use the rainwater for drinking (Table 3.6) and through

informal communication the researcher noted that many of the respondents perceive rainwater to be clean and safe to drink.

Table 3.6. Possible uses of rainwater.

What would you use the rainwater for?	N	Percent of Cases
Gardening	13	13.7%
Cooking	65	65.3%
Drinking	46	46.3%
Washing clothes	54	53.7%
Cleaning the house	73	76.8%
Bathing	73	76.8%
Total	324	294.6%

In addition to questioning the respondents about potential uses of rainwater, additional questions focused particularly on the potential use of the rainwater for drinking (Figure 3.7). In part it was to determine if the respondents are aware of the possible health risks associated with RWH and the need for pre-treating the harvested rainwater. Approximately 44% of the respondents would use the rainwater for drinking, while 23% would drink it sometimes (Figure 3.7). Thirty-three percent reported that they would never drink it.

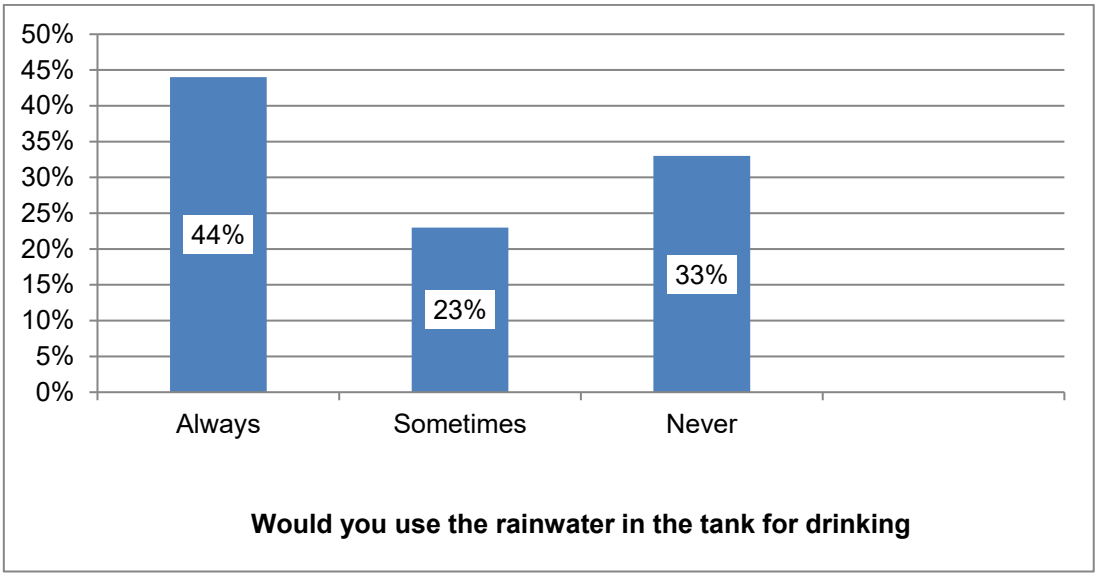

Figure 3.7. Potential use of rainwater for drinking purposes.

As indicated in Figure 3.8, approximately 56% of the respondents would not pre-treat the rainwater before drinking it, while 30% stated that they will always treat it before drinking (Figure 3.8). It is possible that the residents are not aware of rainwater contamination, such as “dirt and faeces which comes mainly from birds and small animals” or “leaf debris and organic material washed into the tank from roofs, insects and birds that have drowned in the water and breeding mosquitoes” (Worm and Van Hattum, 2006). The Microbiology research team will focus on this particular matter as one of their primary aims is to bring harvested rainwater to potable standards.

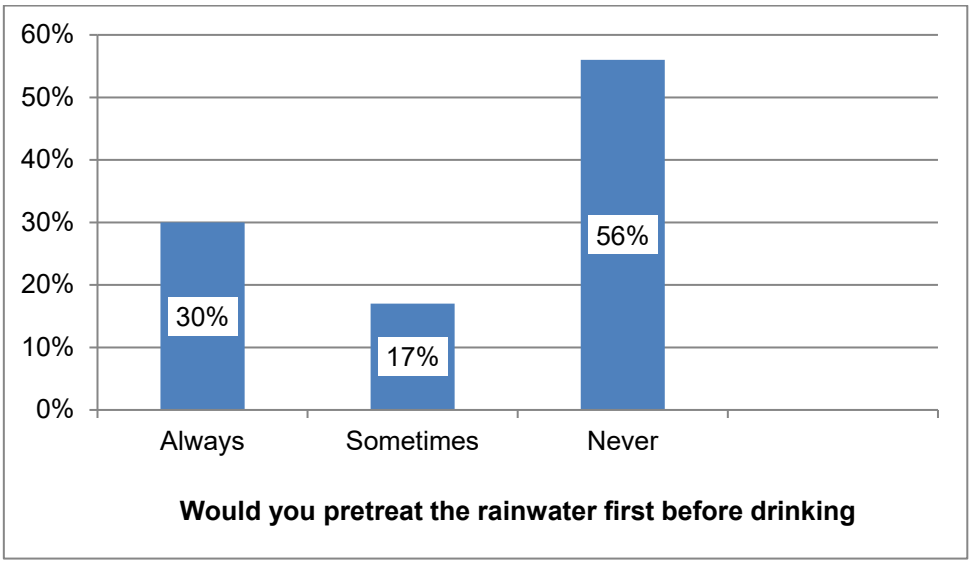

Figure 3.8. Respondents' opinion on pre-treating rainwater before drinking.
*This question only applied to the 64 respondents who reported they will drink/sometimes drink the harvested rainwater (Figure 3.8).

The next question was to establish whether behaviour would change towards RWH should the water be warm. Table 3.7 reflects the recorded responses and as indicated bathing, cleaning the house and cooking were mostly selected by the respondents. Several respondents indicated that they prefer using cold water and would not want the water to be warm. Others were pleased with the idea of having warm water as many said that it would save paraffin and gas used to heat water and therefore save money. However, only 4% said they would use it for drinking, with most of the respondents stating that they would not enjoy drinking warm water, and 1% said they would use it for gardening. One respondent explained that he first has to heat up water before doing his washing in order to "break the cold and to let the soap foam" and that he would definitely use the warm water to do his washing as it will save time, money and energy.

Table 3.7. Possible uses of warm treated rainwater.

Should the water in the tank be warm, what would you use it for?	Responses	
	N	Percent
Gardening	1	1.1%
Cooking	57	60%
Drinking	4	4.2%
Washing clothes	12	12.6%
Cleaning the house	67	70.5%
Bathing	87	91.6%
Total	363	100.0%

Respondents were also asked whether it would help them to have warm water in the tank and if so, why. About 77% of the respondents said that it would help them to have warm water, but not everybody elaborated to say why they think it would help them. Approximately 11% said they do not know if it would help them (Table 3.8). Of the 73 respondents who confirmed that warm water would help them with their daily needs, 33 of them said that it would save gas and paraffin, eight respondents said it would save money because they wouldn't have to buy gas or paraffin to heat water, three said that they would save time, three responded that they wouldn't have to make a fire in the morning to get ready for work, and one respondent said that it would be safer, as it is dangerous to always work with paraffin in the house with his small children. The rest (25 respondents) of the respondents did not want to say why they think having warm water in the tank would help them.

Table 3.8. Feedback on whether users find the availability of warm treated rainwater useful.

Will it help to have warm water in the tank?			
Option to answer the following:	**Frequency**	**Percent**	**Cumulative Percent**
Yes	73	76.8	76.8
No	6	6.3	83.2
Don't know	10	10.5	93.7
Do not wish to answer	6	6.3	100.0
Total	95	100.0	

3.5 USER FEEDBACK ON DESIGN AND LOCATION OF THE RAINWATER HARVESTING SYSTEM

The researcher asked an open question to the respondents to see where residents think the best location would be for the tanks. Thirty respondents said it should be located next to their house. Some motivated this response by adding that they have space next to their house, others said they will make sure no one breaks the tank, and others reported that it will be easier for them to have it next to their house. About 22 respondents said it should be located at the Enkanini Research Centre (ERC) because more people would have access to it. Some of the respondents rightly pointed out that the ERC has more space than any house and that the tanks could be located at this site. Two respondents commented that it would be unfair to only have one multi-tank system in the community and that everybody should be able to access the tanks or have their own tanks. When asked to elaborate, both respondents mentioned that people are very jealous of one another and if the tank were next to her house, they would break it or question why she received a tank and not her neighbour or the rest of the community. Three respondents suggested placing the tank near the communal taps so that more people could use it and it could serve as an alternative water source if there were problems with the municipal taps or water supply. If the municipal taps were to break or there is no municipal water, people would have rainwater to use. Besides those who are not in favour of the project, the rest of the respondents were undecided or did not know where the best location would be for the tanks.

In addition, most of the respondents (68) confirmed that they would use the rainwater instead of municipal water should the tanks be close to their homes. Thirteen reported that they would not use it, while 14 said they will use both tap water and rainwater (Table 3.9).

Table 3.9. Likelihood of using rainwater instead of municipal water if the tank is nearby.

Would you use rainwater instead of municipal water if tank is close to you?	
Option to answer the following	**N**
Yes	68
No	13
Use rainwater and municipal water	14
Total	95

Should the tanks be far from the residents homes, it is unlikely that they will walk to the tank to collect rainwater as 39% confirmed that they will only walk to the municipal taps for water. One lady motivated this by stating: "If I have to walk far, I might as well go to the taps because it doesn't rain all the time". However, 39% also reported that they would walk to both the tank and taps for water, while 13% would walk to the tank for water, even if it is far to get there (Table 3.10).

Table 3.10. User responses on distance to tank

If the tank is far, would you walk to collect rainwater? Or would you only walk to use municipal tap water?			
Option to answer the following:	**Frequency**	**Percent**	**Cumulative Percent**
1. I would walk to the tank to use rainwater	13	13.0	13.7
2. I would only walk to use the municipal tap water	37	38.9	52.6
3. I would walk and use both rainwater and municipal tap water	37	38.9	91.6
4. I don't know	7	7.4	98.9
5. Do not wish to answer	1	1.1	100.0
Total	95	100.0	

For the purpose of this research, it is impossible to provide each resident with a tank. Even though most of the respondents would like the tank to be located next to their own homes, it is suggested that it should rather be located at a neutral place where most of the community members can benefit from it. These neutral places refer to the areas where the communal taps are located, at the church, crèche or at the Enkanini Research Centre. The researcher recommends the ERC as there is sufficient space, the translator who works as co-researcher lives at the ERC, which means it can be taken care of (Figure 3.9). Most importantly, he understands the purpose of the study and can facilitate the community members understanding of how to use it, when to use it and when not to use it.

Figure 3.9. Research Centre, Enkanini. **Source: Sustainability Institute**

3.6 RESPONDENTS' GENERAL OPINION ON WATER

The results for the sample as a whole, as depicted in Table 3.11, show that approximately a quarter (23%) of the respondents are often concerned about water availability, while 42% are sometimes concerned about water availability. Respondents indicated that water interruptions in the past 12 months often took one day before resumption of supplies, which explains their general concerns about water supply.

Table 3.11. Respondents' concerns about water.

How often do you worry about a lack of water?			
Option to answer the following:	**Frequency**	**Percent**	**Cumulative Percent**
Don't want to answer	2	2.1	2.1
Never	18	18.9	21.1
Rarely	12	12.6	33.7
Sometimes	40	42.1	75.8
Often	22	23.2	98.9
Don't know	1	1.1	100.0
Total	95	100.0	

While Table 3.11 signifies that the majority of the respondents are sometimes concerned about water availability, Table 3.12 shows that the community is not familiar with the idea of reusing water, and 59% of respondents never do so. The meaning of "reuse" was explained on the questionnaire and during the interview and refers to using water more than once. An example of the question posed to the respondents was to enquire, "Do you use the same water after a bath to clean the house". Those who did mention reusing water sometimes (22%) or often (6%) were also requested to provide an example to ensure that they understood the question. These examples included using bath water or rice water to water the plants. The majority of people however, use water only once and in general, it is the norm to dispose of any used water outside the house into the streets.

Table 3.12. The reuse of water (using water more than once).

How often do you reuse water/ Use water more than once?			
Option to answer the following:	**Frequency**	**Percent**	**Cumulative Percent**
Don't want to answer	2	2.1	2.1
Never	56	58.9	61.1
Rarely	8	8.4	69.5
Sometimes	21	22.1	91.6
Often	6	6.3	97.9
Don't know	2	2.1	100.0
Total	95	100.0	

Four questions were asked to measure respondents' opinions on municipal water, as these opinions (which are usually based on positive or negative experiences with municipal water) may have an effect on the users' perceptions toward rainwater harvesting. Firstly, respondents were asked whether they think water should be free of charge. Their responses in Table 3.13 indicate that 64 respondents strongly agreed that water should be free, 14 agreed that it should be free, while seven were undecided, and the remaining five did not know. In a related question, respondents were asked whether everybody should pay for the municipal water that they use. When combining the responses of "strongly disagree" and "disagree", the majority (56%) of respondents disagree that they should pay for municipal water (Table 3.14), and some elucidated their response by stating that "we are poor and unemployed and expect water to be free for us".

Table 3.13. Opinion on whether municipal water should be free.

Water should be free for everyone			
Option to answer the following:	**Frequency**	**Percent**	**Cumulative Percent**
Don't want to answer	1	1.1	1.1
Strongly agree	64	67.4	68.4
Agree	14	14.7	83.2
Undecided	7	7.4	90.5
Disagree	2	2.1	92.6
Strongly disagree	2	2.1	94.7
Don't know	5	5.3	100.0
Total	95	100.0	

Table 3.14. Opinion on whether they should pay for the municipal water used.

Everyone should pay for the municipal water they use.			
Option to answer the following:	**Frequency**	**Percent**	**Cumulative Percent**
Don't want to answer	1	1.1	1.1
Strongly agree	10	10.5	11.6
Agree	3	3.2	14.7
Undecided	12	12.6	27.4
Disagree	13	13.7	41.1
Strongly disagree	40	42.1	83.2
Don't know	16	16.8	100.0
Total	95	100.0	

The last question on municipal water was aimed at determining whether respondents considered the municipal water that they receive as sufficient in terms of quantity and quality for the purposes of drinking, cooking, laundry and bathing. Should they perceive the municipal water not to be enough, and sufficiently clean, their acceptance and behaviour towards the DRWH multi-tank station would possibly be more welcoming and supported. According to the results presented, the majority of respondents deem the municipal water to be sufficient for drinking, cooking and bathing. Approximately 71% said that the municipal water is enough for drinking, whereas 15% were unsure if it is enough. According to some respondents, the community has experienced not having access to municipal water due to broken taps or repairs, which could explain why 15% are unsure if municipal water supplied is sufficient for drinking purposes. This could also explain why 20% of the respondents said that they are unsure if the water is enough for washing, while 60% said that it is more than enough for washing. For bathing purposes, about 72% reported that municipal water is enough, while 15% reported that it is not enough. The same result applies to whether the water is enough for cooking, as 72% reported it to be more than enough, while 15% were unsure if it is enough for cooking. In terms of municipal water, the majority of respondents consider it to be enough in terms of quantity, and sufficiently clean in terms of quality

In order to elicit a more objective view of the respondents and to gather some qualitative data, an open question was presented; nearly half of the respondents (46 in total) expressed their opinion, while the rest did not have anything more to say or add. The following responses were captured; 20 of the 46 respondents said that it is a good idea to use rainwater and that they will support the project. Seven reported that they will only support it if they do not have to pay for it. One respondent was concerned about the safety of the tank and said that one should put padlocks around it, so that people won't damage or steal the tap off the tank. Another

respondent observed that many people waste water and that the tank will be a good idea to waste less municipal water. One lady stated that the RWH project should not be implemented in Enkanini, when the researcher asked why, she responded “because we do it in the Eastern Cape, not here. We want taps, not tanks”.

During the interviews it became apparent that many of the residents are concerned about service delivery and are in desperate need of electricity, as many of them often asked for it throughout the five days of data collection. A local woman explained that at night one cannot see or identify the person when one gets attacked, and that a lot of crime happens when it is dark. Without electricity, residents would use paraffin and candles for light purposes and paraffin and gas for cooking purposes. The use of candles and paraffin also contributes to a higher potential for shack fires due to poor design of paraffin stoves and leaving these light and cooking sources unattended. Enkanini was affected in 2013 by a fire in which 35 shacks burned to the ground, caused by an unattended candle. The researcher had to listen to several respondents about their need for electricity, which at times made it difficult to complete a questionnaire. The fact remains that for many of the respondents the main priority is to get electricity. One could assume that if their water supply was under threat and insufficient, then water would become their first and top priority.

Some people associated the researcher with the municipality and demanded services and demanded electricity. Even after explaining that the researcher is affiliated with the university, some people seemed to expect that the university should provide electricity. The researcher had to patiently listen and some of the interviews could not be used for the study as respondents refused to cooperate or focus on the questions being asked. Enkanini has become a core site for several researchers from Stellenbosch University and the Sustainability Institute, which partly explains why several residents were sometimes annoyed by having another researcher asking questions and some refused to partake in the study. Even though the intention of doing the research is to better the facilities in Enkanini, some residents are not open to new ideas and alternative ways to upgrade their living conditions. Therefore many of them used the interview as an opportunity to express their other needs and wants, as some were hoping that the researcher would be able to help them by being their connection to the local municipality.

