

**DEVELOPMENT OF AN EXCRETA PATHWAY FOR KANYAMA PERI-  
URBAN AREA OF LUSAKA USING THE SHIT FLOW DIAGRAM (SFD) TOOL**

By

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## **ABSTRACT**

It is estimated that 70 percent of Lusaka's 2 million population live in peri-urban areas and 90 percent of whom rely on onsite sanitation (OSS) systems which are in poor condition. The rapid population growth in these unplanned settlements coupled with poor sanitation conditions has resulted in severe exposure of the public and the environment to faecal contamination leading to the regular outbreaks of waterborne diseases such as cholera, dysentery and typhoid. In addition, 57 percent of Lusaka water supply is from groundwater resources (boreholes) which are dotted within the city and are prone to faecal contamination due to the existence of OSS systems with poor management of sludge that accumulates in the onsite containment technologies. Kanyama compound is one of the Peri-Urban Areas (PUAs) in Zambia's Capital City, Lusaka. The area represents one of the selected priority project areas for improvement of OSS and Faecal Sludge Management (FSM) under the Lusaka Sanitation Programme (LSP).

This research was aimed at producing an Excreta Flow Diagram (Excreta Pathway) and analysis of OSS and FSM services for Kanyama PUA of Lusaka which is one of the most informal settlement areas hit by poor sanitation in Lusaka. The research also looked at the national legislation and institutional framework on OSS as applied in Kanyama.

This research provided a good understanding of a local level comprehensive SFD. Comprehensive sanitation surveys and mapping exercises were done by Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) through its Climate Friendly Sanitation in Peri-Urban Areas of Lusaka (CFS) Project for Kanyama. Primary data collected was reviewed collecting missing data and secondary data were used to produce the Excreta Flow Diagram. The mapping exercise and surveys conducted in Kanyama were instrumental in understanding the types of sanitation systems in Kanyama and the percent of the population using such systems which greatly informed this study. Developing the comprehensive SFD for Kanyama area required the use of the sanitation surveys and collecting primary and secondary data using the defined methodology prescribed in the SFD manual.

This research demonstrated the gaps that exist in the national legislation on OSS as well as describing efforts being done to reduce the gap. The revisions on the existing legislation include provisions on OSS and FSM.

Out of the 170,000 sampled population in Kanyama area, only 1% of the generated faecal sludge was safely managed and rely on 100 percent OSS. The Excreta Pathway produced, gives the status of excreta from Containment to Treatment highlighting the percentages of safely managed and unsafely managed excreta. This research demonstrated the inadequacy of FSM (containment systems, pit emptying, Transportation, treatment) services in Kanyama posing a high risk to groundwater and other environmental concerns. This study recommends interventions from all stakeholders in order to change the picture in Kanyama by supporting the community in the construction of sanitation facilities, improving the drainage systems, and support small scale community lead workings such as Kanyama Water Trust that could focus on sanitation more. Improving the enforcement of legislation as well as revising the laws on sanitation to include OSS and FSM.

**Keywords:** Sanitation, Shit Flow Diagram, On-Site Sanitation, Faecal Sludge Management, Lusaka Sanitation Program, Faecal Sludge, Climate Friendly Sanitation.

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## **DEDICATION**

*I dedicate this dissertation to my late Father Thomas Sichilima Musonda who inspired me to learn to persevere and face challenges and my wife Abigail Musonda who has always been my strength.*

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## **ABBREVIATIONS AND ACRONYMS**

CBD	Central Business District
CBE	Community Based Enterprise
CFS	Climate Friendly Sanitation in Peri-Urban Areas of Lusaka Project
CU	Commercial Utility
FGD	Focus Group Discussion
FS	Faecal Sludge
FSM	Faecal Sludge Management
FSTP	Faecal Sludge Treatment Plant
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit, GmbH
GRZ	Government Republic of Zambia
KII	Key Informant Interview
KPI	Key Performance Indicator
KWT	Kanyama Water Trust
LCC	Lusaka City Council
LSP	Lusaka Sanitation Program
LWSC	Lusaka Water and Sewerage Company
MLGH	Ministry of Local Government and Housing
MoH	Ministry of Health

MWDSEP	Ministry of Water Development, Sanitation and Environmental Protection
NCC	National Council for Construction
NUSS	National Urban and Peri-Urban Sanitation Strategy
NWASCO	National Water Supply and Sanitation Council
OSS	Onsite Sanitation
PUA	Peri-Urban Area
PPL	Number of People
SFD	Shift -Flow Diagram
SFD PI	Shift Flow Diagram Promotion Initiative
USD	US Dollar
WARMA	Water Resources Management Agency
WHO	World Health Organization
WSUP	Water and Sanitation for the Urban Poor
WWTP	Waste Water Treatment Plant
ZABS	Zambia Bureau of Standards
ZEMA	Zambia Environmental Management Agency

## **DEFINITIONS**

To have a broader understanding of the research topic, the following terms and concepts were defined:

**Onsite Sanitation (OSS):** is a sanitation system in which excreta and wastewater are collected, stored and treated on the same location where they are generated. Examples of onsite technologies include pit latrines, septic tanks, aqua privies, and dry toilets such as Urine Diversion Dehydration Toilets (UDDTs) (Strande, 2014)

**Faecal Sludge (FS):** is a raw, partially digested, a slurry or semisolids that accumulate in OSS systems and have not been transported through a sewer. It results from the collection, storage or treatment of excreta and blackwater, with or without greywater. FS also contains trash, sand, grit, metals and other chemical compounds (Strande, 2014).

**Faecal Sludge Management (FSM):** FSM includes the storage, collection, transportation, treatment and safe end-use or disposal of FS (Strande, 2014). It is a systematic approach to planning and coordinating all the activities along the sanitation service chain.

## **CHAPTER 1: INTRODUCTION**

### **1.1 Background**

Many cities in developing countries are faced with the global challenge of low access to improved sanitation and effective management of human excreta due to rapid urbanization and population growth. The rapid urbanization and population growth are mainly concentrated in urban low-income settlements (also known as Peri-Urban Areas (PUA's) or slums) of many developing countries. The sanitation needs of 2.7 billion people worldwide are served by Onsite Sanitation (OSS) technologies, and that number is expected to grow to 5 billion by 2030 (Strande ,2014). Solutions for effective and sustainable provision of improved sanitation and excreta management present the significance of global need. According to the JPM<sup>1</sup> (WHO and UNICEF, 2015) 2.4 billion people globally still lack access to improved sanitation mainly in low-income settlements in Asia, Africa, Caribbean and Latin-America where government do not have either resources or the capacity to provide adequate sanitation services to the increasing population.

In the past, OSS has been viewed as a temporal solution or alternative to waterborne sewer-based systems (i.e. until sewers are built). However, over the years, in many sub-Saharan Africa and South Asia cities, the rate of sewer-based systems expansion and service provision by the city authorities has been surpassed by the rate of urbanization and population growth leaving the majority to rely on OSS systems. For example, 65-100 percent of urban dwellers in Africa and Asia and some 20 – 50 percent of urban dwellers in Latin America are served by OSS technologies (Strauss, 2000). However, even though the sanitation needs of the majority population are met through onsite technologies such as pit latrines and septic tanks, there is inadequate management systems in place for the resulting excreta or faecal sludge that accumulates in the onsite systems.

Developing solutions for increasing access to sanitation and effective management of faecal sludge is a serious global problem that has received limited attention.

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<sup>1</sup> Joint Monitoring Program for Water Supply and Sanitation by WHO and UNICEF is the official United Nations program tasked to monitor progress towards sustainable development goal Number 6 since 2016.

Zambia's capital Lusaka is faced with these challenges in the management and understanding of onsite sanitation services just like many other cities in the region. The 2010 census estimated the population of Lusaka city to be 1,742,979 (CSO, 2011) with an annual rate of population increase at approximately 3.75 percent between 2010 and 2020 (CSO, 2015). The estimated 2018 population for Lusaka city is 2,526,102 (CSO,2013) of this total population, 70 percent live in the city's PUAs in low-income households and 90 percent of whom rely on OSS systems which are in poor condition (LWSC, 2018). Lusaka's population is expected to grow to 4,560,560 people by 2035 (CSO, 2013), most of which will be concentrated within the PUA's. Therefore, city authorities are facing and will continue to face significant challenges in providing adequate sanitation to the existing and future population. The rapid population growth in these unplanned settlements coupled with poor sanitation conditions has resulted in severe exposure of the public to environmental contamination arising from faecal sludge leading to the regular outbreaks of cholera, dysentery and typhoid. In addition, 57 percent of Lusaka water supply is from groundwater resources (boreholes) which are dotted within the city (LWSC, 2016a). These groundwater sources are at risk of faecal contamination due to the existence of OSS with poor management of sludge that accumulates in the onsite containment facilities.

With most of the Lusaka's population relying on onsite facilities (pit latrines), it has become imperative to put in place sustainable OSS and Faecal Sludge Management (FSM) systems to safely handle the sludge produced in the city along the sanitation service chain. To achieve this, there are many interventions and programs that have been put in place in Lusaka with the major one being the Lusaka Sanitation Program (LSP). LSP is a multi-donor funded program being implemented by Lusaka Water and Sewerage Company (LWSC) which aims at improving access to proper sanitation in Lusaka city. It represents one of the first major investments in Lusaka's Sanitation Master Plan (SMP), the objective of which is to achieve 100 percent safe sanitation coverage by 2035 (LWSC, 2011). Complimentary to the LSP is the Climate Friendly Sanitation in Peri-urban areas of Lusaka (CFS-Lusaka) project. CFS-Lusaka is a project within the Reform of the Water Sector Program in Zambia being implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. The CFS –Lusaka project focuses on establishing prerequisites, standards and procedures for climate-friendly OSS and FSM service chains in the PAU areas of Lusaka. Also, to

effectively program interventions that will have a greater impact leading to improved access to proper sanitation and management of excreta. It is imperative to understand the existing situation at each stage of the sanitation service chain. This can be done by mapping or visualizing the flow of excreta produced within a city or locality along the sanitation value chain through a tool known as a Shift Flow Diagram (SFD). This concept was first developed and tried in 12 cities published in a document ‘A Review of Faecal Sludge Management in 12 Cities’ which was commissioned by the World Bank’s Water and Sanitation Program (Peal, 2015). This review introduced the concept of mapping the flow of faecal sludge along the sanitation service chain, alongside an assessment of the delivery context of FSM services at the city or town level. In this light, the CFS project embarked on the development of SFDs for some selected PUA’s of Lusaka as a way of understanding the baseline situation before the implementation of the interventions planned under the LSP. Thus, this dissertation developed a SFD for Kanyama (PUA) CSE20. Kanyama is one of the selected PUA for the improvement of OSS and FSM under the LSP. The earmarked area is identified by the code Kanyama CSE20.

## **1.2 Problem Statement**

Most PUAs in Lusaka do not have access to improved sanitation facilities that are properly serviced to safely manage the generated sludge. The lack of proper sanitation services creates public health concern and contamination of groundwater. Information on the service delivery and management of excreta along the service chain in most PUAs such as Kanyama is fragmented or unavailable. Kanyama has been hit by Cholera and many other water-borne diseases due to poor sanitation and many lives have been lost from the diseases in recent years. The project area Kanyama is the red spot of poor sanitation service provision. To improve the situation in this area, the excreta pathway is required to be understood so that areas of improvement can be identified along the service chain. There is often inadequate information to provide guidance on the status of the fate of excreta along the sanitation service chain in Kanyama to help make informed decisions on programming or formulation of interventions for improved OSS and FSM service delivery. By these interventions, the risk of human exposure to hazardous pathogens present in human excreta can be reduced thereby having a productive and healthy community.