3.7 CONCLUSIONS AND RECOMMENDATIONS

3.7.1 Conclusions

Informal settlements are neglected parts of cities where housing and living conditions are poor. They range from high-density, squalid central city tenements to spontaneous squatter settlements without legal recognition or rights. Enkanini which means, “force” is one of the few completely illegal informal settlements in Stellenbosch and the court order for eviction still stands, however, due to Enkanini’s population size the order will probably be rescinded (Tavener-Smith, 2012). According to the CORC, there are approximately 4 449 residents living in Enkanini. The socio-economic data revealed that Enkanini, in terms of the populations’ age, is relatively young with 55% of the population being between the ages of 20-34 years of age. In terms of gender, male residents are also in the majority at 54%, while 46% of the residents are females (CORC, 2012). In addition, about 31% of the population is unemployed while 46% are employed, which includes full-time employment, part-time employment and self-employment. The average household size of the 95 people who were interviewed is 2-3 occupants per household, and the average income of the entire population in Enkanini is R1 031.11 per household. This explains the large number of people living off social grants, as many of the residents are unemployed. At the moment the predominant grant received by the resident population of Enkanini is the Child Support Grant.

The study investigated the primary uses of water, and the approximate daily volume of water used, as well as community members' opinion on the ideal location of the DRWH multi-tank station. The average person uses 40 L of water per day, uses a 20 L bucket to collect water and walks at least twice a day to collect water. This excludes the respondents that confirmed that they do not close the tap when they are rinsing their laundry. On washing days, those who fill their buckets, close the tap and then rinse their clothes, use on average 80-100 L per day. All of the respondents (100%) reported using municipal water for daily bathing, drinking and cooking, while 97% use it for cleaning the house, 94% to wash clothes and 25% use it to water their garden.

About 61% of the respondents confirmed that they know what rainwater harvesting is, while 32% did not know what it means. Most of the respondents (67%) voiced that they would use rainwater for their daily needs. In determining what they would use the rainwater for, 77% of the interviewed people selected cleaning the house and bathing, 65% selected cooking with rainwater, while 46% will use it for potable or drinking purposes. In a separate question to establish their knowledge of the health risks associated with drinking rainwater, a total of 67% (those who said they always or sometimes drink it) confirmed that they perceive rainwater to be clean and safe to drink. Hence, 56% of the respondents' reported that they would not pre-treat the water before drinking it. This reveals a general lack of awareness of the potential health risks of consuming untreated rainwater. Many of the respondents were pleased with the idea of having warm water, as many said that this would save the time, paraffin and gas needed to heat up the water. In addition, saving gas and paraffin also means that they will save money. About 92% reported they would use warm water for bathing and 71% reported that they would use it to clean the house.

Surveys can only collect self-reported information of recalled past action or of prospective action (Babbie et al., 2001). Respondents expressed a measure of concern regarding water availability, as there were occasions when the municipal tap water supply was not available and residents had to collect water from the school or from the hostel in Kayamandi. The reuse of water would also have been useful in these circumstances. However, the survey revealed that reuse of water is not common practice in Enkanini. In measuring respondents' opinions on municipal water, the majority (82%) said that water should be free. In a related question respondents were asked if they should pay for the water that they use, and 56% in total said no, they should not have to pay for it, while 14% agreed that payment should be made for water utilised. According to the results, the majority of respondents deem the municipal water to be sufficient for drinking, cooking and bathing and washing. Analysing the qualitative data, many of the respondents are in favour of the project and think that harvesting rainwater will benefit the community.

Inadequate living conditions and poverty are however, concentrated in Enkanini and every day residents have to face these difficult circumstances. There are several research projects headed by the Sustainability Institute and Stellenbosch University, which makes some of the residents reluctant to cooperate in yet another project, despite the fact that the research is meant to improve their living conditions. Many residents are dealing with far more pressing challenges, such as providing food for their children or personal safety concerns. Some of the respondents explicitly expressed "We won't support this", and others turned it into a political issue by stating that "white people should deliver and not make empty promises", or that the university should provide them with electricity. Considering these expectations, perceptions and responses, a DRWH multi-tank system project will have to be carefully facilitated in order to gain the support of the community. In addition, the main water source in Enkanini is communal taps and 139 people have to share one tap. For this reason, the implementation of the DRWH multi-tank station remains relevant, as the research team could optimally determine whether the provision of rainwater as an alternative water source could alleviate the stress placed on the communal standpipes and supplement the current water sources.

3.7.2 Recommendations

a) It is recommended that "champions" – such as the translator – be recruited, as proper facilitation by local residents will play a major part in the successful implementation of the project in Enkanini.

"Champions" or co-researchers have the ability to mobilise and influence people around them, while having a vision to better their circumstances as well as the lives of people in the community. In addition, the people of Enkanini will probably respond better to their own local members during the project implementation period than to the research team, because they come from the same social background. The locals recruited can further bridge the communication gap between the researchers and the community as none of the researchers can speak isiXhosa. Should local Enkanini members be recruited to assist with the implementation of the DRWH multi-tank, it is further recommended that they are well compensated for their time, effort and assistance towards the project. Compensation will require their commitment to follow through and deliver on the project.

b) The ERC could be used to create awareness among the community members of what the DRWH multi-tank is, how it functions, the expected outcomes of the research, and, most importantly, how it will serve the community and how they can benefit from the research. This can be done via a poster illustration inside and outside the ERC together with pamphlets distributed in the community. The information on the poster and pamphlets should be printed in isiXhosa and English because most of the people living in Enkanini are isiXhosa speaking or have an understanding of the language. To cater for the illiterate population, it is recommended that the information is visually explained by using pictures or drawings to illustrate how the DRWH-multi-tank works.
    i. In addition, approximately 32% of the people interviewed did not know what RWH is. It is thus recommended that information on what RWH is, and how to optimise the use of rainwater, including the health risks associated with it, be distributed among the people of Enkanini.
c) Currently there are four other projects headed by the Sustainability Institute being implemented in Enkanini. It is recommended that the researchers involved should be briefed on the DRWH multi-tank station project to understand how it works, in order to share the correct information to the community should people ask them questions about the project.
d) It is further recommended that information on saving water should be circulated, as it was evident that people often waste municipal water by running the water taps unattended. To learn how to reuse water in a safe manner could also be shared and communicated to the community.

CHAPTER 4: GUIDANCE ON THE OPERATION AND MAINTENANCE OF THE DOMESTIC RAINWATER HARVESTING SOLAR PASTEURISATION TREATMENT SYSTEMS

4.1 INTRODUCTION

This section reports on the on-site construction and installation of the pilot DRWH systems to produce water for domestic and potable purposes. This section also reports on activities related to training of selected community members in order to supervise the major and continuous maintenance and repair of the DRWH tanks and treatment systems. In addition, a pamphlet guide (in isiXhosa, English and Afrikaans) and user manual containing general information on domestic rainwater harvesting, the identified primary uses per tank and advice on water storage are presented.

4.2 DESIGN AND INSTALLATION OF THE DRWH SYSTEMS

Enkanini was selected as the location for the installation of the rainwater harvesting solar pasteurisation treatment systems as each of the 32 intermittently located municipal standpipes services 139 individuals (Community Organisation Resource Centre, 2012; Tavener-Smith, 2012; Wessels and Swilling, 2015). Two small-scale rainwater harvesting solar pasteurisation treatment systems were subsequently installed at Mr Victor Mthelo's house (Site 1) and Pastor Makhaya Qondani's church (Site 2), respectively, while a large-scale system was installed at the Enkanini Research Centre (ERC, Site 3), where Mr Yondela Tyawa, the co-researcher on the project, is based (Figure 4.1).

Figure 4.1. Two small-scale rainwater harvesting solar pasteurisation treatment systems were installed at Mr Victor Mthelo's home [Site 1 (A)] and Pastor Makhaya Qondani's church [Site 2 (B)], respectively. A large-scale rainwater harvesting solar pasteurisation treatment system was installed at the ERC [Site 3 (C)].

4.3 BUILDING COMMUNITY CAPACITY ON RAINWATER SYSTEMS

Results from the social perceptions study indicated that 61% of the respondents (n = 95) were familiar with the concept of rainwater harvesting and 67% of the respondents were favourably inclined towards using rainwater for their daily needs. However, as 56% of the respondents reported that they would not pre-treat the rainwater before drinking it, a general lack of awareness of the potential health risks associated with the consumption of untreated rainwater was revealed. These findings highlighted the importance of including a pamphlet guide and user manual containing general information on domestic rainwater harvesting and advice on water storage. A workshop was therefore convened at the ERC with all the participating Enkanini residents (Figure 3.2) in order to educate the community on the principles of the rainwater harvesting solar pasteurisation treatment system, as well as to outline the operation and maintenance aspects, and recommended uses of the treated rainwater. In addition a rainwater harvesting poster, containing the core user information, was provided to each of the ten households that will be involved in the pilot research phase of the project.

Figure 4.2. Workshop held at the ERC on Monday 7th September 2015. Representatives from 10 households attended the workshop on rainwater harvesting, water uses and maintenance of the solar pasteurisation systems.

4.4 DEVELOPMENT OF A PAMPHLET GUIDE

4.4.1 Initial pamphlet

The first pamphlet guide meeting was held on the 27th of February 2015 at Stellenbosch University, in the Department of Microbiology. Attendees included, the Microbiology Research Group (Stellenbosch University), Ms Lauren Tavener-Smith (Sustainability Institute) and Ms Theresa Wigley (graphic designer). The standard procedure and information required for designing the rainwater harvesting pamphlet guide was discussed. The Microbiology research group then provided Ms Wigley with an outline of the pertinent information and graphics which should be included on the pamphlet guide. Following the meeting, Ms Wigley provided the Microbiology

research group with an initial pamphlet guide template sketch, which the Microbiology research group then amended to include information on the storage of the rainwater (Appendix J). The Microbiology research group then continued to liaise with Ms Wigley to amend the information presented on the pamphlet guide.

The preliminary pamphlet guide (Figures 3.3 and 3.4) was then presented to the WRC project K5/2368//3 reference group members for comment on 27th of July 2015. After the reference group had discussed the information contained in the pamphlet guide, numerous recommendations and suggestions were made, in order to clarify various concepts.

The following recommendations or suggestions were incorporated on the first page of the pamphlet guide:

1. The wording under the clouds “Collecting rainwater saves energy…… saving energy saves money”, should be changed to “Collecting rainwater provides you with an additional water source at home.”
2. The wording “Water can be used straight from the tank to water your garden”, should be written on the green rainwater tank in white.
3. The wording “Save Energy” under the sun image should be removed and changed to “Water at home”
4. The wording under Save Energy “The water is cleaned and heated in the solar distiller and will come out of the tap warm”, should be changed to “The water is heated in the solar distiller and treated water will come out of the tap.”
5. The entire bottom frame has to change – the bucket frame should stay and remove all reference to drinking water on the first page – then add a second frame at the bottom indicating “This bucket must only be used for storage and collection of rainwater.”
6. The contact details of the co-researcher living in close proximity to all end-users was added at the bottom right corner of the pamphlet.

The following suggestions were incorporated on the second page of the pamphlet guide:

1. The statement at the top of the pamphlet must be changed from “Treated warm rainwater can be used for:” to “Rainwater from the solar distiller can then be used for:”
2. The image of the house should be removed, while the rainwater tank and the solar distiller must be moved to the centre of the pamphlet, with arrows pointing out from the solar distiller to images illustrating various uses of the water.
3. An image with a no drinking sign should be included.
4. The words under each image should be made bigger, e.g. cooking, washing, etc.
5. The wording on the bottom of the frame below the wording “Rainwater in your home”, should be changed from “Can save you time, energy and money”, to “This system can save you time, energy and money.”

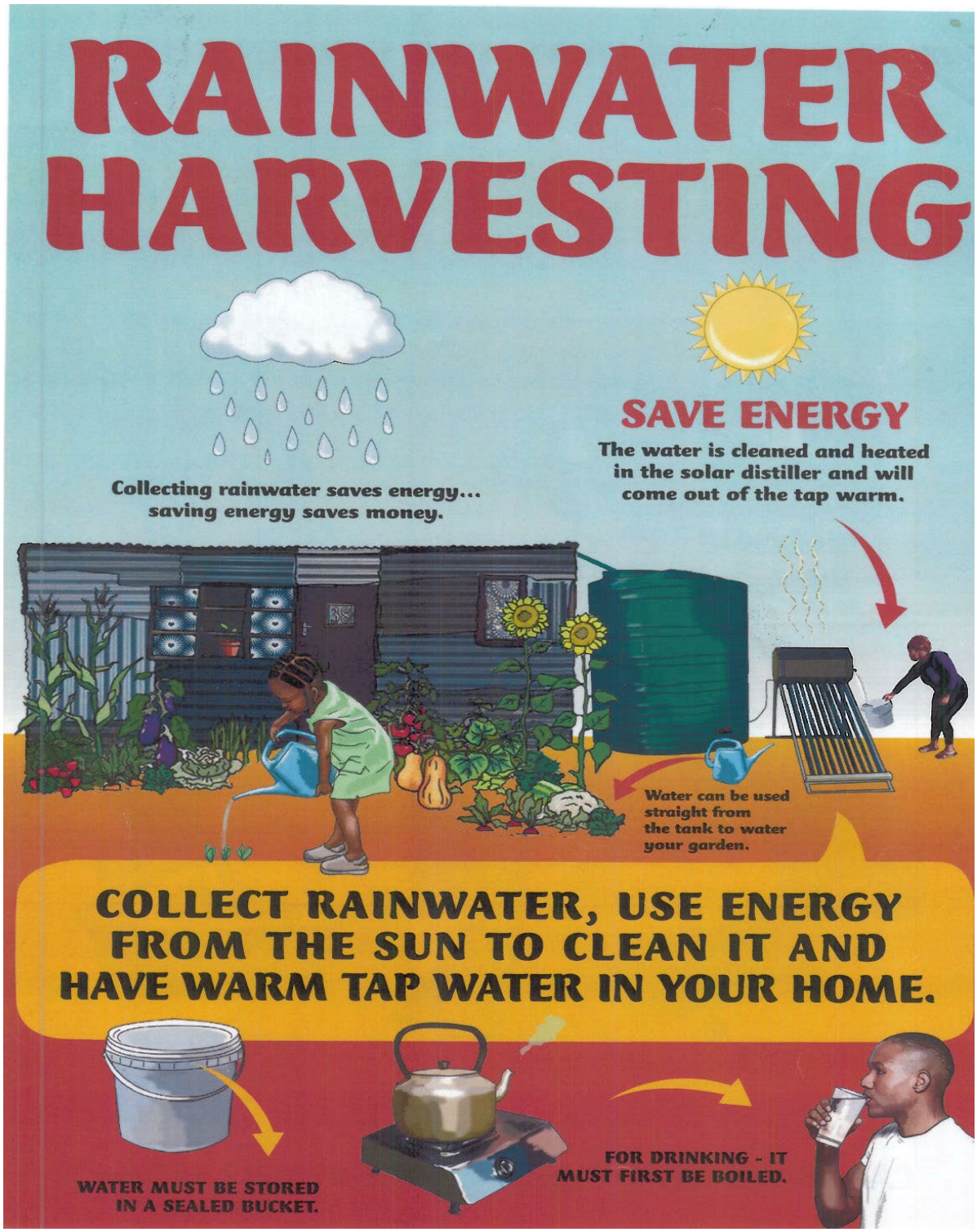

Figure 4.3. The first page of the sample pamphlet guide presented to the WRC project K5/2368//3 reference group members (27 July 2015). An image outlining the small-scale rainwater harvesting solar pasteurisation treatment system is included. Information on water storage and the advantages of rainwater harvesting is also included.