### **1.3 Justification**

Developing solutions for poor access to sanitation and safe management of the generated FS is a priority for all developing countries. However, coming up with effective solutions that will have a greater impact on improving the sanitation situation in a city or a locality entails understanding how FS is managed at each stage of the sanitation service chain. It also calls for transactions and interactions among a variety of people and organizations from the public, private and civil society at every step in the service chain, from the household level user, to the collection and transport companies, operators of treatment plants, and the final end-user of treated sludge (Strande, 2014).

To gain an appreciation of the extent of the sanitation problems to be solved, it is imperative to understand how faecal waste flows along the service chain for the purpose of summarizing the net effect of FSM systems and at the same time highlighting the real bottlenecks to FSM. Thus, SFDs have gained recognition around the world as a simple way to easily visualize the fate of excreta generated within a locality. Based on this, it is an effective advocacy and communications tool to engage stakeholders like political leaders, sanitation experts and civil society organizations in a coordinated dialogue about excreta management. It is also a tool for engineers, planners and policymakers to make informed decisions when coming up with sanitation programs and interventions. Kanyama was selected as one area for interventions under the LSP. However, the flow of excreta is not clearly mapped making it difficult to design appropriate and responsive measures. Therefore, this study was cardinal to address this gap.

### **1.4 Objectives**

#### **1.4.1 Main Objective**

To develop a shit flow diagram for Kanyama that gives excreta pathway and the sanitation services that can aid the design of tools for the generation of appropriate intervention measures.

#### **1.4.2 Specific Objectives**

The following were the specific objectives of this study;

- To establish whether the existing policy, legislative and institutional frameworks are supportive of the implementation of faecal sludge management and OSS in Lusaka

- To establish the proportions of excreta that are safely or unsafely managed through the sanitation service chain in Kanyama by using an SFD.

#### 1.4.3 **Research Questions**

- Does Zambia have adequate policies, legislation, institutional arrangements and service standards which can support improved OSS and FSM service delivery?
- Does Kanyama have a well-established system of managing FS?
- What is the service (OSS & FSM) coverage in Kanyama?
- What are the common types of sanitation systems being used by the residents of Kanyama?
- What is the service (OSS & FSM) coverage in Kanyama?
- Does Kanyama have a well-established system of managing FS?

#### 1.5 **Significance of the Study**

This study served to inform sanitation practitioners and policymakers about the sanitation service outcomes in Kanyama PUA from which interventions can be developed to improve sanitation service using the Shit Flow Diagram tool. The study was also the first of its kind to develop a localized SFD that zooms into an area within a city. Most SFDs developed elsewhere are on a citywide level thus denying the opportunity to bring out the extent of sanitation problems being faced by the urban poor.

#### 1.6 **Scope of the Study**

The focus was to develop an SFD for Kanyama PUA and determine the service delivery context of sanitation services within the area. The SFD was developed for Kanyama PUA and does not cover the whole Kanyama administrative ward. The study was constrained to the area defined as this was the area that was defined as a problematic area by LWSC defined as Kanyama CSE 20. In order for this researched to be useful to LSP, this researched focused on the same defined area. Water and Sanitation for Urban Poor (WSUP) and GIZ through the conducted sanitation mapping exercise of the toilets in the same defined area in quarter two of 2017. Other useful information such as population and demographics data were also collected during the mapping exercise. Thus, such information was further cross-checked with other secondary sources such as the CSO population and demographic data for Lusaka district as well as that for administrative wards.

## **1.7 Organisation of the dissertation**

**Chapter 1** of the dissertation introduces the background of the research highlighting the urban sanitation challenge in developing countries and the need to come up with programs and interventions that will have a greater impact on improving access to sanitation and safe management of excreta; it also focuses on the objectives, significance of the study and ends with defining the scope of the research.

**Chapter 2** presents the literature review that was undertaken to develop the theoretical background around the research topic.

**Chapter 3** describes the methodology. It starts with a brief explanation of what SFDs are and their application and how they are developed following the methodology of the SFD promotion initiative (SFD PI) as well as the tools that have been developed for use during the SFD development process.

**Chapter 4** focuses on the type and sources of data used in the development of an SFD for Kanyama and contextualizes the study area in terms of general sanitation overview as well as ongoing and planned projects that are aimed at improving OSS and FSM in Kanyama.

**Chapter 5** presents the developed SFD graphic and outcomes based on the current service delivery context.

**Chapter 6** presents the findings of the research

**Chapter 7** presents the conclusions and recommendations based on the findings of the study.

## **CHAPTER 2: LITERATURE REVIEW**

### **2.0 Introduction**

Despite intense activities and great achievements in terms of reaching the Millennium Development Goal (MDG # 6) on safe drinking water and basic sanitation, there are still 2.5 billion people in the world that lack access to improved sanitation “*Ensure availability and sustainable management of water and sanitation for all*”. Around 1 billion people are still practising open defecation. According to WHO World Water Day report of 2001, the number of deaths that can be contributed to sanitation-related diseases is still on average around 2 million per year of which children under 5 years are the most affected group.

The fate of excreta produced by urban populations across the globe is often poorly understood. Particularly in low and middle-income countries with rapidly expanding cities, excreta management represents a growing challenge; generating significant negative public health and environmental risks.

A large array of external public donors supports the water and sanitation sector in Zambia. Donors coordinate their activities based on a Joint Assistance Strategy covering all sectors and a Sector Advisory Group for the water sector. One donor has the function of a speaker of the Sector Advisory Group on a yearly rotating basis. There are also coordination groups for the three sub-sectors urban water supply and sanitation, rural water supply and sanitation as well as water resources management.

Donors increasingly use basket funding, based on a basket for rural water supply and sanitation and a second basket for urban water supply and sanitation. Many NGOs, such as CARE and WaterAid, support the sector.

Globally, the great majority of urban dwellers, especially poor people, rely for their sanitation on non-sewered systems that generate a mix of solid and liquid wastes generally termed faecal sludge. In poor and rapidly expanding cities, faecal sludge management represents a growing challenge, generating significant negative public health and environmental risks. Without proper management, faecal sludge is often allowed to accumulate in poorly designed pits, is discharged into storm drains and open water, or is dumped into waterways, wasteland, and unsanitary dumping sites. This research assessed the extent of this issue in Kanyama area which is part of the

LSP and the major constraints that need to be identified to improve faecal sludge management by understanding the excreta pathway.

Partnerships between public bodies and WASH stakeholders are fairly common in Zambia. To date, these have involved partnerships between the public sector and Community-Based Organisations (CBOs), as opposed to Public-Private Partnership (PPP) arrangements. A prominent example of this type of partnership is between LWSC and Water Trusts. LWSC is mandated to provide water and sanitation services in Lusaka and chooses to provide part of this service through Water Trusts – community-based organisations CBOs in different zones that operate through a delegated management model with the utility. At the time this research was undertaken Lusaka had 11 such Water Trusts, the largest which is Kanyama Water Trust (other PUAs are serviced directly by LWSC through the Zonal Branches). Using this approach, LWSC has employed the same management structure to pilot on sanitation in Chazanga area of Lusaka and the project was ongoing.

The SDG has established as key indicator 'the percent of the population using safely managed sanitation services.

The SFD methodology developed through the Shit Flow Diagram Promotion Initiative ([sfd.susana.org/](http://sfd.susana.org/)) has been applied in over 40 cities worldwide and its usage continues to expand globally. As part of this SFD Promotion Initiative, the SFD for Kumasi (Ghana) was developed by Water Engineering and Development Centre (WEDC) and Kumasi Metropolitan Assembly (Furlong, 2015), which provided the basis for this research. The SFD establishes a key indicator, the percent of the population using safely managed sanitation services.

Management of excreta is often a challenging aspect and requires adequate information on the sanitation facilities. According to Williams (2015), human excreta may be released into the environment if the waste is not sufficiently contained on-site, if the waste is “leaked” into the environment through improper disposal or transport, or if the waste is insufficiently treated. Human waste contains pathogens that are harmful to health; thus leakage of human excreta into the household, community, and greater environment is a public health concern (Williams, 2015).

An SFD is a relatively new tool/ approach of mapping the flow of excreta generated in a city or a locality along the sanitation service chain. It has since received a wide

application by sanitation practitioners, city planners, engineers and policymakers in assessing the sanitation situation within a city or a locality. With SFDs being new, there is limited literature available on their development and application. Thus, this literature review was based on related publications and a few SFD reports from other cities.

The first source of information for this literature review was the SFD PI Website where most of the resources and tools related to SFDs are found. Thus, the recommended resources (documents, reports and tools) were reviewed to understand the concept of SFDs and how they are developed.

Then secondly, research was also conducted within the Sustainable Sanitation Alliance (SuSaNa) website which is an open-source knowledge hub, library, project database and discussion forum for anyone wanting to explore the possibilities of sustainable sanitation. Some general books, reports and discussions about sanitation with a focus on OSS, FSM and SFDs were accessed. These resources were reviewed to gain a general understanding of the global trend on sanitation. Other sources of information such as the open-source journals were also searched for books and documents on urban sanitation.

After gaining an overview of the urban sanitation context with a focus on the sanitation service chain, sanitation service delivery, sanitation systems and the concept of mapping the flow of FS along the sanitation service chain, more specific literature about the urban sanitation context in Zambia were sought from various institutions and stakeholders working in the sanitation sector in Zambia. These comprised mostly some grey literature and unpublished reports on OSS and FSM in Lusaka most of which were sought from LWSC, WSUP and GIZ.

Lastly, the literature review was complemented by searching on websites of institutions involved in urban sanitation in developing countries such as WSUP, WSP, Eawag/ SANDEC, WHO and UN. References found in books and reports were also searched on google to find articles in journals and other websites.

The approach to the literature review and the results achieved have been outlined in the content analysis table below.

*Table 1: Literature Review Strategy*

<b>Source of Information</b>	<b>Justification</b>	<b>Results</b>	<b>Comments</b>
SFD PI and SuSaNa Website	This is the website where most of the information related to SFDs can be found. It is also a knowledge hub for sustainable sanitation with a library and project database mainly on sanitation.	Documents for understanding the SFD development methodology were found. Documents on sanitation were also found that gave a general understanding of the global trends on OSS and FSM.	All the information is open-source; thus, no challenges were found to reach documents, articles, reports and SFD development tools.
WSP, Eawag/SANDEC, JMP-WHO/UNICEF, WSUP Websites	These institutions are leads in the sanitation sector. Through browsing their websites, information about their work, articles and reports on sanitation were accessed	Reports and articles supporting the general knowledge about the sanitation service chain and service delivery context in peri-urban settlements were found.	No major problems were found accessing information. However, some research papers and reports found on the websites could not be accessed as they are published in non-open-source journals.

Table 1 continue...

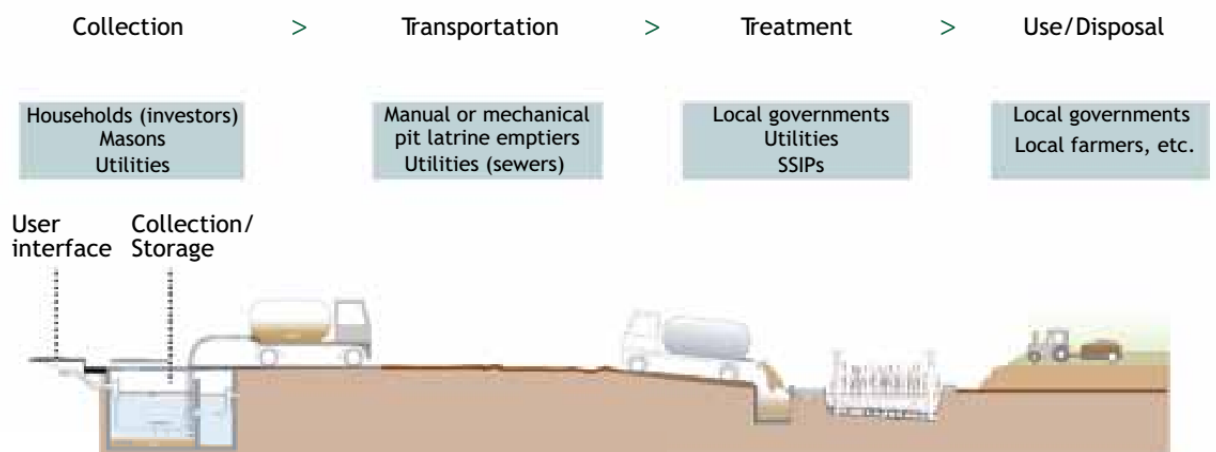
<b>Source of Information</b>	<b>Justification</b>	<b>Results</b>	<b>Comments</b>
Other Sources i.e. LWSC, NWASCO, LCC, GIZ and WSUP Zambia.	These institutions are the major stakeholders in the sanitation sector in Lusaka. Through personal contacts with them, some grey literature and unpublished reports on OSS and FSM in Lusaka were found.	Reports and grey literature on the sanitation covering topics such as sanitation mapping/ surveys, FSM business development, market assessment, Institutional and regulatory frameworks as well as policy (by-laws) were found.	No difficulties were found accessing most of this information. This was facilitated by the involvement of GIZ the sponsors of this research.

## 2.1 Research topic

## 2.2 Excreta Pathway

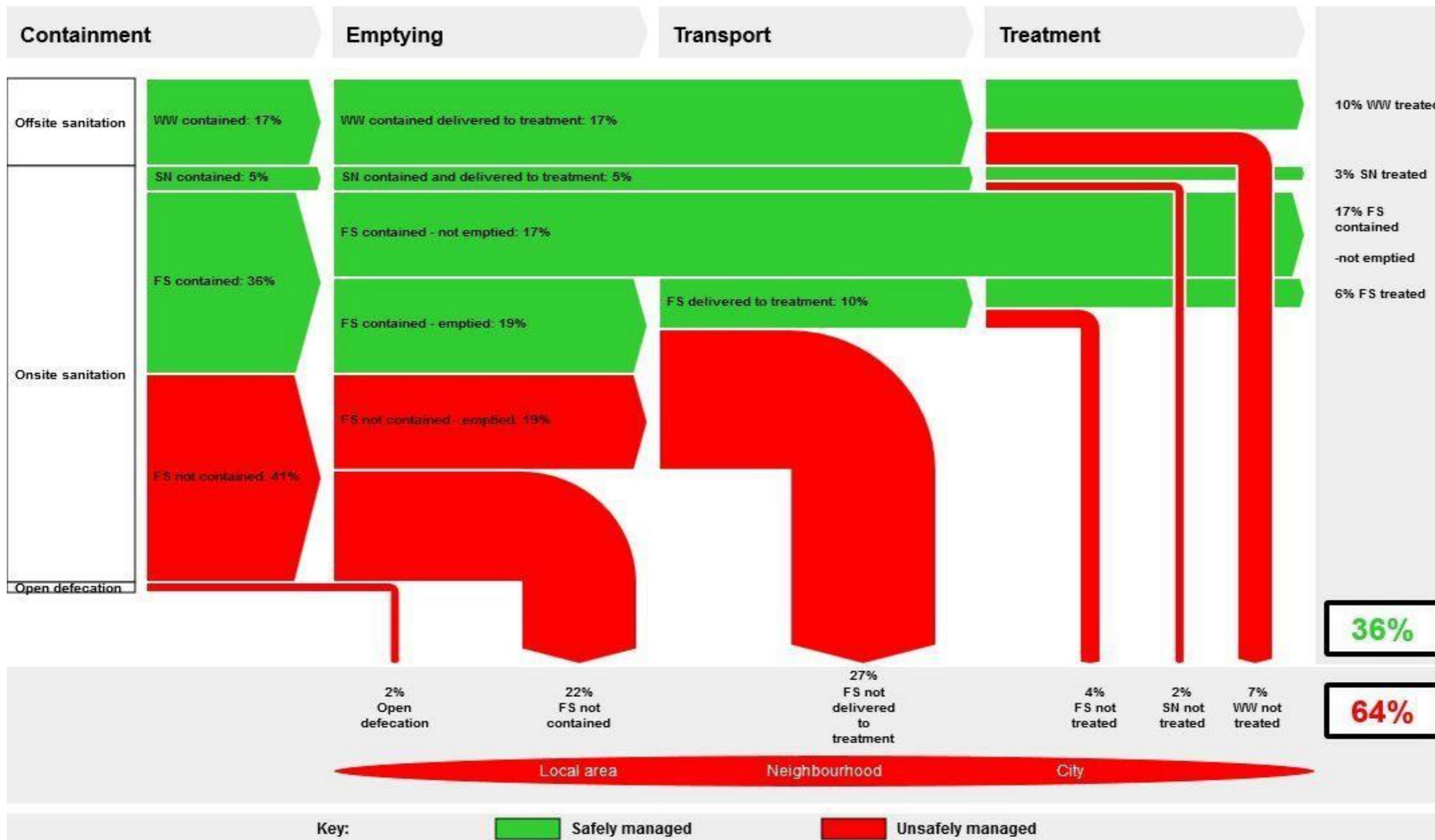
### 2.2.1 Focus on excreta pathways

The high density of the peri-urban areas does not allow families to safely abandon a full pit latrine and construct another one nearby, creating a need for a sanitation service chain (see figure 1 below) to hygienically remove and transport the faecal material to the treatment plant. (Hawkins, 2013).



*Figure 1: Faecal sludge management service chain (Parkinson, 2013)*

The SFD as shown in figure 2 on the next page represents and below visualize how excreta flows along the sanitation service chain. This clearly illustrates the excreta pathway of a city or a defined area. This approach has gained recognition globally and SFDs for different cities, towns or locality continues to be produced around the world. This is because SFDs have proved useful in the programming and planning of sanitation interventions by directing resources and efforts towards sanitation pathways that have the greatest human and environmental exposure to faecal contamination. They also help policymakers, politicians and practitioners realize the importance of FSM. Hence, SFDs can be used as tools for advocacy, decision making and monitoring of sanitation service delivery.



Produced with support from the SFD Promotion Initiative with funding from the Bill & Melinda Gates Foundation.  
 The SFD Promotion Initiative recommends that this graphic is read in conjunction with the city's SFD Report which is available at: [sfd.susana.org](http://sfd.susana.org)

Figure 2: Example of an SFD Graphic (Roeder, 2016)

As shown in figure 2 above, excreta which is safely managed along the sanitation service chain is represented by green arrows moving from left to right in the graphic, while excreta which are unsafely managed are represented by red arrows. The width of each arrow is proportional to the percent of the population whose excreta contribute to that flow.

### 2.2.2 The Sanitation Service Chain

The sanitation service chain as provided in figure 1 reflects that urban sanitation is comprised of several parts that are interlinked. At one end is containment (i.e. capture and storage – which is mainly a household level investment decision responsibility which includes private or shared toilets and at the other end is treatment and reuse/ disposal – typically this is a publicly provided service (Peal, 2015). For OSS systems, removal or emptying of the containment and transportation of the sludge are linked in the sanitation service chain i.e. they link the two ends, forming the chain. The containment system configuration (i.e. the arrangement used for capturing and storing the excreta) have a strong influence on the subsequent links or stages along the chain (Tayler, 2018). This means that the sanitation service chain for OSS systems is complex when compared to that for sewerage systems and requires the interactions of various stakeholders at every step in the service chain (Strande, 2014). This can be illustrated using the sanitation service chain for Maputo, Mozambique as shown in figure 3 below:

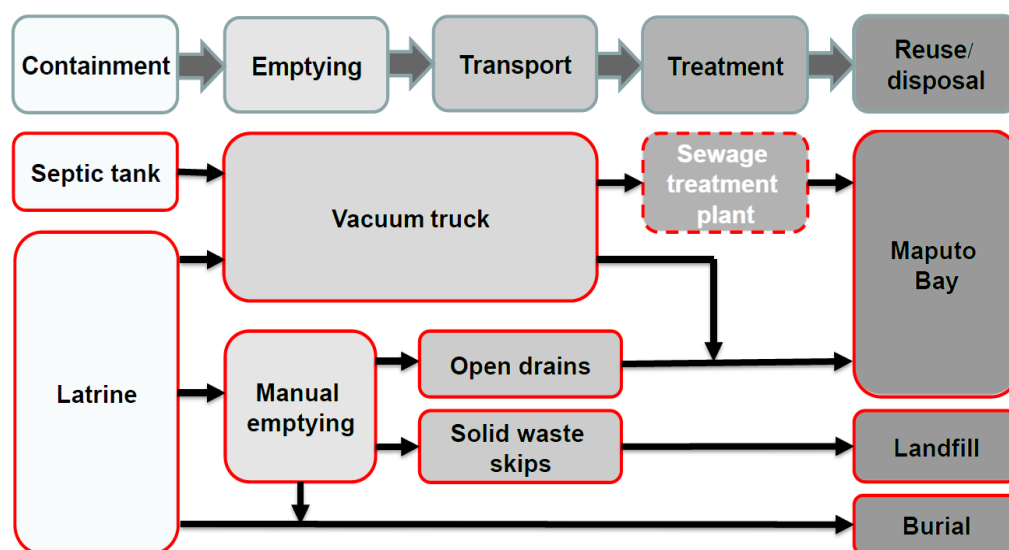


Figure 3: OSS Service Chain for Maputo (source: Adapted from Peal , 2015)

Thus, the chain comprises of containment or capture systems that range from simple pit latrine (with a simple hole in a slab) to un-sewered ablution blocks, septic tanks, pour-flush and dry toilets such as urine diversion toilets (Tayler , 2018). It also comprises a combination of basic manual sludge removal methods and the most sophisticated vacuum truck operations that transport the sludge accumulated in the onsite containment systems to a treatment plant/ or disposal location into the environment. Often due to the complexity of different types of OSS containment and capture systems, a variety of emptying and transportation service providers can be found operating in a city or locality (Mikhael , 2014).

According to Peal (2015), in a conventional sewerage system, the two ends are connected by the publicly operated sewer pipe network system which conveys the excreta from the point of generation to the treatment plant as shown in Figure 4 below.