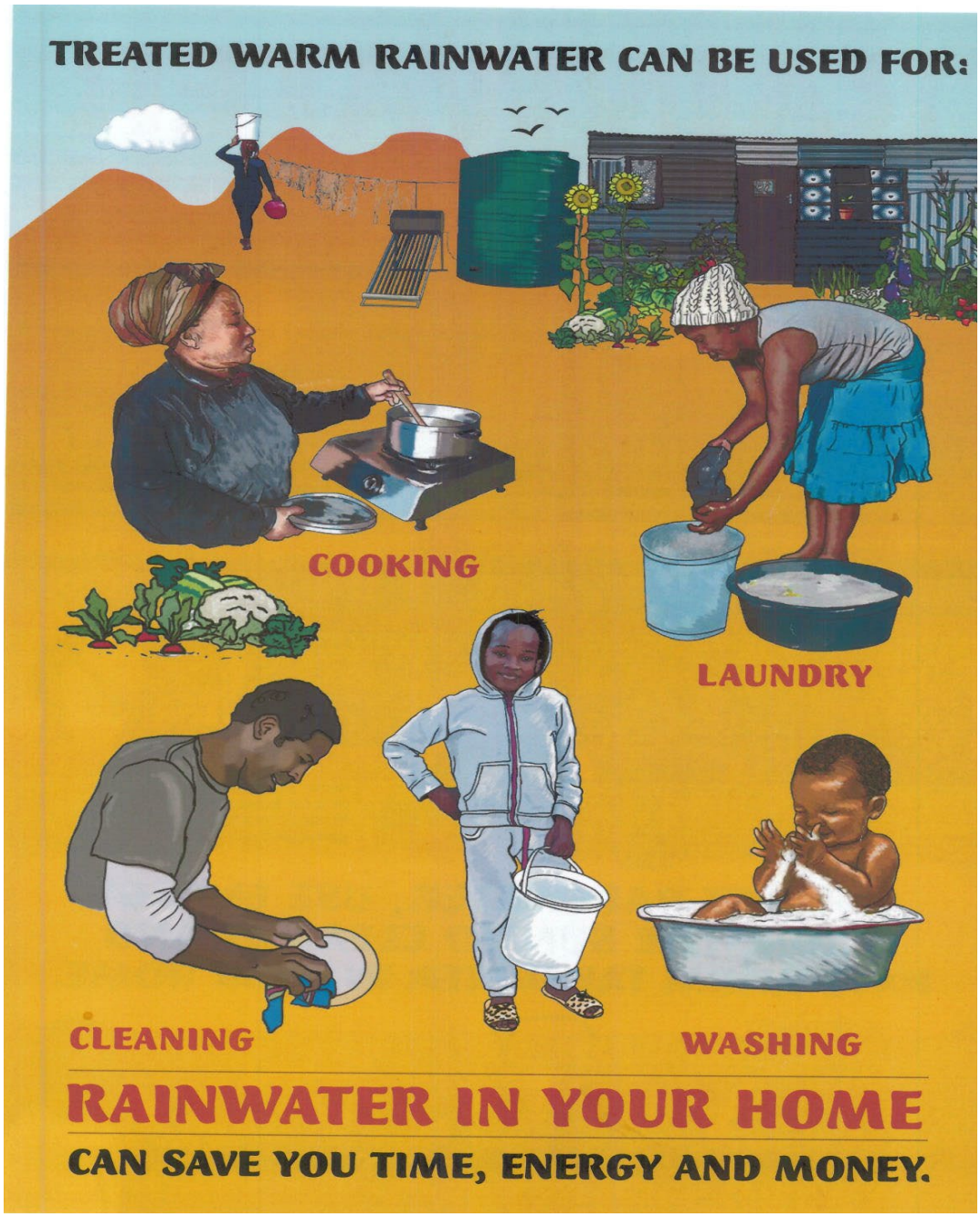

Figure 4.4. The second page of the sample pamphlet guide presented to the WRC project K5/2368//3 reference group members (27 July 2015). The various uses of the treated rainwater are illustrated.

4.4.2 Final pamphlet guide illustrating the uses and storage of treated harvested rainwater

All the suggestions made by the project reference group members were then conveyed to the graphic designer (Ms Theresa Wigley), who incorporated all the recommendations and compiled the final pamphlet guide which is illustrated in Figures 3.5 and 3.6. A meeting regarding the pamphlet guide and the workshop for the launch of the rainwater harvesting solar pasteurisation treatment systems in the Enkanini informal settlement was then held at Stellenbosch University between the Microbiology research group (Stellenbosch University), Ms Lauren Tavener-Smith (Sustainability Institute) and the co-researcher Mr Yondela Tyawa on 24 August 2015. The pamphlet guide was disseminated to all current end-users at the three sites where the rainwater harvesting solar pasteurisation treatment systems have been installed. It was envisioned that by providing the individuals

with a pamphlet guide and presenting the workshop, the users of the on-site systems will be empowered to take ownership and maintain them.

Figure 4.5. The first page of the final English pamphlet guide illustrating the principle of the rainwater harvesting treatment system and its benefits. Information regarding the storage of the rainwater and the contact details of the co-researcher are also provided.

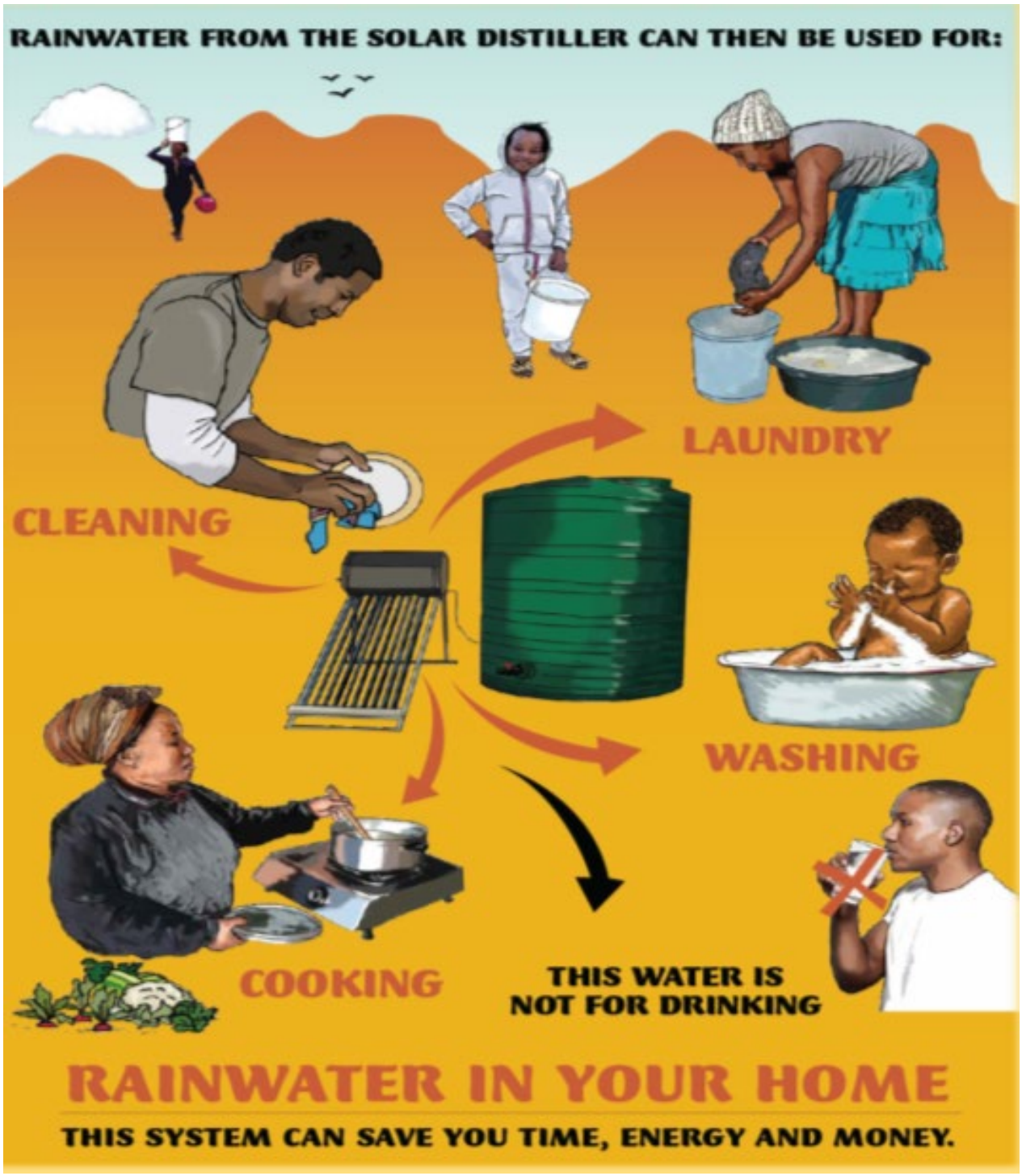

Figure 4.6. The second page of the final English pamphlet guide illustrating the various uses of the treated rainwater.

As the pamphlet guide was only presented in English, Mr Tyawa suggested that it must be translated into colloquial isiXhosa for the end-users to better understand the information included. Mr Tyawa then assisted the Microbiology research group (Stellenbosch University) in translating the pamphlet guide into colloquial isiXhosa (Figures 3.7 and 3.8). It should be noted that the pamphlet was not translated into Afrikaans (not the primary language of the end-users) and is thus only available in English and isiXhosa (first language of all the end-users).

Figure 4.7. The first page of the final isiXhosa pamphlet guide illustrating the principle of the rainwater harvesting treatment system and its benefits. Information regarding the storage of the rainwater and the contact details of the co-researcher are also provided.

As the end-users may find it difficult to display a back-to-back printed pamphlet guide in their houses, it was also decided to convert the two pages of the English and isiXhosa pamphlet guides, respectively into single paged laminated posters, which the end-users could display in their homes as a visual reference (Figures 3.9 and 3.10).

Figure 4.8. The second page of the final isiXhosa pamphlet guide illustrating the various uses of the treated rainwater.

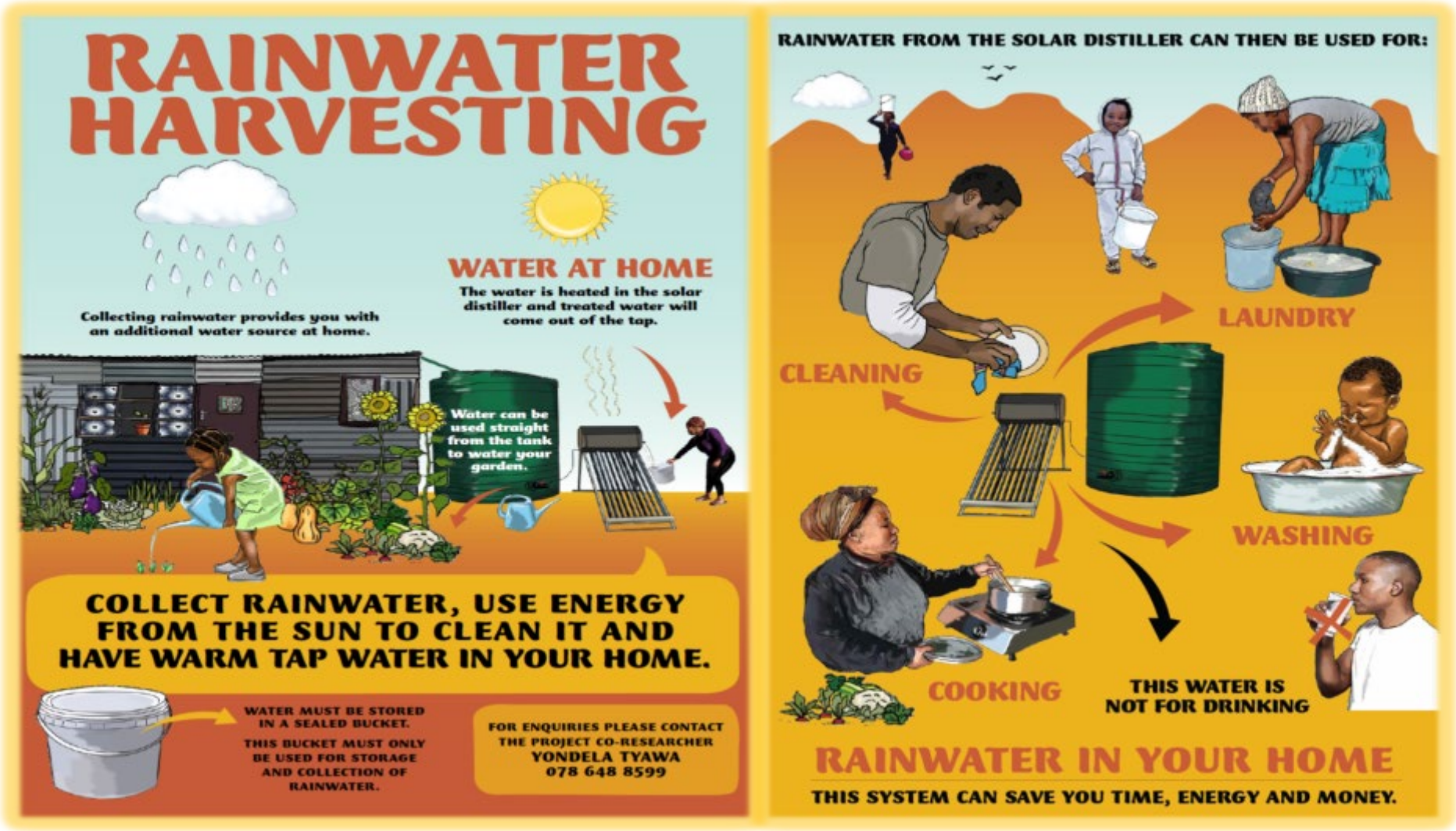

Figure 4.9. The English poster version of the pamphlet guide illustrating the principle of rainwater harvesting, information on the storage of the rainwater, uses of the rainwater, and also the contact details of the co-researcher (Mr Yondela Tyawa).

Figure 4.10. The isiXhosa poster version of the pamphlet guide illustrating the principle of rainwater harvesting, information on the storage of the rainwater, uses of the rainwater, and also the contact details of the co-researcher (Mr Yondela Tyawa).

4.5 MAINTENANCE GUIDE AND USER MANUAL FOR RAINWATER HARVESTING SYSTEMS INSTALLED IN ENKANINI INFORMAL SETTLEMENT

4.5.1 Rainwater Harvesting Workshop Participants

Three rainwater harvesting solar pasteurisation treatment systems were installed in Enkanini informal settlement. The research team from the Department of Microbiology at Stellenbosch University, then coordinated a workshop at the Enkanini Research Centre (ERC) on the 7th September 2015 in order to launch the systems. In total ten households based in Enkanini settlement will be involved in the pilot research phase of the project, and a member from each household was present at the workshop. In addition, Mr Berry Wessels (installation of the systems at the selected sites in Enkanini), Ms Lauren Tavener-Smith (assistance with the preparation of the workshop and associated social studies) and Mr Yondela Tyawa (co-researcher on the project) were present at the workshop. Mr Yondela Tyawa also acted as a translator (English to isiXhosa) during the workshop proceedings. Members of the participating households along with all the key members were invited for lunch at the ERC before the workshop commenced. The aim of the workshop was to welcome participating Enkanini residents to the launch of the rainwater solar treatment system research phase in Enkanini and to explain the principles of the treatment system as well as to outline the maintenance and primary water uses of the treated water.

4.5.2 Colour Scheme for Site Identification

Two small-scale rainwater harvesting solar pasteurisation treatment systems are installed at Mr Victor Mthelo's house (Site 1) and Pastor Makhaya Qondani's church (Site 2), respectively, while a large-scale system is installed at the Enkanini Research Centre (ERC, Site 3), where Mr Yondela Tyawa, the co-researcher on the project, is based.

Each of the sites (1, 2 and 3) are colour coded as follows; the households utilising the system installed at Mr Victor Mthelo's house (Site 1) are assigned the colour red, which means that the key tag as well as the writing on the 20 L container is red. The households utilising the system installed at Pastor Makhaya Qondani's church (Site 2) are assigned the colour green and the households utilising the system at the ERC (Site 3) are assigned the colour blue. The key tags and 20 L containers were then marked in the corresponding colour for each of the sites. Colours were assigned to the various sites so as to easily identify the users of a particular system and so that each household could be responsible for their own 20 L container and set of keys.

Thus, each of the participating households was provided with the following items:

- **Keys**

The keys (containing the corresponding colour key tags) are given to the respective households in order for them to unlock the latch locks connected to the taps of the rainwater tanks and storage tanks of the solar pasteurisation systems (Figure 3.11). It was decided to place latch locks on the taps of each system in order to control the access and accurately monitor the water usage of the rainwater in the systems.

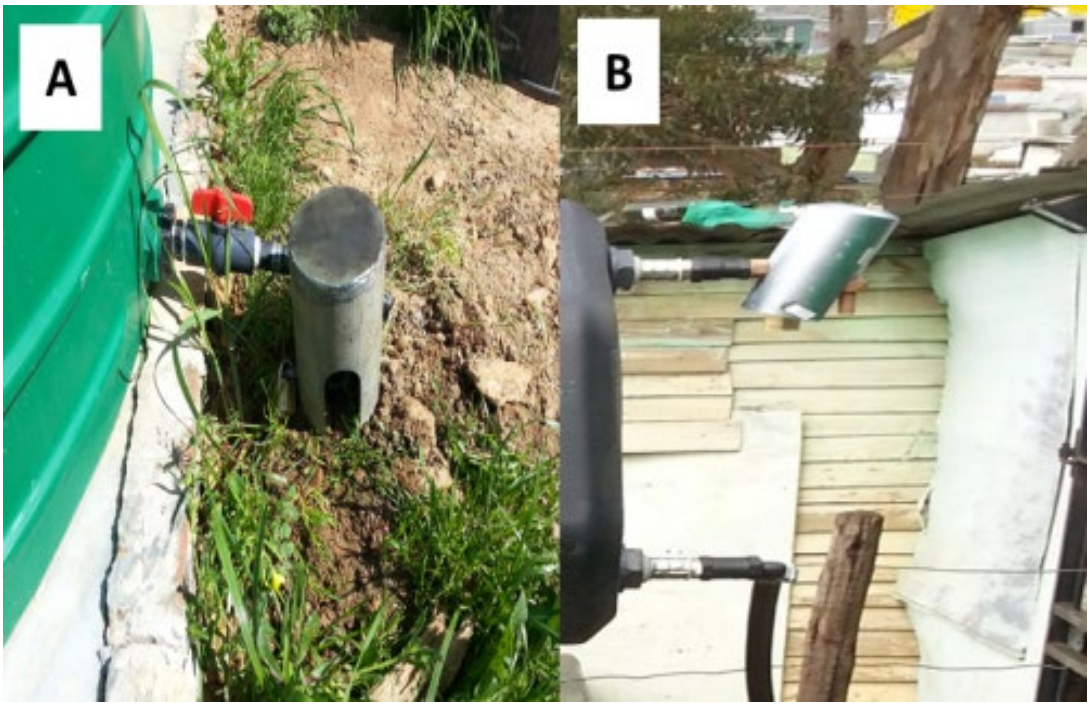

Figure 4.11. The taps connected to the rainwater harvesting tanks (A) and storage units of the solar pasteurisation systems (B) are locked. For this reason each household was provided with a set of keys for the respective latch locks.

Initially only two households opted to utilise the systems installed at Mr Victor Mthelo's house and Pastor Makhaya Qondani's church sites, respectively. However, during the workshop one more household for each site requested the use of each system. Thus, in total, three households opted to utilise the systems installed at Sites 1 and 2, respectively, while four households opted to utilise the system installed at Site 3. For this reason only two sets of keys (that were distributed to the households) are indicated in Figure 3.12 for Sites 1 and 2. However, the two additional households that will be utilising the systems at Sites 1 and 2 have since received a set of keys. The number on the key tag thus corresponds to a specific household utilising a system at a particular site.

Figure 4.12. Each household that opted to utilise the systems installed at Mr Victor Mthelo's house (Site 1), Pastor Makhaya Qondani's church (Site 2), and the Enkanini Research Centre (ERC, Site 3), was handed a key with a colour tag corresponding to the system they were going to utilise.

One of the aims of the Microbiology research group is to monitor the availability and utilisation of pasteurised rainwater by the participating households. For this reason, the members of the households are advised to keep the taps locked at all times, unless they are using it. The taps will need to be unlocked and then locked again once they have collected their required amount of harvested rainwater. In addition, the solar pasteurisation systems have been locked to prevent children from opening the taps and accidently burning themselves with the hot treated rainwater. The sharing or lending of keys to other Enkanini residents (who did not attend the workshop) and allowing them access to the rainwater systems is strongly discouraged as this will affect the predicted water availability for each household.

- **Water collection containers (20 L)**

The 20 L containers are provided to the households specifically for the collection of pasteurised rainwater (Figure 3.13). Corresponding to the keys, the containers are also colour coded; ERC (blue), Pastor Makhaya Qondani's church (green) and Mr Victor Mthelo's house (red). The containers are thus labelled in a particular colour, with the respective site and a number representing the household; 1 to 4 for the ERC and 1 to 3 for Sites 1 and 2, respectively. The number on the 20 L container corresponds to a specific household utilising a system at a particular site. The caption "amanzi emvula" is also indicated on each container which translates to "rainwater".

The household members are requested to utilise the 20 L containers for pasteurised rainwater collection only (Figure 3.13). Other uses, including the collection of standpipe water, are discouraged, as residual pasteurised rainwater may contaminate standpipe water. The representative members of the households are also instructed to keep the containers tightly sealed at all times, in order to minimise the amount of contamination (insects and aerosols) of the stored pasteurised rainwater. In addition, household members are instructed not to clean the containers with any detergents as this may also influence the quality of the stored rainwater. If hot (>72˚C) treated rainwater is collected from the systems at Sites 1 and 2, and the lid of the container is kept tightly sealed, the water may be stored for approximately one week. As the treated water from the system installed at the ERC flows directly into a holding tank, it is recommended that the water is utilised soon after collection. However, analysis on the storage period of the treated water from this system will be conducted and a final recommendation will be made at the end of the study period.

Figure 4.13. Each household utilising the installed systems at each site, namely, Mr Victor Mthelo's house (Site 1), Pastor Makhaya Qondani's church (Site 2), and the Enkanini Research Centre (ERC, Site 3), were given colour coded containers for pasteurised rainwater collection.

- **IsiXhosa pamphlet and poster guides**

IsiXhosa pamphlets and poster guides were provided to the participating households (Figure 3.14). The poster illustrates the purpose of rainwater harvesting and solar pasteurization and the various uses thereof. Each household was also provided with Prestik as the participating members are encouraged to display the posters in their homes as a visual reference guide.

Figure 4.14. To aid in the understanding of utilising a rainwater harvesting solar pasteurisation treatment system, each of the participating households were handed keys, containers, pamphlets, posters and gifts.

- **Small gift**

Each participating household was provided with a small gift as a token of appreciation for participating in the project (Figure 3.14). A bar of soap and sponges were selected, to encourage the use of pasteurised harvested rainwater for domestic purposes.

4.5.3 The sampling of harvested rainwater and pasteurised rainwater by Stellenbosch University

The Microbiology research group will collect unpasteurised and pasteurised tank water samples from each site in Enkanini for the duration of one year (September 2015 until September 2016). Members of the research group have their own set of spare keys for the locks on each system so the members of the households participating in the study will not be disturbed at any time. The participating members should however be aware that samples from their systems will be collected and they are free to enquire about the results obtained on the quality of the harvested rainwater during the research period. The analysis that will be performed on the pasteurised and unpasteurised rainwater samples will include microbial parameters including the enumeration of total coliforms, *Escherichia coli* (*E. coli*) and heterotrophic bacteria. In addition, the pasteurised and unpasteurised rainwater samples will be screened for the presence of selected bacterial genera, considered ubiquitous in rainwater sources, using conventional polymerase chain reaction (PCR). The chemical parameters that will be investigated include the concentration of anions and cations present in the pasteurised and unpasteurised rainwater samples.

In addition, every Friday at approximately 12h00, Mr Yondela Tyawa will require that members of the participating households answer a questionnaire. The two questions that the they will be asked are, “How much water did you collect from the solar systems per day (how many times per day using the 20 L water container provided)?” and “How much water did you collect from the standpipe/tap systems per day (how many times using another container)?” These results will then be recorded in water usage logbooks for each site

(Figure 3.15). Mr Yondela Tyawa was also supplied with a thermometer as he will be monitoring and recording the temperature of the pasteurised rainwater on a weekly basis.

Date	Day	ERC 1 [ ]	ERC 2 [ ]	ERC 3 [ ]	ERC 4 [ ]	Temp °C 12h00 Friday
		Rainwater	Rainwater	Rainwater	Rainwater	
07-Sep-15	Mon					
08-Sep-15	Tue					
09-Sep-15	Wed					
10-Sep-15	Thu					
11-Sep-15	Fri					
12-Sep-15	Sat					
13-Sep-15	Sun					

B

Figure 4.15. (A) Logbooks that Mr Yondela Tyawa will use to record the water usage of each household from the solar pasteurisation system (Sites 1 and 2) and 1500 L storage tank (Site 3). Additionally, a logbook will be used to record municipal standpipe water usage. (B) Example of the inside of the logbook. Mr Yondela Tyawa can insert the name of the household in the brackets provided. Water usage will be recorded for each day and the temperature of the solar systems water measured at 12h00 every Friday.

4.5.4 The components of the rainwater harvesting solar pasteurisation treatment systems

Rainwater harvesting involves the collection of rainwater from a catchment surface and the subsequent storage of the water for later use. The rainwater harvesting systems installed in Enkanini are comprised of four basic components:

- **The catchment area**

The roof surface of a building serves as the catchment area for the rainwater. In Enkanini the roofing material is predominantly composed of zinc and aluminium sheeting. The quality of the rainwater may then depend on the roofing material utilised to construct the roof, the climatic conditions (frequency of rainfall), and the surrounding environment (aerosols, including pesticide residues). A pilot phase research project on the influence of the catchment material on the quality of rainwater is however, being conducted at Welgevallen Experimental Farm, Stellenbosch University.

- **Gutters**

Half-round PVC gutters have been installed along the roof tops of the houses at the respective sites. Gutters will then channel the water down from the catchment area into the collection tanks. The roofing materials of the houses exhibit a “valley” configuration, thus the gutters have been placed along one side of the houses, allowing for the harvested rainwater to flow into the gutters.

- **Storage tank**

The rainwater storage tank is connected to the gutters. The storage tank is the most expensive part of a rainwater system and based on the square meters of the roof catchment system as well as space availability at a particular site, different sizes of storage tanks are installed at each site. The storage tanks are green polypropylene tanks and are closed with a lid to avoid contamination. The tank lid should also remain closed at all times in order to avoid the entry of insects and other pollutants. The tanks are located at the primary locations (Sites 1, 2 and 3) and the households utilising a particular system are situated in close proximity to that site. The weight of water is approximately 0.959 kg per litre so a 5 000 L tank, when full of rainwater, will weigh 4 795 kg (just under 5 tonnes), the rainwater tanks have thus been installed on reinforced cement blocks and are secure. The participating residents should be mindful of the tank overflowing during heavy rainfall and should monitor whether any corrosion of the soil is appearing.

- **Treatment system**

The harvested rainwater in the tanks may not be used directly for drinking purposes, and for this reason, solar pasteurisation systems have been installed at each site to treat the water. The size of the catchment area (roof) of the ERC (Site 3) is larger than the catchment areas of Pastor Makhaya Qondani's church (Site 2) and Mr Victor Mthelo's house (Site 1), and sufficient space was available for the installation of the system at the ERC. A larger solar pasteurisation system is thus installed there. The principle for water treatment in the small- and large-scale solar pasteurisation treatment systems is the same (solar radiation is used to heat water), however the working mechanism of the systems differs.

The harvested rainwater flows through the solar pasteurisation systems components (installed at Sites 1 and 2) in the following manner: the water moves from the green rainwater harvesting tank into the black tubes (borosilicate) of the solar pasteurisation system; as the sun heats the black tubes the water will become warmer and rise into the storage tank. It is very important to note that the water is heated to temperatures as high as 95°C. Based on the UV rays, the water in the solar system is thus **VERY HOT** and it is strongly advised that children do not tamper with the systems, and individuals collecting the pasteurised water should take the necessary precautions. As indicated in Figure 3.16, the locks placed on the systems will hopefully deter children and "NO ENTRY" signs have been placed on each system as a warning. It should be noted, however, that as the solar pasteurisation systems rely on UV and ambient temperature, the temperature of the water inside the storage units will fluctuate. For example, in the morning the temperature of the water from the solar systems may be cooler and will rise again once the ambient temperature increases throughout the day.

Figure 4.16. As a precautionary measure each of the systems have been locked and a "NO ENTRY" sign is indicated on each of the storage tanks of solar pasteurisation systems located at Sites 1 and 2.

The “NO ENTRY” sign has been attached directly to the manifold of the solar pasteurisation system located at the ERC (Figure 3.17). Unlike the two small-scale solar pasteurisation systems installed at Sites 1 and 2, the solar pasteurisation system at the ERC does not have a storage unit, the water will therefore move through the pasteurisation system directly into the holding tank (1 500 L) once the thermostatic release valve opens. In contrast to the small-scale systems, in the large-scale system the water is not treated in the borosilicate glass tubes. The borosilicate glass tubes in the large-scale system contain solar heat transfer rods which facilitate the heating of the rainwater. The solar heat transfer rods are connected to the top part of the solar system manifold and transfer heat to the water as it passed through the borosilicate tubes. Once the water reaches an excess of 75°C the thermostatic release valve opens and the water exits into the 1 500 L storage tank.

Figure 4.17. The solar pasteurisation system connected to the rainwater harvesting tank at the ERC (Site 3). The “NO ENTRY” sign is attached to the manifold as the solar pasteurisation system does not have a storage unit. The treated rainwater thus flows into a holding tank.

The quality of the harvested rainwater will improve due to pasteurisation, but the water in the holding tank will not be hot. The tap located at the top of the system (indicated by a yellow arrow), will however release hot water, but this is solely for sampling purposes, as it is estimated that approximately 5 L will flow out of the tap, and then as the borosilicate tubes fill up with rainwater again from the rainwater tank, contaminated water will flow along the top of the manifold, and this water will not then be safe to use for domestic purposes.

4.5.5 Quality and Uses of Harvested Rainwater

Rainwater has been used for centuries, but is gaining increased popularity for domestic use in South Africa, due to the decrease in available water sources. Rainwater has been described as soft, has a nearly neutral pH and does not contain any by-products that are normally associated with disinfection procedures such as chlorination. The taste of rainwater may also be preferable and due to its softness will not corrode or scale any appliances. Benefits of rainwater harvesting include:

- Rainwater is free
- There is no need for complex distribution systems as the source of water is located where it will be utilised

- Rainwater may augment standpipe water when in limited supply
- Appliances last longer due to the softness of rainwater
- By harvesting the rainwater, the amount of water that flows into the stormwater drains will be limited, thereby reducing the amount of non-point source pollution and decreasing the load on storm drainage systems
- The rainwater systems function in a passive manner and the pasteurisation systems require solar energy thus the expense of electricity is not required

Rainwater harvesting may be a practical alternative water resource; however, this will depend on the volume and frequency of rainfall, the size of the catchment area and how often the harvested rainwater systems are utilised. As rainwater falls onto the catchment area, namely the roof, it may be polluted by many contaminants including faeces of animals such as birds and rats, and aerosols from the atmosphere. The level of contamination may then increase for rainwater systems located in industrial and urban areas. As many of the participating households originate from the Eastern Cape, the concept of rainwater harvesting was not new. However, they were unaware of the fact that the collected rainwater should not be used for potable purposes, as they indicated that individuals living in the Eastern Cape do use the water for drinking. It should thus be highlighted that the quality of the harvested rainwater collected in the rainwater tanks is not of a potable standard, and households are advised not to drink the harvested rainwater, as the air quality in a town such as Stellenbosch will differ from the quality of air in the rural areas of the Eastern Cape. Microbiological contaminants of harvested rainwater include bacteria, protozoa and viruses, which indicate the poor quality of the harvested rainwater.

As studies are still being conducted, it is strongly recommended that the treated water is not used for drinking purposes. However, the rainwater available in the green tank may be utilised for irrigation purposes, for example a vegetable garden may be watered with harvested rainwater from the tank. Additionally, the treated rainwater available in the pasteurisation tanks at Sites 1 and 2 and in the holding tank at Site 3, may be used for domestic activities such as:

- Cleaning of houses
- Bathing
- Cooking (the water would thus be boiled before consumption)
- Laundry

The Microbiology research group (Stellenbosch University) is currently analysing the chemical and microbial quality of the pasteurised rainwater. An overview of the results for all the analysis including the temperatures of the pasteurised rainwater, and the availability and quality of the rainwater will be made available to the participants. As no South African standards currently exist for harvested rainwater quality, the quality of the harvested rainwater will be compared to the drinking water guidelines according to the South African National Standards (SANS) 241 (South African Bureau of Standards, 2005), Department of Water Affairs and Forestry (DWAF, 1996), the Australian Drinking Water Guidelines (ADWG) (NHMRC and NRMMC, 2011) and the World Health Organisation (WHO, 2011). Comparing the data from the analyses to the respective drinking water standards will determine whether or not, in the future, pasteurised rainwater can be used for drinking purposes.

Another workshop will then be conducted at the end of the sampling period and this will allow for the communication of final recommendations to be made to the members of the participating households. At the final workshop, members of the participating households will also be asked for recommendations on how the systems can be improved.

4.5.6 Maintenance of the Systems

Maintenance of the solar pasteurisation and rainwater systems is ongoing and includes:

- **Monitoring the level of water inside the tanks**

As the Western Cape experiences a low rainfall during the summer period, members of the participating households are requested to inform Mr Yondela Tyawa when the solar pasteurisation systems and rainwater tanks are empty, i.e. rainwater is no longer available in the systems. During the high rainfall period (March to September), rain will fall onto the catchment area, then flow into the large rainwater tank via the gutters. It is predicted that the heavy rainfall will discontinue from the month of October. While the tanks are empty, it is requested that the project participants do not fill the rainwater tanks with standpipe water (municipal water). Mr Yondela Tyawa will also monitor whether standpipe water is being stored in the tanks during his weekly Friday visits.

- **Cleaning the gutters and catchment areas**

As first flush diverters have not been installed between the catchment area and the rainwater tanks, it is recommended that any debris, such as leaves and dust, be removed from the gutters and catchment areas before the rainfall period in winter.

- **Repairing and maintaining the system**

The quality of the harvested rainwater should not be affected by the activities of individuals and it has therefore been requested that members should refrain from placing items such as black garbage bags on top of the green rainwater tanks, the holding tank at the ERC (Site 3) or on the solar pasteurisation system storage tanks at Sites 1 and 2. The lid of the rainwater tank should not be removed at any time. Additionally, the heating and treating of the water will depend on direct sunlight onto the solar pasteurisation system and has therefore been advised, that where possible, activities such as hanging a clothing line over the system should be avoided.