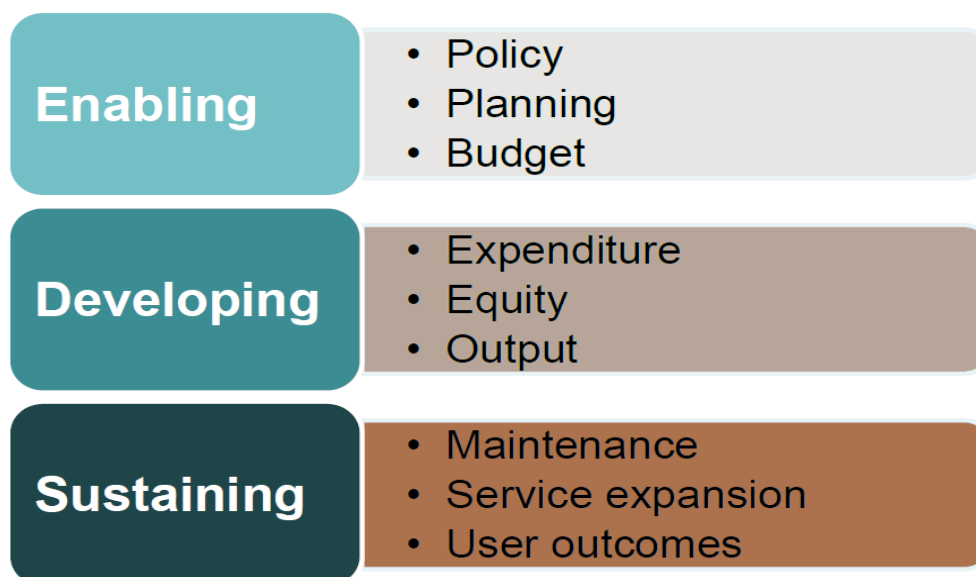


*Figure 4: Simple Sanitation Service Chain for Sewerage (Source: Peal , 2015)*

### **2.2.3 Assessing the Sanitation Service Chain in a City**

Considering the sanitation service chain as outlined above, sanitation can be defined as a multi-step process in which human excreta and wastewater are managed from the point of generation to the point of disposal (Tilley, 2014). The World Bank’s Water and Sanitation Program (WSP) reviewed FSM trends in 12 cities with the aim of developing analytical tools that can be used to assess FSM at a city level, to facilitate the identification of appropriate interventions to improve service delivery (Peal , 2015). This resulted in two tools; one for accessing the FSM service delivery context within a city (adapted and modified from the Service Delivery Assessment (SDA) scorecard) and another, a diagrammatic method used to analyse and illustrate the flow of excreta along the sanitation service chain (Peal , 2015). The latter is the SFD (as shown in figure 2 of this report) which shows the percent of people whose FS is safely managed across the sanitation service chain (Martinez, 2016). The former is an analytical framework for measuring the quality of the enabling environment, the level of service development and the level of commitment to service sustainability (Peal ,

2015). The tool used in the assessment of service delivery context (i.e. the adapted version of the service delivery assessment scorecard) is shown in figure 5 below.



*Figure 5: SDA scorecard adapted to analyse FSM service delivery at city level (Source: Peal , 2015)*

The review of FSM in 12 cities showed that these two analytical tools complement each other and the results of one reflect the results of the other. For example the service delivery assessment core card for Dhaka, Bangladesh indicated that there was no framework within which FSM services were formally being delivered and the result of this poor scenario was reflected in the SFD which showed a failed sanitation service chain with only 2 percent 0percent of the FS generated being safely managed (Peal , 2015).

#### **2.2.4 Deficiencies along the Service Chain**

Deficiencies from a global perspective along the sanitation service chain have been identified through data available from 12 cities selected for FSM review. These weak links are given below.

##### ***Faecal sludge is poorly management:***

- The data from the 12 cities revealed that almost two-thirds of the households in the cities studied rely on OSS systems while on an average only percent of the faecal sludge from these households is safely managed.

***Existence of technical and institutional issues requiring resolution:***

- Many sanitation systems are not well designed and are constructed without consideration of emptying when full.
- In most cities, there is a lack of masons trained in the construction of standard onsite containment systems
- Faecal sludge collection is poorly regulated and illegal dumping is common; and
- There are not enough faecal sludge treatment plants in most cities

***Faecal Sludge Management is Invisible to Policy-makers***

- There is a bias towards rich areas and the construction of sewers in most policies and projects leading to inequitable coverage. Also, sewers are considered the proper form of sanitation thereby considering FSM as a temporary solution (Hawkins, 2014);
- There is limited knowledge for sanitation planning and stakeholder's participation at an institutional level leading to a fragmented sector.

This is the basis for the preparation of the SFD graphic. According to the manual, the data collection methods employed depends on whether the study is desk-based or field-based.

This level is said to be appropriate for informing the percentage of the population using each type of onsite containment (including offsite systems), emptying and transportation of FS by e.g. vacuum tanker operators, the performance of treatment plants, and methods of reuse and disposal of the treated sludge.

**2.2.5 Based on the experiences.**

Experiences on the development and use of SFDs from other cities were reviewed to get insights on how easy it is to use the suggested methodologies and tools developed by the SFD promotion initiative. Partly this was done to understand the challenges faced by the researchers as well as the success stories. This was done through a review of selected published SFD reports.

According to the review report on the experiences gained from producing SFDs under the phase 1 of the "Promotion of SFD" project funded by the Bill and Melinda Gates Foundation (BMGF), the methodology and tools provide a sound basis for completing an SFD analysis in any city or town. Verses, Oscar and Bierker (2017) have identified the following as the main lessons learnt during the promotion of SFDs:

- the results from an SFD report provides a valuable picture of prevailing conditions in the city or town;
- review of various published SFD reports show every few examples of good urban sanitation management (failures in emptying, transportation and treatment are common);
- key informant interviews and other data sources must be triangulated (reliance on single data sources leads to biasness);
- the tools have a significant value in stimulating discussions that challenge standard preconceptions about how services are being delivered; and
- SFD results provide a useful basis for the planning of follow-up actions and investments.

In terms of challenges, Furlong (2016) identified five major challenges they faced when developing the SFD in Kumasi;

- definition of the city boundary was difficult because it was changed in 2013 and the data could not be disaggregated (the study area was based on the old boundary);
- the year 2015 was a transition period from millennium development goals (MDGs) to sustainable development goals (SDGs) and most of the excreta management plans and programs were being updated to reflect this;
- definition of sanitation technology terms and concepts used was a difficulty as most of them are used interchangeably making it difficult to achieve common understanding among different stakeholders (e.g. terms such as septic tank and aqua privy were used interchangeably to describe sanitation technologies);
- difficulties to have access to certain information collected by local agencies and lack of information on manual pit emptiers.
- other possible sources of excreta flow such as schools and public places were not considered. Consideration of these requires a detailed understanding of usage to avoid double counting bearing in mind that the potential users are most likely captured already at the household level.

SFDs have also been recently used as a tool to model future scenarios i.e. how the sanitation situation within a city or town will change following the implementation of planned interventions and programs. According to Martinez (2016), once the current SFD has been developed and future projects identified, the SFD methodology can be

used to illustrate the future scenarios, measuring how the SFD is going to change in the next years once those projects are implemented successfully while taking into consideration population increase. SFDs also have the potential to be modified to indicate how volume, mass and even nutrient flow along the sanitation value chain, making it possible to identify parts of the chain that have the potential to derive value (Peal, 2014). This is possible only when good quality data is available.

A Sanitation system is defined by Tilley (2014) as a context-specific series of technologies and services for the management of excreta or waste generated within a city or locality. In a system, the excreta or sludge travels through a series of technologies that are selected according to the context.

The most commonly known form of a sanitation system for urban settings are conventional sewers. Sewer systems have been considered for many years as the most viable, long term solution to fulfil the sanitation needs of urban dwellers (Strande, 2014, p. 1). Conventional sewer systems require huge capital as well as operation and maintenance investments, thus, their expansion and development are not likely to keep on pace with the rapid urbanization typical of low and middle-income countries (Strande 2014). Many utilities and municipalities in low-income countries are not able to meet this criteria and demand, implying that the vast majority of households will remain served by some form of OSS for the foreseeable future (Luthi, 2011). These OSS can comprise onsite septic tanks and leach pits, conventional drop and store systems which include various types of pit latrines and vaults and container-based systems (i.e. cartridge systems) that require faecal sludge removal or collection at intervals for a week or less (Tayler, 2018). According to Strande (2014), these onsite systems can represent cost-effective and viable options if the entire sanitation service chain is managed adequately. Other emerging OSS systems include self-contained systems that are designed to allow onsite treatment and transformation of FS into safe dry solids that can be manually removed and used as manure (Tayler, 2018). These include dry twin-pit and twin-vault systems as well as toilets that use worm composting to treat the faecal matter.

Many case studies have been done in many developing cities on the quality of construction of these onsite systems. Results of these studies show that these onsite systems are mostly rudimentary and poorly constructed pit latrines or cesspits which are characterised with poor quality of onsite containment structures (Luthi, 2011).

Hawkins & Blackett, (2017), identified the major onsite system (i.e. containment) challenges which are being or need to be addressed for efficient FSM as:

- direct discharge of septic tank effluent and pit latrine overflows into the environment through storm drains, rivers and canals;
- lack of a removable cover to access a pit or a tank for emptying; and
- poorly constructed pit latrines which are unable to be emptied mechanically, for fear of collapse which is mostly emptied using manual methods.

This brief overview of the common sanitation systems found in urban settlements of developing cities leads to the conclusion that most people rely on OSS systems and will therefore need a working sanitation service chain i.e. emptying, transportation, and treatment/ disposal systems in the foreseeable future before sewer systems are implemented.

### **2.3 Urban Sanitation Status in Lusaka**

This section describes the current sanitation status in Lusaka, including existing sanitation systems, sanitation knowledge, attitudes and practices as well as social-economic conditions with a focus on the peri-urban areas in Lusaka. The descriptions are based on information and data gathered through the review of reports from LWSC and GIZ, sanitation and socio-economic surveys as well as other related policy and strategy documents. The bulk of the data was also obtained from sanitation mapping exercises conducted in four PUAs of Lusaka (i.e. Chawama, Kanyama, George and Chazanga) from 2017 to 2018 by GIZ in collaboration with its partners such as LWSC and Lusaka City Council (LCC).

#### **2.3.1 Sanitation Coverage**

Lusaka city is on both offsite and OSS systems. Offsite sanitation systems cover about 30 percent of the city with 420km of reticulated sewer pipes connected to two centralized wastewater treatment facilities and five wastewater stabilization ponds (LWSC, 2016b). The sewer system services mostly the central parts of the city (as shown in figure 9) while the remaining areas are serviced by OSS facilities mainly in form of septic tanks and pit latrines according to LWSC, 2016b. The offsite systems only services between 10 to 14 percent of the estimated population for Lusaka. Thus, 90 percent of the population rely on OSS systems for their sanitation needs, of which about 70 percent live in densely populated informal settlements also known as peri-

urban areas (LWSC, 2018). Figure 6 on the next page shows the coverage of onsite and offsite sanitation systems in Lusaka.