- **Using the water efficiently**

As water is a precious resource, the harvested rainwater should be used when necessary and not wasted. For example, if the water is to be used to wash a car, a bucket should be used instead of attaching a hose to the harvested rainwater tank.

- **Cleaning the black tubes**

During the course of the year, the black borosilicate tubes of the pasteurisation systems may become covered in dust. As the efficiency of the solar pasteurisation systems relies on UV penetration, maintenance will include washing the tubes at least once a month to remove the dirt. Mr Yondela Tyawa will be monitoring the cleaning of the tubes during his weekly visits to the respective sites.

- **Repairing the leaks on the solar and rainwater harvesting system**

Should any of the systems' components malfunction or break, Mr Yondela Tyawa should be contacted immediately so that adjustments can be made. For example, if a borosilicate tube breaks or cracks, or a participating household member loses one of their keys, Mr Tyawa should be contacted. Households that will be utilising the rainwater and solar pasteurisation systems are encouraged to contact Mr Tyawa should any problems arise during the course of the year. Mr Tyawa will then contact the Microbiology research group regarding maintenance issues.

4.6 CONCLUSIONS

Although pilot-scale studies have indicated that solar pasteurisation is effective in treating harvested rainwater, on-site monitoring of the treatment efficiency and operational sustainability of the systems is required in order

to determine whether it will be a viable alternative and provide an additional water source to individuals residing in informal settlements. Two small-scale and one large-scale rainwater harvesting solar pasteurisation treatment systems were, therefore, installed on-site in the Enkanini informal settlement. It was rationalised that the establishment of these decentralised systems would improve the quality of lives of the individuals in the informal settlement, by providing not only water on site, but also a source of hot water (Sites 1 and 2).

However, it also became clear that without knowledge and the necessary training to maintain and use the tank and solar system optimally, it was possible that this project will not be sustainable. It was thus envisioned that by providing the individuals with a pamphlet guide and completing the workshop, the users of the on-site systems would be empowered to take ownership and maintain the rainwater harvesting solar pasteurisation treatment systems. The aim of the workshop was thus to welcome participating Enkanini residents (10 households) to the launch of the rainwater solar treatment system research phase in Enkanini and to explain the principles of the treatment system as well as to outline the maintenance and primary water uses of the treated water.

The efficiency of the small-scale and large-scale pasteurisation systems in treating harvested rainwater at different pasteurisation temperatures, will be assessed throughout a year. The microbial parameters that will be investigated include the enumeration of total coliforms, *E. coli* and heterotrophic bacteria. In addition, the treated and untreated rainwater samples will be screened for the presence of selected bacterial genera, considered ubiquitous in rainwater sources, using conventional polymerase chain reaction (PCR). The chemical parameters that will be investigated include the concentration of anions and cations present in the treated and untreated rainwater water samples. Readings for both solar radiation and the temperature of the rainwater collected from the pasteurisation systems will be recorded. The volume of potable water that the system could produce at a given temperature will also be determined. Additionally, Mr Yondela Tyawa will determine the daily water use from the rainwater harvesting solar pasteurisation treatment system and municipal standpipe water use for each of the ten participating households.

A workshop will then be conducted at the end of the sampling period and this will allow for the communication of final recommendations to be made to the members of the participating households. The households will also be granted the opportunity to provide recommendations to the research group as to how the systems can be improved.

4.6.1 Recommendations

a) When organising a workshop, it is important to ascertain which date and time the individuals will be available. It is also important to allow for extra time at the start of proceedings as some individuals travel from a distance (households from Site 1) and some mothers need to bring their children along, which could increase travel time.
b) It is advised that a small thank you gift be provided to the participating individuals in appreciation for their participation in the project. This small gesture of appreciation goes a long way in building research relationships with the project participants.
c) It is also quite possible that more individuals will attend the workshop and will want to be included in the on-site study than was initially planned for. It is therefore recommended that extra posters, keys, 20 L containers etc. be available at the workshop so as to accommodate any additional households.
d) During discussions with the participating individuals, it became clear that posters are preferable to pamphlets. Additionally, the isiXhosa poster was preferred over the English version.
e) An English user manual has been compiled for Mr Yondela Tyawa to keep at the ERC; however, if an isiXhosa version is requested, the Microbiology research group will have the user manual translated.
f) It is important that a Xhosa translator be present when information is conveyed to the participating residents. Although the majority of the individuals understand English, the use of a translator could

negate any possible confusion, and by repeating all the information in both English and isiXhosa, the chances of information retention by the individuals is improved.

g) It is important that information pertinent to the understanding of the project is translated into a local dialect. The pamphlets were thus translated into colloquial isiXhosa, as not all the individuals speak traditional isiXhosa (as is used by the University).

h) A question and answer session will greatly improve the participants' understanding of the workshop, as it allows them to participate and make suggestions and raise possible concerns.

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APPENDIX A: CONSENT FORM AND ENGLISH QUESTIONNAIRE

SURVEY OF COMMUNITY PERCEPTIONS ON UTILISING RAINWATER HARVESTING IN ENKANINI

CONSENT TO PARTICIPATE IN RESEARCH

Hello!

I work at Stellenbosch University's Water Institute, and would like to ask you to help me with a study I am doing for the Water Research Commission.

I want to learn what the community members of Enkanini think about collecting rainwater in tanks which will be provided at selective locations next year, 2015. I want to find out whether the harvested rainwater could help community members of Enkanini, or not.

I would like to talk to you, as a community member, about this for about 10 to 15 minutes. I will ask you questions on this form, and write your answers on the form.

This study will not be used to tell the Water Research Commission, Stellenbosch University or the government about what you do with the water, or how you feel about the tank, or what you think about collecting rainwater. For this reason, I will not write your name or your address anywhere on this form.

You can choose if you want to be in this study or not. If you choose to talk to me, but feel unhappy in any way, or do not like the questions I ask you, please tell me. You do not have to answer any questions that you don't want to answer, and we can stop at any time.

If you have any questions or are unhappy about what we talked about, please contact me Dominique Mannel on 021 436 0999 or Wesaal Khan on 021 808 5803.

Before we begin, please answer the following questions by ticking "Yes" or "No"`:

Do you understand what I explained to you?	Yes	No
Do you understand that nobody except me will know what you tell me today?	Yes	No
Do you understand that we can stop at any time?	Yes	No
Do you have any questions that you want to ask me before we start?	Yes	No
Can I start asking you the questions on the form?	Yes	No

Signature of respondent: _____

Date: _____

I have explained the project and the implications of being interviewed to the respondent, and I believe that the consent is informed and that he/she understands the implications of participation.

Name of interviewer: Dominique Mannel

Signature of interviewer:_____

Date: _____

Q. no. | | | |

INTERVIEW SCHEDULE

A1. How often do you use municipal tap water?
1 Daily
2 A few times a week
3 Less often than weekly
4 Never

2. For what do you use the tap water? (select all that apply)
1 Gardening 2 Cooking 3 Drinking
4 Washing clothes 5 Cleaning the house 6 Bathing
Other [specify]: ……

3. What is the distance that you have to walk to collect water?
1 less than 1km
2 1-2km
3 2+km
4 if more than 2km, please indicate how far .....
5 unsure

4. How many times per day do you walk to fetch water for the household?
1 1
2 2
3 3
4 4
5 If more than five times per day, please indicate how often.
……

5. What bucket size do you use to fetch water?

1. 5 L
2. 10 L
3. 20 L
4. If bigger than 20 L, please specify.....

6. When you do laundry and rinse your clothes, do you run the tap water continuously until all the soap is out of the clothes?
1 Yes
2 No
3 Sometimes
4 N/A (I do not do the laundry)
5 Do not wish to answer

7. When you do laundry and rinse the clothes, do you fill the bucket with clean water, close the tap and then rinse the clothes in the bucket?
1 Yes
2 No
3 Sometimes

4 N/A (I do not do the laundry)
5 Do not wish to answer

7.1 If yes or sometimes to the previous question, how often do you refill the bucket to rinse the clothes?
1 Once
2 Twice
3 Three times
4 More than 3 times. Please specify.....

8. Do you know what rainwater harvesting is?
1 Yes
2 No
3 Unsure

Researcher will explain in short what rainwater harvesting (RWH) is: RWH is collection of rainwater into a tank/container. The harvested water can be used for cleaning, watering one's garden, bathing and if treated, also for drinking and cooking.

9. Next year in 2015, SU aims to provide project participants with a multi-tank system. This is a pilot plant (in other words a TEST) to see if the rainwater can be treated to make it safe to drink.
Because it is a test, only project participants will benefit from the harvested rainwater. Will you use the rainwater for your daily needs?

1 Yes. Please explain. ……..
2 No. Please explain …….
3. Unsure
4. Do not wish to answer.

10. Where do you think will be the best location to put the tanks?
……
10.1 Why ?
.....
.....

11. If the tank is close to your house, would you use the harvested rainwater instead of municipal water?
1 Yes
2 No
3 Never
4 Sometimes
5 I will use both rainwater and municipal water

12. Do you think your neighbours would use the harvested rainwater?
1 Yes
2 No
3 Never

13. Should the tank be far from your house, would you walk to the tank to fetch rainwater? Or would you only walk to make use of municipal tap water?
1. I will walk to the tank to use rainwater.
2. I will only walk to the municipal tap water.
3. I would walk and use both rainwater and municipal tap water.

4. I don't know.
5. Do not wish to answer.

14. Next year, when the tanks are here, how often do you think would you use the rainwater in the tank?
    1 Daily
    2 A few times a week
    3 Less often than weekly
    4 Never

15. For what would you use the water in the tank? [select all that apply]
1 Gardening 2 Cooking 3 Drinking
4 Washing clothes 5 Cleaning the house 6 Bathing
Other [specify]: ……

16. Should the water in the tank be warm, what would you use it for?
1 Gardening 2 Cooking 3 Drinking
4 Washing clothes 5 Cleaning the house 6 Bathing
Other [specify]: ……

17. Will it help you to have warm water in the tank?
1. Yes. Why?.....
2. No. Why? .....
3. Don't know.
4. Do not wish to answer.

B. ACCESS TO AND MANAGEMENT OF WATER

1. Would you use the rainwater in the tank for drinking?
1_ Yes, always
2_ Yes, sometimes
3 No, never

1.1. If yes, would you pre-treat the water first?
1 Yes, always
2 Yes, sometimes
2 No, never

2. How often do you:

		Never	Rarely	Some-times	Often	Don't know	Don't want to answer
a.	have disagreements with family/community members over water?	1	2	3	4	9	0
b.	worry about a lack of water?	1	2	3	4	9	0
c.	reuse water? Use water more than once? E.g. First bath, then clean the house with the same water?	1	2	3	4	9	0

3. Please tell me whether you agree or disagree with the following statements:

		SA	A	U	D	SD	Don't know	Don't want to answer
a.	Water should be free for everyone	1	2	3	4	5	9	0
b.	Everyone should pay for the municipal water they use	1	2	3	4	5	9	0
c.	We should have access to clean municipal water	1	2	3	4	5	9	0
d.	Collecting rainwater is a good thing	1	2	3	4	5	9	0

4. Do you get enough water from the municipality for:

		More than enough	Enough	Unsure	Not enough	Not at all enough	Don't know	Don't want to answer
a.	drinking?	1	2	3	4	5	9	0
b.	cooking?	1	2	3	4	5	9	0
c.	washing?	1	2	3	4	5	9	0
d.	bathing?	1	2	3	4	5	9	0

5. Is there anything else you would like to tell me about the things we spoke about?

……

……

6. How many people live on your site?

……

Thank you for your time. Enjoy the rest of your day!

APPENDIX B: CONSENT FORM AND QUESTIONNAIRE IN isiXHOSA

UPHANDO LWEEMBONO ZOLUNTU
NGOKUSEBENZISA AMANZI AGCINIWEYO
EMVULA KWINGINGQI
YASENKANINI

IMVUME YOKUTHATHA INXAXHEBA KOLU PHANDO

Molo!

Ndisebenza kwiZiko lemicimbi yezaManzi kwiYunivesithi yase-Stellenbosch, kwaye ndinqwenela ukukucela ukuba undincede kolu phando ndilwenzayo lweKomishini yoPhando ngaManzi.

Ndifuna ukwazi ukuba amalungu oluntu aseNkanini acinga ntoni ngokuqokelela amanzi emvula kwiitanki eziza kubekwa kwiindawo ezikhethiweyo kulo nyaka uzayo, ngo-2015. Ndifuna ukufumanisa ukuba ingaba amanzi agciniweyo angaluncedo kusini na kumalungu oluntu ase-Enkanini, okanye hayi.

Ndinqwenela ukuthetha nawe, njengelungu lasekuhlaleni, malunga noku imizuzu eli-10 ukuya kweli-15. Ndiza kukubuza imibuzo ekolu xwebhu, ze ndibhale iimpendulo zakho kolu xwebhu.

Olu phando alusayi kusetyenziselwa ukwazisa iKomishini yoPhando ngaManzi, iYunivesithi yase-Stellenbosch okanye urhulumente ngento oyenzayo ngamanzi, okanye ngendlela oziva ngayo ngetanki yamanzi, okanye into oyicingayo ngokuqokelela amanzi emvula. Ngenxa yesi sizathu, andisayi kulibhala igama lakho okanye idilesi yakho naphi na kolu xwebhu.

Uvumelekile ukukhetha ukuba kolu phando okanye ungangeni kulo. Ukuba ukhetha ukuthetha nam, kodwa uziva ungonwabanga ngayo nayiphi indlela, okanye awuyithandi imibuzo endikubuza yona, uncede undazise. Akunyanzelekanga ukuba uphendule nayiphi imibuzo ongathandiyo ukuyiphendula, kwaye singayeka nanini na.

Ukuba unemibuzo okanye awonwabanga ngento esithetha ngayo, nceda uqhagamshelane nam uDominique Mannel kwa-021 436 0999 okanye u-Wesaal Khan kwa-021 808 5803.

Ngaphambi kokuba siqalise, ndicela uphendule le mibuzo ilandelayo ngokuphawula ku-“Ewe” okanye ku-“Hayi”:

Uyayiqonda into endikuchazele yona?	Ewe	Hayi
Uyaqonda na ukuba akakho omnye umntu ngaphandle kwam oza kwazi ngento ondixelele yona namhlanje?	Ewe	Hayi
Uyaqonda na ukuba singayeka nanini na?	Ewe	Hayi
Ingaba unayo imibuzo ofuna ukundibuza yona ngaphambi kokuba siqalise?	Ewe	Hayi
Ndicela ukuqalisa ukukubuza imibuzo ekolu xwebhu?	Ewe	Hayi

Utyikityo lwalowo uphendulayo: _____

Umhla: _____

Ndicacisile ngale projekthi kunye neempembelelo zodliwano-ndlebe kulowo uphendulayo, kwaye ndiyakholwa ukuba uvuma ngokufanelekileyo kwaye uyaziqonda iimpembelelo zokuthatha inxaxheba kolu phando.

Igama lalowo wenza udliwano-ndlebe: Dominique Mannel

Utyikityo lwalowo wenza udliwano-ndlebe: _____

Umhla: _____

Q. no. | | | |

ISHEDYULI YODLIWANO-NDLEBE

1. Uwasebenzisa kangakanani amanzi etephu kamasipala?
1 Yonke imihla
2 Amatyeli ambalwa ngeveki
3 Kambalwa kakhulu kunesithuba seveki
4 Andiwasebenzisi tu

2. Uwasebenzisa kwizinto zini amanzi etephu? (khetha zonke ezibhekiselele kuwe)
1 Ukutyala 2 Ukupheka 3 Ukusela
4Ukuhlamba impahla 5 Ukucoca endlwini 6 Ukuhlamba umzimba
Okunye [cacisa]: ……

3. Ungakanani umgama ekumele ukuba uwuhambe ukuya kukha amanzi?
1 ngaphantsi kwe-1km
2 1-2km
3 2+km
4 ukuba ungaphezu kwe-2km, nceda ubonise ukuba kukude kangakanani .....
5 awuqinisekanga

4. Mangaphi amatyeli ngosuku othi uwahambe ukuya kukha amanzi asetyenziswa endlwini?
1 1
2 2
3 3
4 4
5 Ukuba kungaphezu kwamatyeli amahlanu ngemini, nceda ubonise ukuba uya kangaphi.
……

5. Ingakanani i-emele oyisebenzisayo ukuya kukha amanzi?
1. 5L
2. 10L
3. 20L
4. Ukuba ingaphezu kwe-20L, nceda ucacise.....

6. Xa uhlamba impahla ze uhlambulule (upule) impahla yakho, ingaba amanzi etephu uhlala uwavulile de kuphume yonke isepha esezimpahleni zakho?
1 Ewe
2 Hayi
3 Ngamanye amaxesha
4 Ayibhekisi kum (Andizihlambi iimpahla)
5 Andinqweneli kuphendula

7. Xa uhlamba impahla ze uzihlambulule, ingaba uyayizalisa i-emele ngamanzi acocekileyo, uyivale itephu ze uhlambulule iimpahla e-emeleni?
1 Ewe
2 Hayi
3 Ngamanye amaxesha
4 Ayibhekisi kum (Andizihlambi iimpahla)
5 Andinqweneli kuphendula

7.1 Ukuba uyavuma okanye uthe ngamanye amaxesha kumbuzo ongaphambili, uyizalisa kwakhona amatyeli amangaphi i-emele ngamanzi okuhlambulula iimpahla?
1 Kanye
2 Kabini
3 Amatyeli amathathu
4 Ngaphezu kwamatyeli ama-3. Nceda ucacise.....