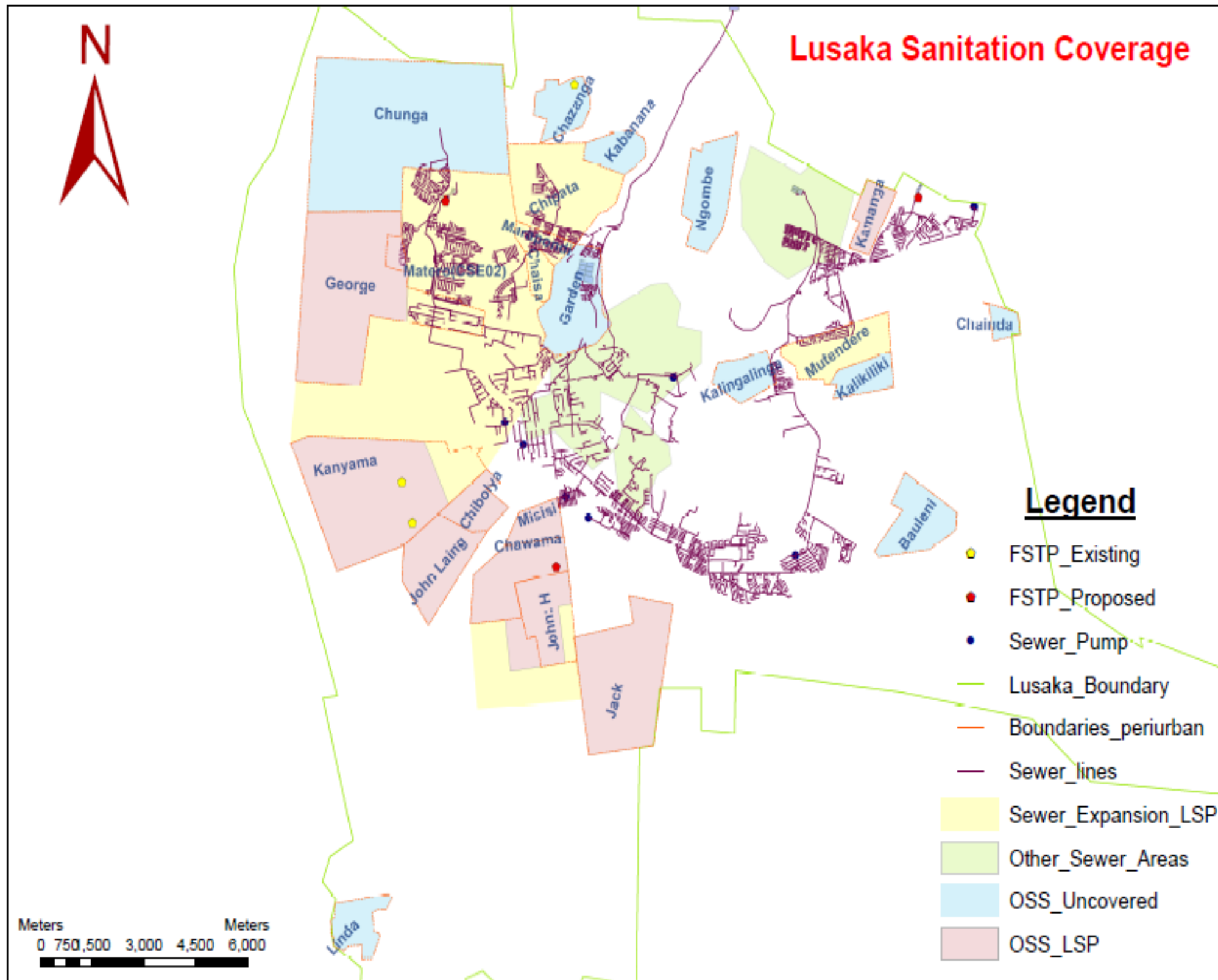


Figure 6: Sanitation Coverage Map for Lusaka including planned project under the LSP (Source: GIZ, 2017)

### 2.3.2 Types of OSS Facilities Found in Lusaka

Findings from the city-wide sanitation mapping survey (herein referred to as Lusaka Sanitation Mapping) conducted by LWSC between September to October of 2016 showed that most of the households in areas with no reticulated sewer network systems use simple pit latrines and waterborne toilets connected to septic tanks (LWSC, 2016b). The survey also found that open defaecation stood at about 1.2 percent. Table 2 below presents the population percent using each facility:

Table 2: Household percent using various sanitation facilities in Lusaka City (Source: LWSC, 2016b)

sn	Type of sanitation technology used in OSS areas	% of households
1	Water closet connected to sewer system	8.3
2	Water closet connected to a septic tank	15.4
3	Pour flush/squat pan connected to septic tank	7.4
4	Pour flush/squat pan discharging into a pit	8.4
5	Ventilation Improved Pit (VIP)	4.5
6	Simple improved pit latrine	46.6
7	Traditional pit latrine made from wood, metal drums or tires	7.9
8	Bush, river or abandoned plot	1.2
9	Ecosan	0.3
<b>Total</b>		<b>100</b>

Baseline and socio-economic surveys that were conducted by Vision RI consultants in the LSP selected project areas showed similar results to those shown in the table above (LWSC, 2016).

The two were all city-wide surveys with a sample size of 1, 523 households. However, the picture at a local level changes especially with a focus on the PUA's. This was revealed through the sanitation mapping exercise that was conducted by GIZ and its partners in four PUAs of Lusaka (Chawama, Kanyama, George and Chazanga). This

mapping exercise was a census to spatially map all the sanitation facilities in the project areas as a first step towards creating a city-wide database of all OSS facilities. The exercise showed that most of the households (on average 90 percent) in the PUA areas are using traditional and simple improved pit latrines, less than 10% are using waterborne facilities mostly connected to cesspits (sealed tanks with no outflow) and a few have proper septic tanks (GIZ , 2018). Table 3 below shows the proportion percent of the sanitation facilities found in the four PUA areas where sanitation mapping has been conducted.

Table 3: OSS Facilities at PUA Level (GIZ, 2018)

<b>Type of System</b>	<b>Chawama</b>	<b>Kanyama</b>	<b>George</b>	<b>Chazanga</b>	<b>Total</b>	<b>%</b>
Sewer	0	0	0	0	0	0
Flushing toilets	391	825	188	2,088	3,492	9.8
Pour flush toilets	451	897	412	1,050	2,810	7.9
Ordinary pit latrines	4,963	9,200	3,330	9,545	27,038	75.8
Ecosan toilets	5	65	19	46	135	0.38
VIP Latrine	117	1,560	60	637	2,197	6.2
<b>Total</b>	<b>5,927</b>	<b>12,547</b>	<b>4,009</b>	<b>23,125</b>	<b>35,672</b>	<b>100</b>

### 2.3.3 Knowledge, Attitudes and Practices

In terms of sanitation Knowledge, Attitudes And Practices (KAPs) the sanitation mapping exercise conducted in the four PUAs showed that the lack of design and construction standards for sanitation facilities, coupled with the non-existence of trained toilet construction masons or builders has led to poorly constructed sanitation

systems in the PUAs, most of which are in poor condition. There is also a lack of knowledge among the residents on when to have their facilities emptied and how to access the service (GIZ , 2018).

#### **2.3.4 Sharing of Sanitation Facilities**

Sharing of sanitation facilities among households is a common practice in Lusaka, especially in the densely populated peri-urban areas. The LS mapping found that 55percent of the sanitation facilities are shared among several households (LWSC, 2016). According to the 2010 CSO census report, household sanitation facilities located outside are more frequently shared among households than those located inside. This finding can be seen more pronounced in PUA where most sanitation facilities are located outside. The findings of the GIZ, (2018), mapping exercised showed that on average, sanitation facilities are shared among 3 households. Using the average household size of six, this is equivalent to 18 people sharing one facility.

#### **2.3.5 Structures of Sanitation Facilities**

According to the LS mapping, most of the sanitation facilities superstructure (i.e. 86 percent) are made from cement blocks (see figure 7 below), with the rest made from plastics, metal, timber and other materials (LWSC, 2016b). These superstructures differ when it comes to construction due to the lack of construction standards and guidelines. The other factor which brings about differences is the hydrogeological conditions. The western and southern parts of the city which are predominantly on karstic geology, the sanitation facilities are raised above normal ground level due to difficulties of excavating in the rock outcrop. On the other hand, in the northern and eastern sides of the city, the structures are built on the ground level and much deeper as the geology is mostly schists.



*Figure 7: Typical Latrine Superstructure Types (Source: GIZ 2018)*

#### **2.4 FS Emptying and Transportation Services**

According to the FSM market assessment conducted by LWSC (2018), there are three categories of emptying and transportation services in the city:

- i)** informal manual pit emptying services;
- ii)** formal manual pit emptying services; and
- iii)** vacuum tanker operators.

Service categories (i) and (ii) targets mostly pit latrines users in peri-urban areas while the last category is the more mature mechanized service (vacuum tanker operators) which target emptying septic tanks in more affluent mid and high-class areas that are not connected to the sewer line.

Category (i) services are provided by informal, unregistered individuals or groups (including, for instance, a member of the household) whereby FS is emptied from the latrine and dumped within the plot or another location in an unsafe manner (LWSC, 2018). Unlike category (i), category ii services are offered by Kanyama and Chazanga water trusts who operated on a delegated service management arrangement with LWSC. The emptying is conducted by professionally trained manual emptiers and the FS collected is transported to micro FS treatment plants located within Kanyama and Chazanga.

#### **2.5 Policy and legislation**

The government of the Republic of Zambia has put up several policies on water and sanitation services for both urban and rural areas. In this respect, National sector policies will be said to apply for Kanyama PUA as well. There is no specific policy on

sanitation but sector policies are there to provide guidance. The important policies include:

- i) National Water Policy;
- ii) National Housing Policy; and
- iii) Other strategies.

#### 2.5.1 Policy on Sanitation

The government of the Republic sets a respective objective on water supply and sanitation which is “to promote sustainable water resources management and development with a view to facilitating an equitable provision of adequate quantity and quality of water for water supply and sanitation in a timely manner”. It is now under revision to include measures that will support the development of standards, strategies and guidelines for the regulation of onsite sanitation service provision. The latter refers to national strategies and programs such as the Urban Water Supply and Sanitation Program (NUWSSP) (2011 – 2030) which aims at achieving universal access to sanitation and water supply services for all urban residents, institutions and industry for improved health, well-being and livelihood by 2030. Specifically, the National Urban and Peri-Urban Sanitation Strategy (2015- 2030) provides a framework for financing and implementing the sanitation component of the NUWSSP and has set a target to “provide adequate, safe and cost-effective sanitation services to 90 percent of the urban population by 2030”. The following institutions will be major players in the provision of urban onsite sanitation services

#### 2.5.2 Policy on Sanitation

The government of the Republic of Zambia has put up several policies on water and sanitation services for both urban and rural areas. In this respect, National sector policies will be said to apply for Kanyama PUA as well. The following policies were reviewed:

- ***National Water Policy:***

The National Water Policy of 2010 sets a respective objective on water supply and sanitation which is “to promote sustainable water resources management and development with a view to facilitating an equitable provision of adequate quantity and quality of water for water supply and sanitation in a timely manner” (MEWD, 2010). To achieve this, the policy has provided for the need to set up measures that

will support the provision of adequate and safely managed water supply and sanitation services paying attention to environmental protection. This means that the government is committed to providing adequate and safely managed sanitation services (which can be a mixture of both sewerred and non-sewerred sanitation services) to areas such as Kanyama PUA where the prevalence of poor standard OSS systems with no adequate safe faecal sludge management services poses a higher risk to contamination of groundwater resources that the utility depends on to supply water to the residents.

Despite this policy, there is no specific direction on sanitation service delivery; the inference is made to this in one way or the other as explained above. There is an ongoing revision of the Water Supply and Sanitation Policy which shall include Solid Waste Management by government. The 2016 Draft Water, Sanitation and Solid Waste Management Policy defines sanitation as “safe collection, transportation, treatment and disposal or reuse of human excreta, domestic liquid waste, industrial effluents and municipal solid waste” (NWASCO, 2018). In this revised policy, one of the measures is to develop standards, strategies and guidelines for the regulation of OSS service provision.

- ***National Housing Policy:***

The national housing policy covers housing Infrastructure development and the need to provide services such as water supply, electricity, drainage and sanitation for improved living standards of the people. The policy refers to road networks, waste disposal, sanitation, water supply, drainage, energy, communications and social facilities which are the basic infrastructure, whose availability enhances the quality and value of shelter. In relation to sanitation services, the policy recognizes the need to provide adequate and proper toilet facilities and highlights that this requires sanitation sensitization campaigns and training of masons in constructing improved OSS facilities for communities with no access to piped water and sewer reticulation systems. It also stresses the required government support in undertaking infrastructure services provision which includes roads, water supply, drainage, street lighting and sanitation.

- ***Other Documents:***

Several other documents have been developed to guide the implementation of national policies regarding water and sanitation developed by the government. The guidelines

are implemented at the national and local level through local government organs. The National Urban Water Supply and Sanitation Program (NUWSSP) – 2011 to 2030 - enables all urban residents, commerce, institutions and industry to have access to sanitation and utilize it in an efficient and sustainable manner for improved health, well-being and livelihood by 2030 (MLGH, 2010). Specifically, the National Urban and Peri-Urban Sanitation Strategy (NUSS, 2015- 2030) provides a framework for financing and implementing the sanitation component of the NUWSSP and has set a target to “provide adequate, safe and cost-effective sanitation services to 90 percent of the urban population by 2030”. To achieve this target, one of the objectives will be to improve access to sanitation and safely manage sanitation systems to reduce the incidence of water-borne diseases outbreaks such as cholera. At the local level, LWSC’s ‘Onsite Sanitation Strategy Brief’ of 2017 provides for the most required support for OSS and FSM in Lusaka city, especially targeting the PUAs such as Kanyama. The brief highlights the acceptable technical solutions, service models and financing options as well as outlining the proposed immediate non-sewered sanitation investments and interventions being implemented under the LSP (LWSC, 2017). Kanyama PUA is one of the project areas proposed under the LSP for improvement of OSS and FSM.

### 2.5.3 Legislation

There are four major legislative provisions at a national level which are important to OSS service provision:

- ***The Water Supply and Sanitation Act (No. 28) of 1998:***

This act provides for the regulation of water supply and sanitation service provision to urban areas by water utility companies. The act creates a regulator, NWASCO to implement and enforce the provisions of the act. The objective of the act is to ensure improved service provision of water supply and sanitation services through water utility companies (GRZ, 1998). It also ensures sustainable operations of CUs, protection of consumer interests through the setting of viable tariffs, provision of service level standards and consumer adequate access to water and sanitation services through improved performance by CUs. In terms of provision of sanitation services to PUAs such as Kanyama, NWASCO has set guiding principles for sanitation service providers and these include:

- i. Environmental protection with a specific focus on groundwater contamination;
- ii. Quality service provision; and
- iii. Consideration of safety and health of workers.

- ***The Public Health Act (Chapter 295 of the Laws of Zambia):***

The Public Health Act empowers a local authority to ensure a clean, habitable and sustainable living environment within the boundaries of its jurisdiction (GRZ, 1995). In this regard (LCC) has the mandate to ensure the prevention of communicable diseases and pollution of the environment to protect public health. Under this act LCC through its public health department is the authority delegated by the Ministry of Health to implement and enforce the provisions of the act.

Thus, LCC provides guidelines for regulations on building, drainage and OSS in relation to the implementation of the act. In relations to the building regulation, the act states (in Section 75 and 114) that any property development-building plan submitted to the local authority should show the position and dimensions of the OSS facility to be constructed in connection with the building. It also states that any pit latrine must be approved by the local authority especially about groundwater resources.

- ***The Local Government Act (Chapter 480 of the Laws of Zambia):***

The act provides for the establishment of councils for districts, the functions of local authorities and the local government system (GRZ, 1991). Some of the functions related to licensing business entities which includes pit-emptiers and vacuum tanker operators. The act also gives powers to local authorities such as (LCC) to make by-laws for their respective city or town which are in the interest of the public.

- ***Environmental Management Act:***

This act provided for the establishment of the Zambia Environmental Management Authority (ZEMA) which is mandated to ensure environmental protection and pollution control to provide for the health and wellbeing of persons, animals, plants and the environment (GRZ, 2011). This act gives ZEMA the mandate to license any persons or entities wishing to collect waste from commercial or domestic activities and transport it to the waste disposal sites with a waste management license.

#### 2.5.4 Institutional roles

The institutional roles for the sanitation sector are shared among different institutions providing sanitation service and guidance. The following are the key stakeholders in the sanitation sector:

- ***Ministry of Water Development Sanitation and Environmental Protection (MWDSEP)***

MWDSEP has the overall role as Water and Sanitation Sector lead. It is responsible for water resources management and development, water supply and environmental protection. The ministry has three key authorities set up to regulate and manage water and sanitation in Zambia namely ZEMA, NWASCO, and the Water Resources Management Authority (WARMA). MWDSEP as the sector lead has the overall responsibility for the formulation of policies and the enactment of sector laws and regulations. Through WARMA, the ministry has recently started regulating the development and installation of boreholes and protect and regulate groundwater abstraction as well as siting of boreholes. When it comes to OSS and FSM, the ministry will in the same line regulate service provision through NWASCO once standards are in place. In the new regulatory framework for urban OSS and FSM, the ministry will enact statutory instruments (SIs) for the regulation of operations and maintenance of OSS facilities and reuse of treated faecal sludge/ or wastewater. The Water Supply and Sanitation Act is also under review by the ministry.

Other ministries such as the Ministry of Health are also important to the sector that enhances the framework for public health and develop guidelines for risk mitigation and sanitation safety planning. The ministry of community development also addresses sanitation by promoting hygiene behaviour change through health workers and support CUs and LAs in identifying vulnerable and marginalized individuals/groups within local communities such as Kanyama. These ministries are found at a local level within Kanyama through government-established structures.

- ***Lusaka City Council***

Under the directive of the Ministry of Local Government (MLG), LCC focuses on the enforcement of Ministry of Health's Hygiene regulations and, development of by-laws on sanitation service provision through the Public Health Departments. Currently, LCC is developing OSS and FSM by-laws for the city of Lusaka that will aim at safe

management of faecal sludge to protect the environment, groundwater and public health. LCC also holds most of the shares in LWSC and seats on the board as well as delegates' service water supply and sanitation provision to LWSC, as per the WSS act No. 28 of 1997. LCC, through Environmental Health Officers and Health Inspectors, are mandated to enforce and regulate the sanitation relevant laws related to the Public Health Act (Drainage and Latrine), Regulation 1994 (Amended 2006) related to the collection, transportation and treatment of wastewater. LCC also has a mandate for other services that relate to the quality of the urban environment and therefore have a broader responsibility for sanitation that also includes solid waste management and storm-water drainage system of areas within Lusaka district.

- ***Lusaka Water and Sewerage Company (LWSC)***

LWSC is the commercial Utility Company delegated by LCC to provide water supply and adequate sanitation services to the urban and informal areas of Lusaka province. LWSC is overseen and regulated by NWASCO and manages the current water supply and sanitation infrastructure for the city. Due to the challenges of providing services to unplanned informal settlements in the city, water supply to 11 PUAs in Lusaka is managed by Water Trusts who operated decentralized water supply systems with boreholes and local networks. The water trusts are community-based enterprises that operate under a delegated service management contract with LWSC. They are financially self-sustaining and receive technical support and assistance from LWSC Peri-urban department.

Water supply and sanitation to Kanyama ward provided by both LWSC and Kanyama Water Trust (KWT). Water supply and sanitation services to Kanyama PUA are provided by KWT. KWT was the first water trust in Lusaka to introduce a safe FSM service that targeted servicing customers or households with pit latrines in Kanyama PUA. The FSM services of KWT are supported by LWSC through the PUA department. Further technical assistance and support on FSM is also provided by WSUP through the FSM project funded by Comic Relief and the Bill and Melinda Gates Foundation. KWT provides pit-emptying services to households in Kanyama and the sludge is transported to a treatment facility located within Kanyama. KWT works with other community-based committees such as Kanyama Ward Development Committee, Water Committee Members WASHE committee for Kanyama in providing water supply and sanitation services.

- ***National Water Supply and Sanitation Council (NWASCO)***

Under the Water Supply and Sanitation Act of 1997, the mandate of advising, licensing and regulation for sanitation services lies with NWASCO. NWASCO regulates the CUs with the aim to improve service delivery, efficiency and sustainability of water supply and sanitation services. According to MLGH (2015) NWASCO is responsible for:

- i. Defining sanitation service levels and standards;
- ii. Provision of guidance to support service delivery enhancements, including tariffs OSS service provision;
- iii. Development of regulatory instruments, benchmarks and monitoring schemes for OSS service providers; and
- iv. Reporting of OSS and offsite sanitation service coverage.

In this regard, the provision of FSM services to Kanyama by LWSC through KWT is in line with the provisions of this new regulatory framework.

- ***Zambia Environmental Management Agency (ZEMA)***

ZEMA is an independent environmental regulator and coordinating agency, established through an Act of Parliament, the Environmental Management Act no 12 of 2011. ZEMA is responsible for applying the legal framework for the protection of the environment and the control of pollution. Under the Environmental Management Act, no 12 of 2011, ZEMA regulates discharges into the environment and promotes water pollution monitoring and prevention programs based on enforceable water quality guidelines and standards. ZEMA is also responsible for issuance and enforcement of waste management licenses to any individual or entity who wishes to collect and transport domestic and commercial waste in the city for environmental protection.

## **2.6 Physical and economical Characteristics of Kanyama**

### **2.6.1 Location and Kanyama Peri-urban Area Context**

Kanyama (PUA) is located on the western side of Lusaka city centre about 7km from the central business district (CBD) and bordered by Los Angeles road on the western side and Mumbwa road on the eastern side. The area represents one of the selected priority project areas for improvement of OSS and FSM under the LSP. The Lusaka

Sanitation Program is a 5-year initiative by the LWSC aimed at uplifting Lusaka residents' quality of sanitation by providing affordable sanitation options. Kanyama PUA which this study was focused on is shown in figure 8. The PUA covers an estimated area of 14.25 km<sup>2</sup> (GIZ, 2017). According to CSO, the 2010 population density for Kanyama ward<sup>2</sup> was reported to be approximately 5636 people/ km<sup>2</sup> (Brinkhoff, 2018). The residents live in rented multi-room dwellings that accommodate more than one household (i.e. a building with several rooms each occupied by a family). Being closer to the city's CBD, the area is the biggest, most highly built and densely populated PUA in Lusaka as its residents are primarily migrants from the rural areas coming to seek for employment opportunities in the city. 253 out of which 84,714 were males and 84,539 were females living in 35,682 households (Brinkhoff, 2018). Access to adequate sanitation and the existence of service chains is very poor in Kanyama PUA. A recent baseline sanitation mapping conducted by GIZ in collaboration with WSUP in the first quarter of 2017 revealed that there are only 12,650 onsite facilities (with no reticulated sewer network in the area) in Kanyama PUA (GIZ, 2017). This is against an estimated 2018 population of over 220,000 people (calculated by applying the exponential population projection formula using the 2015 population growth rate for Lusaka city). The low access to sanitation facilities coupled with the non-existence of an effective FSM service as well as the presence of a highly vulnerable groundwater aquifer has led to near yearly outbreaks of. During the 2017/2018 cholera outbreak in the city of Lusaka, Kanyama PUA alone recorded over 1,000 cholera cases (WHO and MoH, 2018), making it one of the two worst affected areas with the second being Chipata PUA. However, this number covers also other cases from close proximity PUA's of Lusaka.