8. Ingaba unolwazi ngokuba yintoni ukugcina amanzi emvula?
1 Ewe
2 Hayi
3 Andiqinisekanga

Umphandi uza kucacisa ngokufutshane ukuba yintoni ukugcina amanzi emvula (RWH: Ukugcina amanzi emvula kukuqokelela amanzi emvula kwitanki/kwisiqulathi. Amanzi agciniweyo anokusetyenziselwa ukucoca, ukunkcenkceshela isitiya sakho, ukuhlamba imizimba kanti xa ecociwe, anokusetyenziselwa nokusela nokupheka.

9. Kulo nyaka uzayo ngo-2015, iYunivesithi yase-Stellenbosch iceba ukubonelela abathathi-nxaxheba kwiprojekthi ngenkqubo yamatanki asetyenziselwa iinjongo ezininzi. Le yinkqubo yokulinga (ngamanye amazwi LUVAVANYO) ukubona ukuba amanzi emvula angacocwa na ze akhuseleke ukuba angaselwa.
Kuba luvavanyo, ngabathathi-nxaxheba kwiprojekthi kuphela abaza kuxhamla emanzini agciniweyo. Ingaba uza kusebenzisa amanzi emvula kwiimfuno zakho zemihla ngemihla?

1 Ewe. Nceda ucacise. ……..
2 Hayi. Nceda ucacise …….
3. Andiqinisekanga
4. Andinqweneli kuphendula.

10. Ucinga ukuba yiyiphi eyona ndawo ilungele ukubeka ezi tanki?
……
10.1 Ngokuba kutheni?
.....
.....

11 . Ukuba itanki ingakufuphi nendlu yakho, ungawasebenzisa amanzi agciniweyo emvula endaweni yamanzi kamasipala?
1 Ewe
2 Hayi
3 Andisoze
4 Ngamanye amaxesha
5 Ndingawasebenzisa omabini amanzi emvula namanzi kamasipala

12. Ingaba ucinga ukuba abamelwane bakho bangawasebenzisa amanzi agciniweyo emvula?
1 Ewe
2 Hayi
3 Abasokuze

13. Xa itanki ingakude nendlu yakho, ungahamba uye kule tanki uye kukha amanzi emvula? Okanye ungahamba kuphela xa uya kusebenzisa amanzi etephu kamasipala?

1. Ndingahamba ndiye etankini ukuya kusebenzisa amanzi emvula.
2. Ndingahamba kuphela ukuya kwitephu yamanzi kamasipala.
3. Ndingahamba niwasebenzise omabini amanzi emvula namanzi etephu kamasipala.
4. Andazi.
5. Andinqweneli kuphendula.

14. Kulo nyaka uzayo, xa sele zikho iitanki, ucinga ukuba ungawasebenzisa kangakanani amanzi emvula asetankini?
1 Yonke imihla
2 Amatyeli ambalwa ngeveki
3 Kambalwa kakhulu kunesithuba seveki
4 Andisokuze

15. Ungawasebenzisela ntoni amanzi etanki? [khetha zonke ezibhekiselele kuwe]
1 Ukutyala 2 Ukupheka 3 Ukusela
4 Ukuhlamba impahla 5 Ukucoca endlwini 6 Ukuhlamba imizimba
Okunye [cacisa]: ……

16. Xa kunokwenzeka amanzi etanki afudumale, ungawasebenzisela ntoni?
1 Ukutyala 2 Ukupheka 3 Ukusela
4 Ukuhlamba impahla 5 Ukucoca endlwini 6 Ukuhlamba imizimba
Okunye [cacisa]: ……

17. Ingaba kungaluncedo kuwe ukuba namanzi afudumeleyo etankini?
1. Ewe. Ngokuba kutheni?.....
2. Hayi. Ngokuba kutheni?.....
3. Andazi.
4. Andinqweneli kuphendula.

B. UKUFUMANEKA NEMPATHO YAMANZI
1. Ingaba ungawasebenzisa amanzi emvula asetankini kwiinjongo zokusela?
1 Ewe, ngalo lonke ixesha
2 Ewe, ngamanye amaxesha
3 Hayi, andisokuze

1.1. Ukuba uthi ewe, ungawasusa iintsholongwane kuqala amanzi lawo?
1 Ewe, ngalo lonke ixesha
2 Ewe, ngamanye amaxesha
2 Hayi, andisokuze

2. Ingaba oku ukwenza amatyeli angakanani:

		Andiyenzi kwaphela lo nto	Andifane ndiyenze lo nto	Ngamanye amaxesha	Amaxesha amaninzi	Andazi	Andifuni kuphendula
a.	ungavumelani ni nosapho lwakho/namalungu asekuhlaleni ngamanzi?	1	2	3	4	9	0
b.	worry about a lack of water?	1	2	3	4	9	0
c.	ukuwasebenzisa kwakhona amanzi?Ukusebenzisa amanzi amatyeli amaninzi? Umzekelo: Uqale uhlambe, ze ucoce indlu kwangala manzi manye?	1	2	3	4	9	0

3. Nceda undichazele ukuba ingaba uyavumelana kusini na okanye akuvumelani nezi ngxelo zilandelayo:

		Ndivumela na kakhulu	Ndiyavumelana	Andikenzi sigqibo	Andivumelani	Andivumelani kakhulu	Andazi	Andifuni kuphe-ndula
a.	Amanzi kufanele afumaneke simahla kumntu wonke	1	2	3	4	5	9	0
b.	Wonke umntu kufanele awahlawulele amanzi awasebenzisayo kamasipala	1	2	3	4	5	9	0
c.	Kufanele sifumane amanzi acocekile kamasipala	1	2	3	4	5	9	0
d.	Ukuqokelela amanzi emvula yinto elungileyo	1	2	3	4	5	9	0

4. Ingaba ufumana amanzi oneleyo kumasipala okweza oku:

		Angaphezu kokwanela	Oneleyo	Andiqinisekanga	Akonelanga	Akonelanga kwaphela	Andazi	Andifuni kuphe-ndula
a.	ukusela?	1	2	3	4	5	9	0
b.	ukupheka?	1	2	3	4	5	9	0
c.	Ukuhlamba impahla?	1	2	3	4	5	9	0
d.	Ukuhlamba imizimba?	1	2	3	4	5	9	0

5. Ingaba ikho enye into ongathanda ukundazisa yona malunga nezinto esithethe ngazo?

……

……

6. Bangaphi abantu abahlala kwisiza sakho?

……

Enkosi ngexesha lakho. Ulonwabele usuku lwakho lonke!

APPENDIX C: CONSENT FORM AND QUESTIONNAIRE IN AFRIKAANS

OPNAME VAN GEMEENSKAPSPERSEPSIES M.B.T
DIE GEBRUIK VAN OPGAAR REENWATER
IN ENKANINI

TOESTEMMING TOT DEELNAME IN NAVORSING

Hallo!

Ek werk by die Universiteit van Stellenbosch se Water Instituut, en wil jou vra om my te help met ‘n ondersoek wat ek vir die Kommissie van Waternavorsing doen.

Ek wil leer wat die gemeenskapslede van Enkanini dink oor die opgaar van reënwater. Ek wil uitvind of die watertenke wat volgende jaar op selektiewe areas geplaas gaan word, die gemeenskap van Enkanini sal help, of nie.

Ek wil graag met jou, as lid van die gemeenskap, vir ongeveer 15 tot 20minute daaroor gesels. Ek sal vir jou vrae op hierdie vorm vra, en jou antwoorde op die vorm skryf.

Hierdie ondersoek sal nie gebruik word om die Kommissie van Waternavorsing, die Universiteit van Stellenbosch of die regering te vertel wat jy met jou tenk doen, of hoe jy oor die tenk voel, of wat jy dink van die opgaar van reënwater nie. Daarom sal ek nêrens op hierdie vorm jou naam of adres skryf nie.

Jy kan kies of jy in hierdie ondersoek wil wees, of nie. As jy met my wil gesels, maar op enige manier ongelukkig voel, of nie hou van die vrae wat ek vir jou vra nie, sê dit asseblief vir my. Jy hoef nie enige vrae te antwoord wat jy nie wil antwoord nie, en ons kan enige tyd stop.

Indien jy enige vrae het, of ongelukkig voel oor dit waaroor ons gesels het, kontak my Dominique Mannel asseblief by 021 4620 000 of Dr.Wesaal Khan by 021808 5803

Voor ons begin, antwoord asseblief die volgende vrae deur ‘n regmerkie by “Ja” of “Nee” te maak:

Verstaan jy wat ek vir jou verduidelik het?	Ja	Nee
Verstaan jy dat niemand behalwe ek sal weet wat jy vandag vir my sê nie?	Ja	Nee
Verstaan jy dat ons enige tyd kan stop?	Ja	Nee
Is daar enige vrae wat jy my wil vra voordat ons begin?	Ja	Nee
Kan ek begin om vir jou die vrae op die vorm te vra?	Ja	Nee

Handtekening van respondent: _____

Datum: _____

Ek het die projek en die implikasies van ons onderhoud aan die respondent verduidelik, en vertrou dat die toestemming oorwoë is, en dat hy/sy die implikasies van deelname verstaan.

Naam van onderhoudvoerder: Dominique Mannel

Handtekening van onderhoudvoerder: _____

Datum: _____

V. no. | | | |

Vraelys

A. INLIGTING MET BETREKKING TOT MUNISIPALE WATER

1. Hoe dikwels gebruik jy munisipale kraanwater?

1. Daagliks
2. ‘n Paar keer per week
3. Minder dikwels as weekliks
4. Nooit

2. Waarvoor gebruik jy die munisipale kraanwater ? [merk alles wat van toepassing is]

1. Tuinmaak 2. Kook 3. Drinkwater
4. Klere was 5. Huis skoonmaak 6. Bad

Ander [spesifiseer]: ……

3. Wat is die distansie wat jy na die naaste kraan moet loop?

1. Minder as 1km
2. 1–2km
3. Indien verder as 2km, spesifeer asb. .....

4. Hoeveel keer per dag loop jy om kraanwater te gaan haal vir die huis?

1. 1
2. 2
3. 3
4. 4
5. 5
6. Indien meer as 5 keer per dag, spesifiseer hoeveel.....

5. Wat is die kom groote wat jy gebruik om water te haal?

1. 5L
2. 10L
3. 20L

6. Wanneer jy die wasgoed uitspoel, laat loop jy die kraanwater totdat al die seep uitgespoel is?

1. Ja
2. Nee
3. Somtyds
4. N.v.t. Ek was nie wasgoed nie.
5. Wil nie antwoord nie

7. Wanneer jy die wasgoed was, maak jy die kom vol water, maak die kraan toe en spoel die klere af in die kom?

1.Ja
2. Nee
3. Somtyds
4 N.v.t. Ek was nie wasgoed nie.
5. Wil nie antwoord nie.

7.1 Indien ja of somtyds, hoe dikwels moet jy jou kom vol maak om die wasgoed uit te spoel?
1. 1
2.2
3.3
4. meer as 3 keer. Spesifeer asb.....

8. Weet jy wat dit beteken om reenwater op te vang?
1. ja
2. nee
3. onseker

Navorser verduidelik kortliks. Dit is wanneer reenwater in tenke/houers opgevang word sodat een dit kan gebruik om huis skoon te maak, tuin te maak en wanneer dit behandel word, dit gebruik kan word om dit te drink en om daarmee te kook.

8.1. Sal jy opgaar reenwater gebruik?
1. Ja
2. Nee
3. Onseker
4. Wil nie graag antwoord nie.

9. Volgende jaar in 2015, beoog SU om projek deelnemers met ‘n multi-tenk-sisteem te voorsien. Dit is vir navorsingsdoeleindes en is dus ‘n TOETS om te sien of die reenwater behandel kan word sodat dit veilig is om te drink.
Omdat dit ‘n TOETS is, sal slegs projek deelnemers voordeel trek van die reenwater. Dink jy dis ‘n goeie idée om slegs tenke aan deelnemers te gee en nie aan almal nie?

1. Ja. Hoekom ……..
2. Nee. Hoekom .....
3. Onseker
4. Wil nie graag antwoord nie.

10. Waar dink jy sal die beste plek wees om die multi-tenk-sisteem te sit?
.....
10.1 Hoekom?
.....
.....

11. Indien SU die tenke volgende jaar bring vir navorsing, sal jy die reenwater wat opgevang is, gebruik?
1. ja
2. nee
3. nooit
4. onsker

12. Indien die tenke naby jou huis is, sal jy eerder die reenwater gebruik instede van munisipale water?
1. ja
2. nee
3.nooit
4.somtyds
5.Ek sal beide reenwater en munisipale water gebruik.

13. Dink jy jou bure sal die reenwater gebruik?
1. ja
2. nee
3. nooit
4. onsker

14. Indien die tenk ver is van jou huis, sal jy soontoe loop om water te gaan haal? Of sal jy slegs loop tot by die munisipale krane om water te gaan haal.
1. Ek sal na die tenk loop om reenwater te gebruik.
2. Ek sal slegs loop tot by die munisipale krane om water te haal.
3. Ek sal loop om beide reenwater en munisipale water te gebruik.
4. Ek weet nie.
5. Ek wil nie graag antwoord nie.

15. Wanneer die tenke volgende jaar hier is, hoe dikwels dink jy sal jy die reenwater in die tenke gebruik?
1. Daagliks
2. n Paar keer per week
3. Minder dikwels as weekliks
4. Nooit

16. Waarvoor dink jy, sal jy die water in die tenk gebruik? [merk alles wat van toepassing is]
1 Tuinmaak 2 Kook 3 Drinkwater
4 Klere was 5 Huis skoonmaak 6 Bad
Ander [spesifiseer]: ……

17. Indien die reenwater in die tenk warm sou wees, waarvoor sal jy die water gebruik?
1 Tuinmaak 2 Kook 3 Drinkwater
4 Klere was 5 Huis skoonmaak 6 Bad
Ander [spesifiseer]: ……

18. Sal dit vir jou help indien jy warm water in die tenk sou he.
1. Ja. Hoekom? .....
2. Nee. Hoekom? .....
3. Ek weet nie.
4. Wil nie graag antwoord nie.

B. TOEGANG TOT EN BESTUUR VAN WATER

1. Sal jy die water in die tenk gebruik as drinkwater?
1 Ja, altyd
2 Ja, soms
3 Nee, nooit

1.1. Indien ja, sal jy dit eers behandel?
1 Ja, altyd
2 Ja, soms
2 Nee, nooit

2. Hoe dikwels:

		Nooit	Selde	Soms	Dikwels	Weet nie	Wil nie antw.
a.	stry jy met gesins-/gemeenskapslede oor water?	1	2	3	4	9	0
b.	bekommer jy jou oor ‘n gebrek aan water?	1	2	3	4	9	0
c.	hergebruik jy water? Bv. Gebruik badwater om die huis skoon te maak?	1	2	3	4	9	0

3. Sê asseblief vir my of jy met die volgende stellings saamstem of verskil:

		SSS	SS	O	V	VS	Weet nie	Wil nie antwoord
a.	Water behoort vir almal verniet te wees	1	2	3	4	5	9	0
b.	Almal behoort vir die munisipale water wat hulle gebruik, te betaal	1	2	3	4	5	9	0
c.	Ons het toegang tot skoon munisipale water	1	2	3	4	5	9	0
d.	Om reënwater op te gaar, is ‘n goeie ding	1	2	3	4	5	9	0

4. Kry jy genoeg water van die munisipaliteit om:

		Meer as genoeg	Genoeg	Onseker	Nie genoeg	Glad nie genoeg nie	Weet nie	Wil nie antwoord
a.	te drink?	1	2	3	4	5	9	0
b.	te kook?	1	2	3	4	5	9	0
c.	wasgoed te was?	1	2	3	4	5	9	0
d.	te bad?	1	2	3	4	5	9	0

5. Is daar enigiets anders wat jy graag vir my wil vertel oor die dinge waaroor ons gepraat het?

……

6. Hoeveel mense woon op jou perseel?

.....

Dankie vir jou tyd. Geniet die res van jou dag!