The research was focused on Kanyama PUA because it is an epicentre of waterborne diseases outbreaks and the area sits on the karst Lusaka dolomite aquifer (a useful groundwater resource for the city) which is highly vulnerable to contamination with faecal matter from the poorly managed OSS systems. Apart from this, the area represents one of the PUA's in Lusaka that are selected for the improvement of OSS and FSM to protect groundwater contamination. The SFD was thus developed to determine

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<sup>2</sup> Kanyama Ward is bigger than the study area herein referred to as Kanyama PUA. Kanyama Ward covers a total area of 30 km<sup>2</sup> and Kanyama PUA is found within this administrative ward. Kanyama PUA is the most densely populated area within the ward with the remaining area being an industrial area and a few farming blocks.

the baseline situation in Kanyama with regards to excreta management and flow along the sanitation service chain. Figure 8 shows the study area boundary and location of Kanyama PUA.

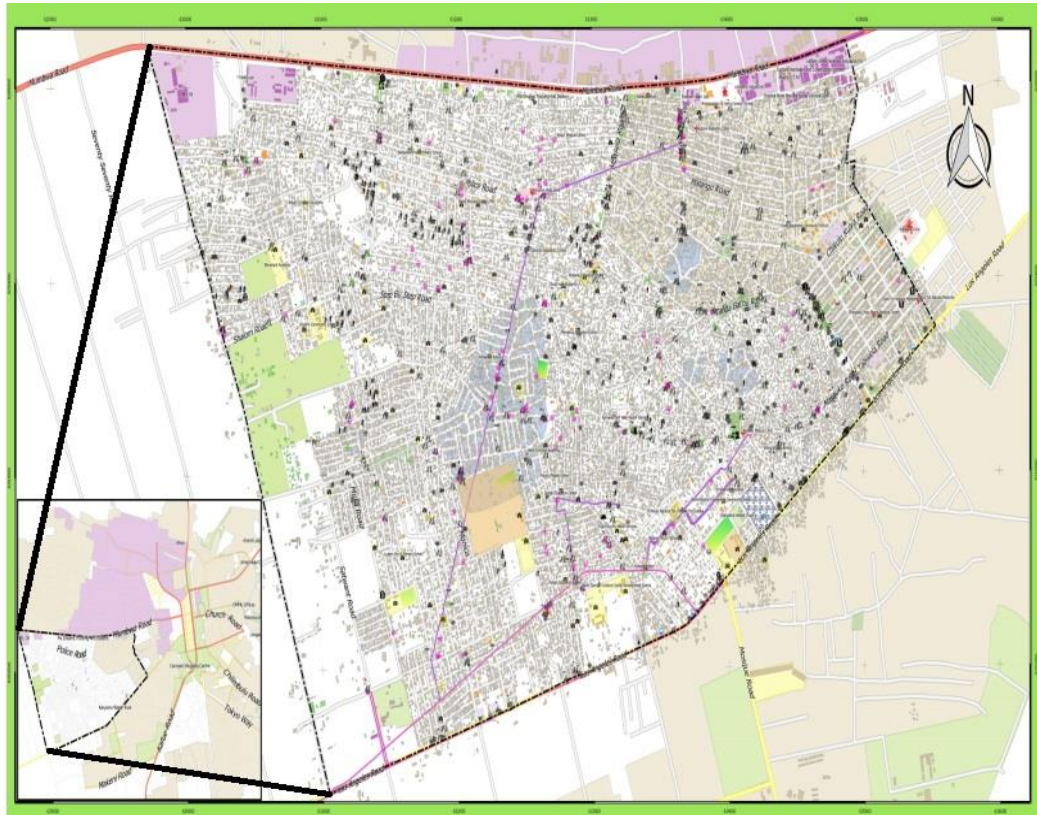


Figure 8: Location of Kanyama and Study Area Boundary (Source: GIZ 2018)

## 2.6.2 Physical Characteristics

### 2.6.2.1 Climate

Falling within Lusaka, the climate for the study area is primarily the same as that for Lusaka province. Due to its high altitude, Lusaka features a humid subtropical climate. Lusaka features hot summers and warm winters, with cold conditions mainly restricted to nights in June and July. The hottest month is October, which sees daily average high temperatures at around 32°C. The coldest month is July. Table 4 below presents the main elements of the climate around Lusaka.

Table 4: Climatic Conditions of Study Area.

<b>Element</b>	<b>Description</b>
Seasons	The climate of Lusaka is characterised by four seasons; namely, winter running from June to August, the pre-rainy season from September to October, the rainy season from November to March and the post-rainy season from April to May (Yachiyo Engineering Co. Ltd, 1995).
Precipitation	The 30-year average annual rainfall for Lusaka is 857mm with 77 rainy days per year. More than 90% of the annual rainfall is concentrated in the rainy season from November to March. The remainder falls in October and April.
Temperature	Temperature variations between the cold and hot seasons are considerable. The lowest average temperature of 8.4°C was recorded in July and the highest of 31.0°C was recorded in October, respectively.
Humidity	Relative humidity is in the region of 40-60 percent and 60-86 percent during the dry and wet seasons, respectively.
Wind	The windiest month is September and the least is March. The average annual wind speed is 1.8m/s
Sunshine	The mean annual sunshine hours for the area are 7.7 hours per day. The longest hours of sunshine recorded are from November to March while the shortest are from April to October

#### **2.6.2.2 Hydrology**

Lusaka is drained by three small streams, namely Chunga, Chalimbana and Ngwerere as shown in Figure 9. From the hydrology map (figure 9), it can be seen that the Chunga River and its tributaries flow westwards and then south into the Mwembeshi, a major tributary of the Kafue River. The other streams i.e. Ngwerere and Chalimbana flow north-east and east, respectively to join the Chongwe river, which flows south-east to the Zambezi river (Gauff Ingeniure, 2018).

With respect to the study area, there is no natural surface drainage system (rivers) in Kanyama. This is because the area is relatively flat and sits on highly extensive dolomite aquifer which is characterized by karst features. The karst feature act as conduit or channels where all the surface water recharges straight into the aquifer with no intermediate subsurface flow (Karen, 2018).

All the above information was obtained from the report: Detailed Design, Procurement and Supervision of Sewerage Works under AfDB component of the LSP (Gauff Ingeniure, 2018).

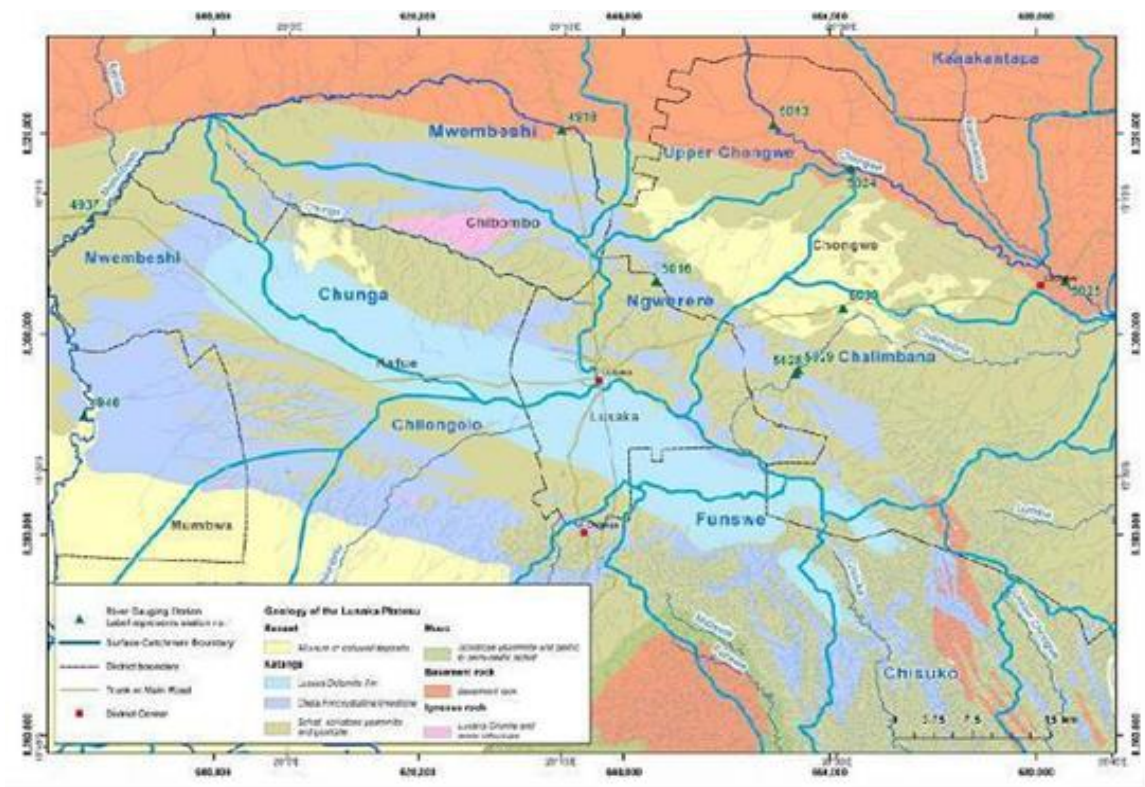


Figure 9: Lusaka's Main Drainage System (Source: Gauff Ingenieure, 2018)

### 2.6.2.3 Hydrogeology

The Lusaka dolomite Karst aquifer, the carbonate rocks of the Cheta Formation and the schists are of special interest about groundwater aquifers for Lusaka (Gauff Ingenieure, 2018) Kanyama PUA area is generally underlain by the Lusaka karst dolomite aquifer with less soil cover and a shallow lying groundwater table. It is categorized as a high-risk area to groundwater contamination with reference to the groundwater vulnerability map for Lusaka (Nick, 2012). Figure 10 shows the location of the Lusaka Karst aquifer with reference to Lusaka city.