APPENDIX D: LIST OF INVITED PARTICIPANTS

Water Research Commission Project K5/2368//3 WORKSHOP

Western Cape – Stellenbosch

Stellenbosch University (AI Perold Building)

List of invited participants

Name	Organisation	E-mail address
Dr Nonhlanhla Kalebaila	WRC	nonhlanhlak@wrc.org.za
Dr Jean-Marc Mwenge Kahinda	CSIR	JMwengeKahinda@csir.co.za
Mrs Marna De Lange	Socio-Technical Interfacing	marna@global.co.za
Dr Gunnar Sigge	Stellenbosch University	gos@sun.ac.za
Prof. Alf Botha	Stellenbosch University	abo@sun.ac.za
Mr Ferdi Postma	Stellenbosch University	16234081@sun.ac.za
Mr Andre van Niekerk	Stellenbosch Municipality	Andre.vanniekerk@stellenbosch.gov.za andren@stellenbosch.org
Mr Lester van Stavel	Stellenbosch Municipality	lesters@stellenbosch.gov.za
Ms Zama Masondo	Department of Water Affairs	masondoz@dwa.gov.za
Mr Berry Wessels	Sustainability Institute	mixedberries@gmail.com
Ms Lauren Tavener-Smith	Sustainability Institute	tavenersmith@gmail.com
Mr Jacques De Villiers	Crest Africa	Jacques@crestafrica.co.za
Mr Thomas Prins	Crest Africa	tgprins@dpcapital.co.za
Mr Dion Wessels	Crest Africa	dion@themediagenius.com
Mr Etienne Nel	Nel Tanks	enel@icon.co.za
Ms Estella Heyliger Cleghorn	JoJo Tanks	estella@jojotanks.co.za
Dr Danielle Wain	Bath University	Danielle.wain@gmail.com
Ms Penelope Dobrowsky	Stellenbosch University	14118734@sun.ac.za
Mr Thando Ndlovu	Stellenbosch University	18557570@sun.ac.za
Ms Monique Waso	Stellenbosch University	16546075@sun.ac.za
Mr Brandon Reyneke	Stellenbosch University	16571916@sun.ac.za
Dr Wesaal Khan	Stellenbosch University	wesaal@sun.ac.za
Ms Nicolette Hanning	Stellenbosch University	hanningn@cput.ac.za
Prof Eugene Cloete	Stellenbosch University	eugenecloete@sun.ac.za

APPENDIX E: WORKSHOP PROGRAMME

Water Research Commission project K5/2368//3 WORKSHOP

Western Cape - Stellenbosch

Stellenbosch University (Room 2005, Al Perold Building)

Monday 15 September 2014:

08h30 to 09h00	**Tea/Coffee**
09h00 to 09h30	Welcome – Prof Eugene Cloete
09h30 to 10h00	Project Outline – Ms Penelope Dobrowsky and Dr Wesaal Khan
10h00 to 10h45	Field trip to Pilot Plant at Welgevallen Experimental Farm
10h45 to 12h15	Site Visit Enkanini - Viewing possible locations for large- and small-scale DRWH treatment systems
12h15 to 12h30	Return to Stellenbosch University
12h30 to 13h15	**Lunch**
13h15 to 15h00	Discussion on locations of small- and large-scale DRWH treatment sites and design of multi-tank solar pasteurization treatment systems
15h00 to 15h30	**Tea/Coffee**
15h30 to 16h00	Commercialisation prospects
16h00 to 16h15	Closing Remarks

Enquiries:

Dr W Khan

Department of Microbiology

Faculty of Science

Tel: +27 21 808 5804

Fax: +27 21 808 5846

Email: wesaal@sun.ac.za

APPENDIX F: WORKSHOP ATTENDANCE REGISTER

Water Research Commission project K5/2368//3 WORKSHOP
Stellenbosch University (A1 Perold Building)
15 September 2015

Name	Organisation	Contact number	E-mail address	Signature
Dr Jean-marc Mwenge Kahinda	CSIR	0723969799	jmwengekahinda@csir.co.za	
Mrs Marna De Lange	Socio-Technical Interfacing	0828076523	marna@global.co.za	
Mr Lester van Stavel	Stellenbosch Municipality	082 442 7709	lester.vanstavel@stellenbosch.gov.za	
Mr Jacques De Villiers	Crest Africa	0824448 7776	jacques@crestafrica.co.za	
Mr Thomas Prins	Crest Africa		tprins@dpcapital.co.za	
Mr Dion Wessels	Crest Africa			
Ms Estella Heyliger Cleghorn	JoJo Tanks	0829204103	estella@jojotanks.co.za	
Dr Dainelle Wain	Bath University		d.j.wain@bath.ac.uk	
Ms Zamanyambose Masonda	Department of Water Affairs	0837951947	masondoz@dwa.gov.za	
Ms Nandi Dube	Department of Water Affairs			
Mr Berry Wessels	Sustainability Institute	084 2698053	mikedberries@gmail.com	
Ms Lauren Travener-Smith	Sustainability Institute			
Dr Gunnar Sigge	Stellenbosch University	082 576 1670	gos@sun.ac.za	
Prof Alf Botha	Stellenbosch University	021 808 5856	abo@sun.ac.za	
Mr Ferdi Postma	Stellenbosch University	082 3976613	16234081@sun.ac.za	
Ms Penelope Dobrowsky	Stellenbosch University	0827864643	14118734@sun.ac.za	
Mr Thando Ndlovu	Stellenbosch University	073 630 9359	18557570@sun.ac.za	
Ms Monique Waso	Stellenbosch University	083 619 6030	16546075@sun.ac.za	
Mr Brandon Reyneke	Stellenbosch University	083 658 8654	16571916@sun.ac.za	
Dr Wesaal Khan	Stellenbosch University	082 461 3430	wesaal@sun.ac.za	
Ms Nicolette Hanning	Stellenbosch University	0716411285	hanningn@cput.ac.za	
Prof Eugene Cloete	Stellenbosch University	021 8084370	eugenecloete@sun.ac.za	

UNIVERSITEIT STELLENBOSCH UNIVERSITY

Water Research Commission project K5/2368//3 WORKSHOP
Stellenbosch University (A1 Perold Building)
15 September 2015

Name	Organisation	Contact number	E-mail address	Signature
Dr. Lee Bryant	Univ. of Bath		L.Bryant@bath.ac.uk	
Dion Wessels	Creepy Africa	0826581465	dion@themediagenie.com	
HANS WENDT	TO GO PROD	082 5214616	hans@togoproductions.co.za	
Johru Robyn	SM	0218088460	johru.robyn@stellenbosch.gov.za.	

APPENDIX G: WORKSHOP MINUTES

Minutes of the Water Research Commission (WRC) project deliverable two, workshop titled: Design, construction and monitoring of sustainable domestic rainwater harvesting treatment systems in Enkanini informal settlement (Stellenbosch), held on Monday, 15 September 2014 at 08h30 in Room 2005, Al Perold Building, Stellenbosch University, Western Cape.

PRESENT:

Name	Organisation
Dr W Khan (Chairperson)	*University of Stellenbosch*
Prof. TE Cloete	*University of Stellenbosch*
Ms P Dobrowsky	*University of Stellenbosch*
Mr T Ndlovu	*University of Stellenbosch*
Ms M Waso	*University of Stellenbosch*
Mr B Reyneke	*University of Stellenbosch*
Dr G Sigge	*University of Stellenbosch*
Prof. A Botha	*University of Stellenbosch*
Mr F Postma	*University of Stellenbosch*
Mrs N Hanning (Secretary)	*University of Stellenbosch*
Mr B Wessels	*Sustainability Institute, University of Stellenbosch*
Mr J De Villiers	*Crest Africa*
Mr T Prins	*Crest Africa*
Mr D Wessels	*Crest Africa*
Mr H Wendt	*Crest Africa*
Ms E Heyliger Cleghorn	*JoJo Tanks*
Mr L van Stavel	*Stellenbosch Municipality*
Mr J Robyn	*Stellenbosch Municipality*
Ms Z Masondo	*Department of Water Affairs*
Dr J-M Mwenge Kahinda	*Council for Scientific and Industrial Research*
Mrs M De Lange	*Socio-Technical Interfacing*
Dr D Wain	*University of Bath*
Dr L Bryant	*University of Bath*

APOLOGIES:

Name	Organisation
Dr N Kalebaila	*Water Research Commission*
Ms N Dube	*Department of Water Affairs*

1. CONSTITUTION OF THE MEETING

1.1. The Chairperson welcomed all those present at the meeting and thanked them for accepting the invitation to attend the WRC project K5/2368//3 workshop, where the design of the small- and large-scale solar pasteurization rainwater treatment systems will be discussed. She then handed over to Prof Cloete, the project leader, who officially welcomed everyone to the workshop.

Prof Cloete explained that they were lucky to have received funding on two occasions from the Water Research Commission. In the first project the research team monitored the quality of harvested rainwater at the experimental site in Kleinmond as all the demarcated houses had rainwater harvesting systems. One of the first objectives of that study was to monitor the chemical and microbiological quality of the stored tank water, while the second objective was to determine how the people would interact with the technology. For the second project, which was going to be discussed at today's workshop, rainwater harvesting treatment sites would be implemented in Enkanini informal settlement. Prof Cloete stressed that there needed to be a combination of value and ownership of the system in order for the water not to be wasted and the challenge would be to get an individual or the community to own the system. Again, social science analysis would be included in order to determine how the residents would react to this technology.

Prof Cloete added that in certain rural areas it was not possible to harvest rainwater as there were still many thatched roof houses, leading to the idea of building a system with multiple tanks in order to see how people interacted with it. The challenge however that came with this concept would be the quality of the water. He added that from a chemical point of view, the water met the standards in South Africa, but that from a microbiological point of view the standards for drinking water were not met. The water needed to be treated, which brought about the concept of pasteurization. The team came up with the idea of an ordinary solar panel to heat up the water and pasteurize it. Nucleic acids (DNA) could then be extracted after pasteurization to determine the quality of the water. In the future this could lead to common sanitation systems for households to, *inter alia*, shower, wash their clothes, water their gardens, i.e. more than just harvesting water. The ultimate aim was to meet the water requirements per household which is why pasteurization of large quantities of water is being analysed. Prof Cloete concluded that the help, experience and insight of the members present was needed to determine the way forward as well as identify the ideal location for such a system.

Mrs De Lange queried the establishment of a centralised, communal system in Enkanini. In response to her query Dr Khan advised that, as discussed in the WRC project K5/2368//3 Inaugural meeting on 22 July 2014, a centralised multi-tank station would no longer be established, but rather decentralised, domestic on-site one-home systems will be constructed. The research centre could however possibly be utilised as the site for the large-scale system.

Dr Khan thanked Prof Cloete for the official welcome, whereafter Prof Cloete informed those present that unfortunately he was unable to attend the rest of the workshop due to prior commitments.

At this point there was a round of introductions by all members present (Appendix F). Dr Khan advised that the agenda for the day (Appendix E) included an outline of the project by Ms Dobrowsky and Dr Khan, followed by a brief of the aims for the workshop and areas that needed to be focused on. Thereafter members present would be taken on a field trip to the pilot plant at Welgevallen Experimental Farm and then a trip to the research centre in Enkanini informal settlement, to locate possible sites for the rainwater harvesting systems. After lunch the afternoon session would be crucial in focusing on the two designs and obtaining the meeting's advice and input on how and where to implement the decentralised systems.

1.2. After the apologies had been noted and sustained, the Chairman declared the meeting properly constituted.

2. PROJECT OUTLINE

2.1 Ms Dobrowsky provided a brief outline of the WRC project titled, “Design, construction and monitoring of a sustainable domestic rainwater harvesting (DRWH) multi-tank system”. Briefly, DRWH was earmarked by the government as a short term intervention to provide rainwater for communities in urban informal settlements and ultimately rural areas as a sustainable solution to water shortage and availability. Enkanini Settlement, Stellenbosch, was selected as the primary, experimental site for the project as it is the largest settlement in Stellenbosch, and currently, based on the demographic profile for Enkanini Settlement (CORC, 2012), there are 32 functional communal standpipes dispersed throughout the settlement, servicing the ~4500 plus inhabitants.

Ms Dobrowsky also provided an overview of the first deliverable titled, “Social perception of implementing a pilot DRWH multi-tank station in Enkanini informal settlement.” Ninety-five households in Enkanini (sections E and F, **Error! Reference source not found.**) were sampled and a summary of the results showed that on average 70% of the households utilise a 20 L container to collect water twice a day. In addition, 58 respondents (61%) indicated that they are familiar with the concept of rainwater harvesting (RWH). For the third project deliverable, pilot plant roofing systems, consisting of corrugated zinc sheets and chromadek®, were constructed at Welgevallen Experimental Farm. The research team will thus investigate the effect of environmental factors on the respective roofing systems and the corresponding effect on the physico-chemical and microbial quality of the harvested rainwater over time. These experiments are being conducted as these two roofing materials are the primary building materials utilised in informal settlements.

2.2 Dr Khan then provided the meeting with a brief outline of the workshop deliverable (second deliverable for project K5/2368//3) which will focus on the design of the pilot DRWH solar pasteurization treatment systems for optimum space utilisation. She also advised that in this preliminary pilot project it was essential to identify sites for the small- and large-scale treatment systems in the informal settlement for the maximum harvesting of rainwater. In addition, they were investigating the possibility of providing a dual system of cold and warm treated rainwater (large-scale system).

3. FIELD TRIP TO PILOT PLANT AT WELGEVALLEN EXPERIMENTAL FARM AND SITE VISIT TO ENKANINI

3.1 After the introduction sessions, delegates at the meeting went on a field trip to the pilot plant at Welgevallen Experimental Farm, Stellenbosch University. The solar pasteurization treatment system utilised in project K5/2124//3 is installed at the farm as well as the pilot plant for analysis of the effect of roofing materials on the quality of harvested rainwater. In addition, the new solar pasteurization system, designed by Crest Africa, was showcased and Mr De Villiers (Crest Africa), a collaborator on the project and the supplier of the solar pasteurization systems, then highlighted the significant differences between the South African design and mould versus the solar system utilised in the previous WRC study (project K5/2124//3). In the WRC project K5/2124//3 deliverable five report, it was suspected that metals such as aluminium, iron, lead and nickel, were leaching from the stainless steel storage tank of the solar pasteurization system (increased metal concentrations in the pasteurized water detected in comparison to the unpasteurized control samples). Crest Africa has subsequently changed the mould and the storage tank of the new solar pasteurization system is constructed from a high density polyethylene, which should minimalize leaching. In addition, in the new system, the outlet tap has also been placed near the top of the storage tank and the volume storage capacity has been increased from 100 L to 125 L. Moreover, Crest Africa is importing a thermostatic solar release valve, which effectively implies that the water in the system will only be released once a pasteurization temperature of 72°C is obtained. Finally the new system contains 10 × 2 m borosilicate tubes, in comparison to the system utilised in the previous project, which contained 12 × 1.8 m borosilicate tubes.

3.2 The delegates were then taken to the Enkanini informal settlement to view possible locations for the small- and large-scale domestic rainwater harvesting treatment systems. Firstly, Mr Yondela Tyawa (co-researcher on numerous Sustainability Institute projects and on the current project) provided a brief overview on the history of Enkanini as well as the establishment of the Enkanini Research Centre. Ms Lauren Tavener-Smith and Mr Berry Wessels then provided an overview of the primary Sustainability Institute projects they are currently involved with in Enkanini, such as the iShack project (Mr Wessels) and the sanitation upgrading project (Ms Tavener-Smith). Dr Khan then informed the delegates that the Enkanini Research Centre was selected as the site of the large-scale solar pasteurization treatment system as Mr Tyawa would be able to directly monitor and utilise the treated water for the Research Centre's restaurant. Moreover, space is severely limited in Enkanini settlement and sufficient space for the implementation of the large-scale system is available next to the Research Centre. For sampling purposes, homesteads surrounding the Enkanini Research Centre were viewed for the implementation of the small-scale solar pasteurization treatment systems and three sites were then suggested, namely directly next to Mr Vuyo Mafu's house (Pastor M. Qondani 's church grounds), directly next to Mr Lwandile Bula's property (neighbour to Enkanini Research Centre) and the iShack Office. The delegates associated with the WRC project K5/2368//3 workshop then returned to Stellenbosch University for the afternoon session.

4. DISCUSSION ON LOCATIONS OF SMALL- AND LARGE-SCALE DRWH TREATMENT SITES AND DESIGN OF MULTI-TANK SOLAR PASTEURIZATION TREATMENT SYSTEMS

Upon return to the meeting venue at Stellenbosch University, the delegates at the workshop agreed that the selected location for the large-scale system would be the Enkanini Research Centre. After discussions, where the quality of the roofs and the space available at the various homesteads were considered, the sites selected for the implementation of the small-scale solar pasteurization rainwater treatment systems included the church grounds (next to Mr Vuyo Mafu's house) and directly next to Mr Lwandile Bula's property (house neighbouring Enkanini Research centre). The iShack office was disregarded as a site due to limited space available surrounding the office building. Dr Mwenge Kahinda voiced his concern about the security of the equipment at the various locations and Mr Wessels and Mr De Villiers suggested that barricaded fencing or caging systems could be built around the solar pasteurization systems.

Mr van Stavel (Human Settlements and Property Management, Stellenbosch Municipality) also advised that the proposed research project did not infringe in any way on any of the municipality's activities in the local informal settlements and that if successful, would provide Enkanini residents with an alternative water source. He added that the challenge would be to latch onto what was being done and roll it out on a bigger scale. In addition, he added that it was a struggle to obtain funding specifically for informal settlements. Ms Masondo then advised that rainwater harvesting was earmarked as a priority by the Department of Water Affairs, however funding would have to be sourced locally per region. Mr Robyn (Human Settlements and Property Management, Stellenbosch Municipality) added that as a Department, they tried to encourage these types of actions and initiatives as they could only be beneficial to the municipalities and the municipalities should be looking at longer term sustainability in informal settlements. Dr Khan added that the new Water Services Task Team launched in Stellenbosch, also ensured successful communication between the Water Sector, Stellenbosch Municipality and researchers and that all information would be communicated to the local municipality. In response to a question from Ms Masonda regarding the municipality's plans for service provision in the local informal settlements, Mr Robyn noted that their immediate plan was access to basic services, while the medium to longer term goals was zoning of the area, for which a consultant had been appointed.

Dr Khan was requested to compile a cost analysis of the complete rainwater harvesting solar pasteurization treatment systems as the Stellenbosch Municipality required a ballpark figure for the cost per unit. The large-scale system and all analysis for the current project would be funded by the budget for WRC project K5/2368//3, while the small-scale systems and analysis specific for the CSIR would be funded by Dr Mwenge Kahinda (CSIR). In addition, Dr Mwenge Kahinda would install a weather station at one of the sites. Ms Heyliger Cleghorn from JoJo Tanks advised that the most cost effective tank would be the medium volume tank (2500 L). She added that JoJo tanks had conducted an analysis which confirmed that square tanks were not feasible but that the design of the tank could be considered. Mr De Villiers also advised that from a costing point of view it would be cheaper to install and utilise the small-scale decentralised system as four banks of collectors could be employed to pasteurize the water. However, he did add that with a centralised system much larger volumes of potable water could be produced, however as noted space limitations is a huge problem in Enkanini and similar informal settlements.

Dr Khan advised that the primary objective was to have the entire treatment system installed and up and running before the rainy season of next year (~ April 2015). Ms Tavener-Smith will compile a pamphlet guide on the use of the system and this could include informing the community about the importance of closing the taps and saving water. Training sessions on the utilisation and maintenance of the system will also be conducted with all members of the households, where the small- and large-scale systems are constructed. Dr Khan further stressed that in their social science report (deliverable one of WRC project K5/2368//3) it was noted that residents indicated that they wanted their own system for ownership and so that they could look after and maintain it. Only 30% mentioned that they wanted a centralised system so that all residents could utilise and benefit from the alternate water source.

Dr Mwenge Kahinda and Mrs De Lange advised that it would be necessary to look at the demand as a starting point, the roof area (15 to 20 square metres) and the rainfall pattern of the area and then calculate the sizing component of the tank with the space that was available. A meeting would be held with Dr Khan to help determine this calculation.

Dr Khan stressed that whatever system was sufficient per roof area for that family to utilise on a daily basis is what they were aiming for and that they would monitor the operational sustainability of the on-site systems, i.e. how much water was being utilised by the household on a daily basis, how much water was being harvested per day, etc. Mr de Villiers noted that it would be beneficial to install a counter in all the systems. Mrs De Lange also cautioned that there would be overflow and that it would be important to look at the location of the tank and to plan carefully for when any overflow occurred.

5. COMMERCIALISATION PROSPECTS

Mr Wessels suggested that it was important to develop the brand and investigate possible commercial aspects for the solar pasteurization treatment system. He suggested a few examples of how this could be implemented, such as, allowing a student registered in the Marketing Management course (Stellenbosch University) to design a launch campaign as an undergraduate or postgraduate project, utilising Mercy Ships (OM International) as a carrier to developing countries and possibly approaching Coca-Cola™ for endorsement.

Mr Prins also noted that in order for a project like this to work, national and local government needed to work together. Prof Botha then suggested that from a commercialisation perspective, an alternative use for the tank treatment system could be as a storage system for municipal water in the dry summer months. It was however, noted by Mr Wessels, that while the Enkanini residents were in favour of paying for a warm water source, once the rainwater treatment system was linked to the municipal

supply, there would be no form of ownership and the water supply would no longer be considered a scarce commodity for the residents.

In response to a question regarding the durability and maintenance of the system, Mr De Villiers noted that only the black borosilicate tubes of the system could break. He added that the replacement of the borosilicate tubes could be incorporated into the training process on how to clean the system in order to enable optimal operation of the solar pasteurization system.

Dr Khan informed the meeting that while the aim of the initial WRC K5/2124//3 project was to monitor the chemical and microbial quality of tank harvested rainwater and analyse various point-of-use treatment systems, crucially the next project will focus on the optimisation and analysis of the proposed decentralised solar pasteurization rainwater treatment systems on site in Enkanini informal settlement. Based on the results obtained, the next phase would involve discussions with the local municipalities and the development of a business plan for the roll-out of the optimised systems.

6. GENERAL

6.1 Attendance Register

A copy of the signed attendance register (Appendix F), with the contact details of all the delegates is attached to the minutes of the meeting.

6.2 Date of the first draft deliverable report

Dr Khan advised that the deliverable report would be written up and compiled by 17 October 2014 would be sent to all members for their comments. The final report would then be submitted to the WRC by 21 November 2014. Implementation for the small- and large-scale pasteurization systems was then earmarked for before the start of the 2015 rainy season (by April 2015).

7. CONCLUSION OF THE MEETING

Dr Khan thanked all the workshop participants for their attendance and valuable input and the workshop ended at 14:15

…… ……..……..

CHAIRPERSON **DATE**

APPENDIX H: CONSENT TO PARTICIPATE

PERMISSION FORM FOR THE ESTABLISHMENT OF THE RAINWATER HARVESTING TREATMENT SYSTEMS AT THE SELECTED SITES IN ENKANINI

CONSENT TO PARTICIPATE IN RESEARCH

Dear Participant,

We form part of a research group at Stellenbosch University (Department of Microbiology) and we would like to ask you to help us with a study we are doing for the Water Research Commission.

We would like to find out whether collecting (harvesting) rainwater could help community members of Enkanini by providing them with an additional water source. We are at the very beginning of our research and only three houses have been selected for the study.

During a site visit to Enkanini on Monday 15 September 2014, your house was selected as one of the first sites for the establishment of a rainwater tank and a solar treatment system in 2015. We will have to use a section of your plot next to your roof to construct these systems. We will cover all the costs for the installation and we will train all the people living in your house how to use and maintain the system. You will be able to use the rainwater for your daily water needs and warm water will be available from the solar pasteurization system. However, from May 2015 until December 2016, we will visit the site once every two weeks to collect water samples and make sure the system is working.

If you have any questions or are unhappy about what we talked about, please contact Wesaal Khan on 021 808 5804.

By signing this form you are confirming that you understand what was explained to you and you are agreeing to be part of the study. In addition, you are granting us permission to install the rainwater treatment systems on your plot and you are allowing us to collect water from the systems from May 2015 to December 2016.

Signature of respondent: _____

Date: 22/04/2014

I have explained the project to the respondent, and I believe that the consent is informed and that he/she understands the implications of participation.

Name of interviewer: Wesaal Khan

Signature of interviewer: _____

Date: 23/04/2014

PERMISSION FORM FOR THE ESTABLISHMENT OF THE RAINWATER HARVESTING TREATMENT SYSTEMS AT THE SELECTED SITES IN ENKANINI

CONSENT TO PARTICIPATE IN RESEARCH

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Signature of respondent: _____

Date: 22/09/2014

I have explained the project to the respondent, and I believe that the consent is informed and that he/she understands the implications of participation.

Name of interviewer: Wesaal Khan

Signature of interviewer: _____

Date: 23/04/2014

PERMISSION FORM FOR THE ESTABLISHMENT OF THE RAINWATER HARVESTING TREATMENT SYSTEMS AT THE SELECTED SITES IN ENKANINI

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If you have any questions or are unhappy about what we talked about, please contact Wesaal Khan on 021 808 5804.

By signing this form you are confirming that you understand what was explained to you and you are agreeing to be part of the study. In addition, you are granting us permission to install the rainwater treatment systems on your plot and you are allowing us to collect water from the systems from May 2015 to December 2016.

Signature of respondent: _____

Date: 22/09/2014

I have explained the project to the respondent, and I believe that the consent is informed and that he/she understands the implications of participation.

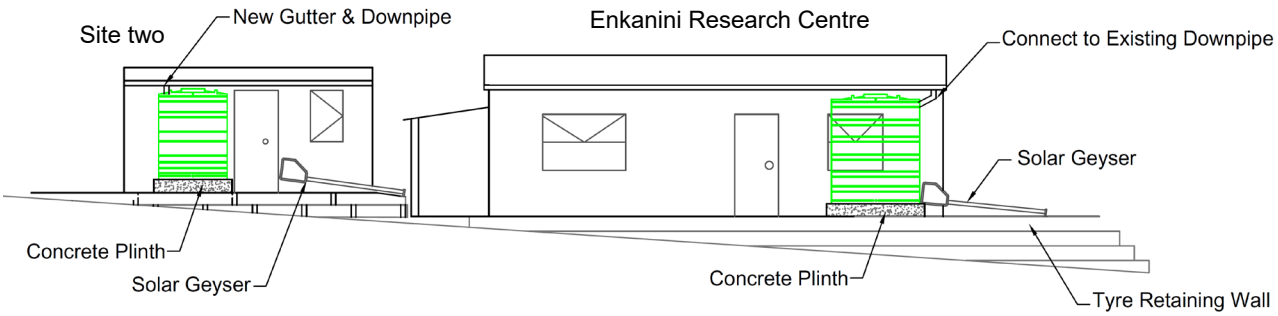
Name of interviewer: Wesaal Khan

Signature of interviewer: _____

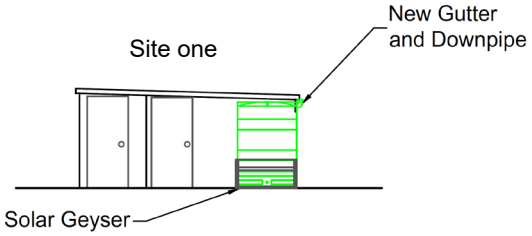
Date: 23/09/2014

APPENDIX I: OUTLINE OF THE PROPOSED SYSTEMS

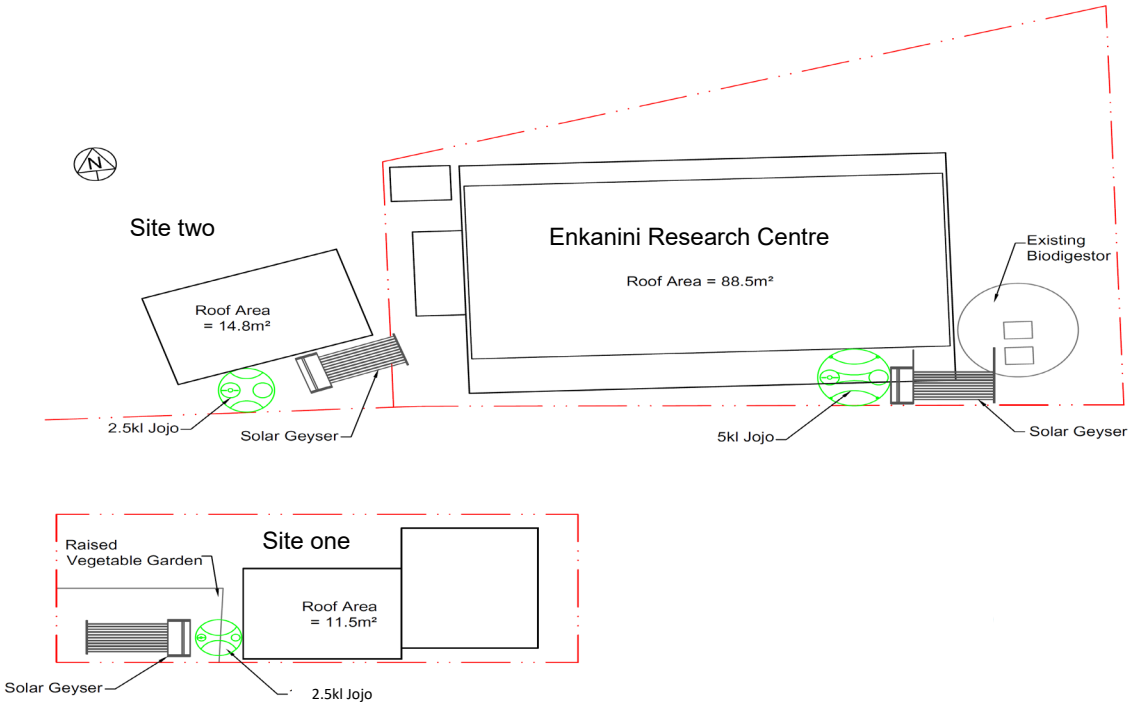
1. **Front elevation of site two (small-scale solar pasteurization rainwater harvesting treatment system) and Enkanini Research Centre (site for the implementation of the large-scale solar pasteurization rainwater harvesting treatment system):**



2. **Side elevation of site one (small-scale solar pasteurization rainwater harvesting treatment system):**



3. **Plan view of proposed solar pasteurization rainwater harvesting treatment system installations at all three sites [sites one and two (small-scale systems) and Enkanini Research Centre (large-scale system]:**



APPENDIX J: INITIAL PAMPHLET GUIDE TEMPLATE

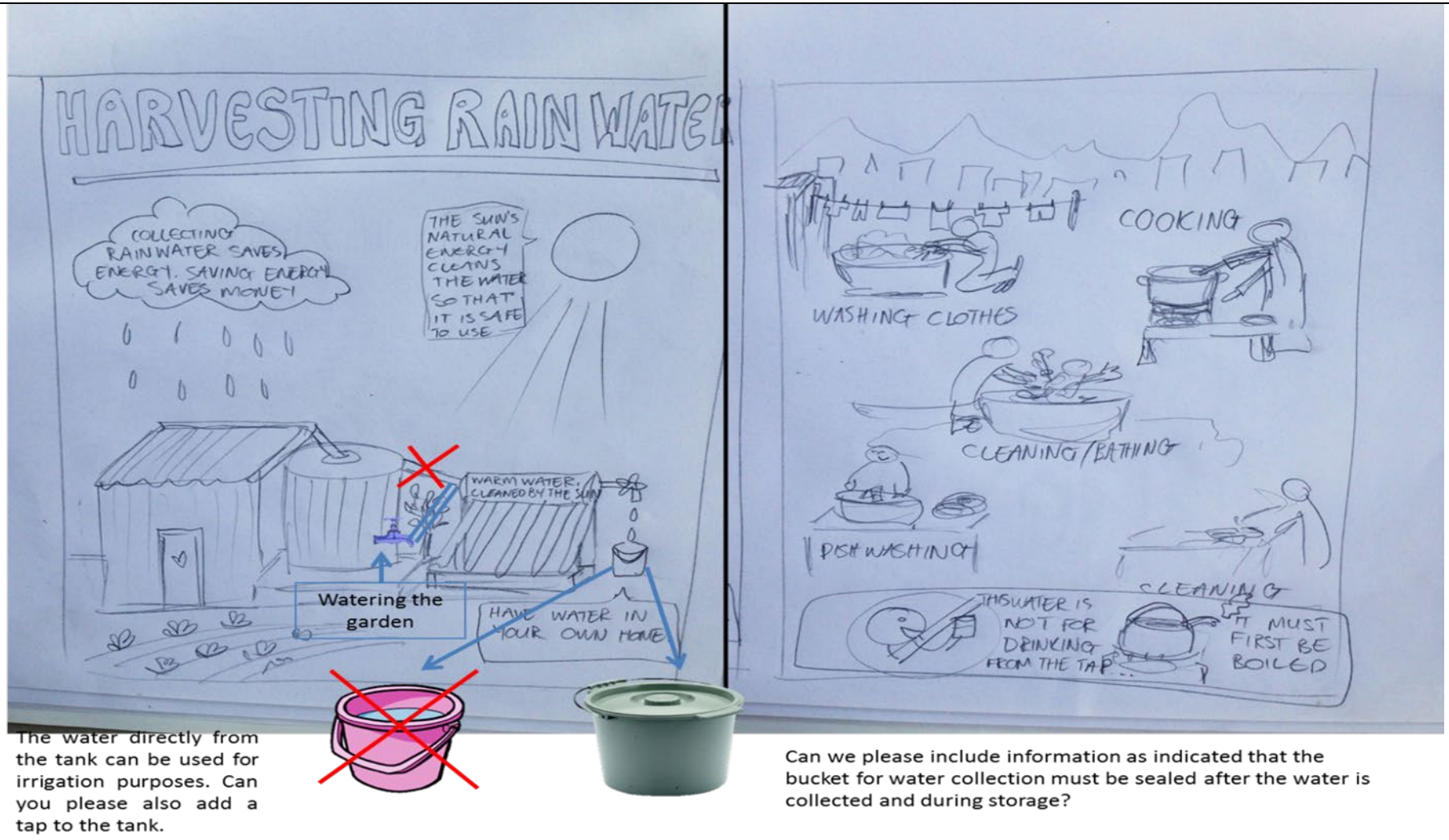


Figure 1. Initial illustration used to construct the sample pamphlet guide that was presented to the reference group members.