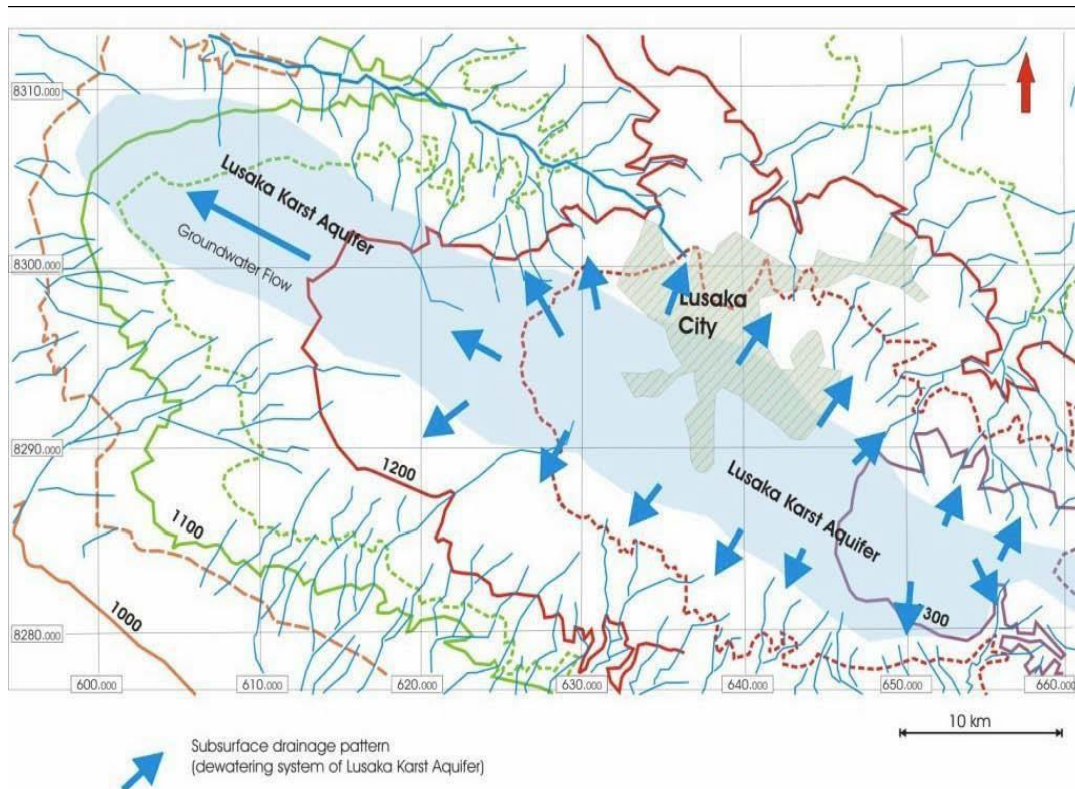


Figure 10: Lusaka Karst Aquifer (Source: Gauff Ingenieure, 2018)

## 2.7 Summary

With reference to the literature reviewed under this section, the concept of mapping the flow of excreta though relatively new has received worldwide recognition and application. The methodologies and tools developed by the SFD promotion initiative have been reported to be appropriate and adequate for application in completing an SFD analysis in any city or town. The methodology basically involves analysing various information related to enabling environment for sanitation service delivery (i.e. using the SDA scorecard tool) and the sanitation service chain (using the SFD tool). Both tools and approaches are combined together during the SFD development process to produce the SFD diagram and a report which details the service delivery assessment outcomes (i.e. the SFD report). This offers an opportunity of identifying the deficiencies along the sanitation service chain which is accompanied by an analysis of the framework within which OSS and FSM services are provided. The completion of such an analysis offers an opportunity to identify areas which need to be prioritized for improvement.

The deficiencies along the sanitation service chain which were identified by the review of FSM trends in 12 cities study are consistent with those highlighted in some of the

local literature reviewed on the sanitation status in Lusaka. This shows that the sanitation landscape in most cities in developing countries is comparable.

SFDs have recently been used as a tool to model future scenarios i.e. how the sanitation situation within a city or town will change following the implementation of planned interventions and programs. This is based on the understanding that results from an SFD report provide a valuable picture of prevailing conditions in the city or town.

Finally, a review on policy is given and clearly shows that there is a gap in addressing sanitation in Zambia.

## **CHAPTER 3: METHODOLOGY**

### **3.1 Introduction**

The literature review revealed that urban sanitation approaches require proper management of each step along the sanitation service chain. Thus, this calls for an understanding of the sanitation situation in the target city or locality as a preliminary to sanitation planning by various stakeholders charged with providing safe sanitation service to the public. As a result of this, the WSP project funded by the World Bank embarked on a study to analyse the flow of excreta along the service chain in 12 cities selected from developing countries in Sub-Saharan Africa, South and East Asia as well as Latin America. This study saw the birth of a methodology and tools which can be used to easily produce standardized SFD in any city or town. This methodology has been promoted by the SFD promotion initiative project funded by the Bill and Melinda Gates Foundation (BMGF) and tested in more than 50 cities in Africa, Asia and Latin America (SFD Promotion Initiative, 2015). Thus, the methodology of this research is based on the SFD methodology and tools as outlined and explained in the SFD production manual prepared by the SFD promotion initiative project.

This chapter henceforth focuses on the application of the SFD methodology and tools based on experiences from different cities where they have been extensively tested and used to produce SFDs. The study relied on detailed desk studies and analysis of available secondary data, expert opinions gathered through key informant interviews, analysis of primary data on sanitation facilities and practices gathered through the GIZ funded sanitation mapping exercise, field observations and focus group discussions (FDGs) with the community members as primary data. The chapter also describes how the SFD methodology and tools were applied in this study to produce the SFD for Kanyama PUA.

### **3.2 Research Focus**

The focus of this study was to develop an SFD based on primary information collected through a sanitation mapping exercise that was conducted by GIZ in June 2017 to develop a toilet database for Kanyama PUA as well as secondary information gathered through various surveys and studies conducted by LWSC. The objective of the SFD was to illustrate the baseline situation in Kanyama PUA with regards to excreta management along the sanitation service chain.

### **3.3 Description of the SFD Development Methodology**

The methodology employed to develop the SFD graphic together with the report followed the methods and approaches as explained in detail in the SFD manual produced by the SFD promotion initiative.

#### **3.3.1 SFD Promotion Initiative Methodology and Tools**

The SFD Promotion initiative standardized guidance – a methodology and tools – for easy production (once the data is collected) for standardized SFDs, supported by a description of information sources and the sanitation delivery chain in the city concerned (Sustainable Sanitation Alliance, 2015). Thus, the key information on SFDs was obtained from the SFD PI website, which is a knowledge management and information sharing platform where most information related to SFDs can be accessed. The website has some recommended documents as well as literature on the methodology to follow when developing an SFD for a city. These resources and documents were reviewed and analysed to understand the SFD and have an overview of the approach through learning from published SFD reports from other developing countries.

##### **3.3.1.1 SFD Manual**

This manual forms the main document recommended for guidance on the process followed within the SFD PI to produce an SFD report and the graphic. It also details the process of collecting information about the service delivery context to assess the status of sanitation services and management of excreta within the defined area. This is the basis for preparation of the SFD graphic. According to the manual, the data collection methods employed depends on whether the study is desk based or field based.

According to this manual, there are three levels of SFDs (including the reports) that can be produced based on the level of details and information collected which are:

- level 1 - initial SFD;
- level 2 - Intermediate SFD; and
- level 3 - Comprehensive SFD

Level 3 is the more detailed SFD which requires a systematic primary data collection process with wider stakeholder engagement. It also requires data from key informant

interviews, field observations and measurements to verify data accuracy (SFD Promotion initiative, 2018). This level is said to be appropriate for informing planning of sanitation programs and interventions for service improvement and will apply for this research.

Following this approach and methodology, various information related to the enabling environment for sanitation service delivery and the sanitation service chain is gathered as well as analysed. The manual also highlights the approach of analysing the sanitation service chain which is the basis of producing the graphic. The first approach is to define and understand the terminology and concepts related to service chain such as types of onsite technologies used within the target area. The second approach is to collect and analyse data related to service outcomes of both onsite and offsite sanitation system at each stage of the sanitation service chain. The data required includes; types of onsite containment systems, usage levels (i.e. percent of the population using each type of onsite containment including offsite systems), emptying and transportation of FS by e.g. vacuum tanker operators, the performance of treatment plants, and methods of reuse and disposal of the treated sludge.

### **3.3.1.2 SFD PI Tools**

The SFD PI has also produced some tools that can be used to generate the SFD graphic and the report. All the tools are available and accessible free from the SFD PI website ([www.susana.org/en/knowledge-hub/shit-flow-diagrams-sfds-excreta-flow-diagrams/sfd-promotion-initiative](http://www.susana.org/en/knowledge-hub/shit-flow-diagrams-sfds-excreta-flow-diagrams/sfd-promotion-initiative)). The tools include the following:

- **SFD Graphic Generator:** This tool is used to generate the SFD graphic. It contains the **SFD selection grid** (for selecting the types of onsite containment systems) and assessment of the risk to groundwater contamination with faecal matter.
- **Master SFD Graphic:** the visual representation of excreta flows across a town, city or urban area that shows the pathways taken by all excreta from defaecation top disposal along the sanitation service chain.
- **SFD Matrix:** a table which contains the means to calculate the variables for each of the sanitation systems chosen in the SFD section grid.
- **Assessment of risk to groundwater pollution:** this is the means to assessing the risk for groundwater sources contamination with faecal matter because of poorly

constructed sanitation facilities and vulnerability of the aquifer (i.e. based on the depth of water table and the hydrogeology of the area).

All the above terms descriptions of the tools were adapted from the SFD PI website, 2018.

This research was based on level 3 SFD development for Kanyama PAU.

### **3.4 Development of Kanyama PUA SFD**

The process for developing the SFD started with gaining a broad understanding of Kanyama PUA context with relation to population, demographic and sanitation. Most of this was done through detailed desk studies on sanitation in PUAs of Lusaka as well as population and demographic through a detailed review of previous socio-economic and sanitation surveys that have been conducted in Lusaka between the period 2015 – 2017. Most of these secondary sources of information were obtained through personal contacts with various stakeholders in the sanitation sector.

After understanding the Kanyama PUA context in relation to sanitation, population and demographic, a desk-based detailed assessment of the enabling environment for sanitation service delivery within PUAs of Lusaka with a focus on Kanyama was conducted. This was done following the modified service delivery assessment tool for FSM as described in the SFD Manual. Sources of information included policy documents, regulatory frameworks/ or tools, planning and strategy documents for the utility i.e. LWSC and regulators i.e. the NWASCO as well as the local authority i.e. (LCC). Interviews were also conducted with these institutions to understand better how the regulatory environment for urban OSS and FSM.

The data collected and information reviewed met the criteria set by the SFD PI to develop level 3 SFD which is a field-based SFD. Field-based SFDs require intense data collection at each stage of the sanitation value chain through detailed desk reviews combined with FGDs, informant interviews and field-based observations.

Stakeholder engagement (refer to Appendices 1, 2, 3 and 4 for the stakeholder tracking tools) was a critical part of the SFD production process. It served as a means of consensus building to gain acceptance and support for the SFD development process. Most of the stakeholder engagement was done throughout the study period and further, a workshop was held where the initial results of the study were presented to a wider stakeholder grouping for commenting, critique and feedback. The feedback gathered

from the workshop was used to revise the outcomes of the study to ensure acceptance of the final SFD graphic that gives the excreta pathway for Kanyama PUA, see Appendix 4.

### **3.5 Types and Sources of Data**

Selecting the appropriate methods for data depends on the amount and quality of available secondary data, the kinds of data needed and how the collection of these data can give a different perspective of the subject to the researcher (Denscombe, 2007).

There are typically two types of data that was collected during this research;

- Secondary data coming from documents such as government reports, other research, official documents or field studies. Some of the data required for the development of the SFDs was provided, captured during the sanitation surveys and mapping exercises conducted by GIZ in Kanyama PUA in 2017.
- Primary data gathering from:
  - ✓ Observations in the field (see appendices 5,6 & 7), gathering qualitative data from measurements of service provision and facilities through the sanitation and FSM service chain and qualitative data from visiting the service providers and facilities through the sanitation and FSM service chain (SFD Promotion Initiative, 2015)
  - ✓ Interviews including FGDs with key stakeholders such as community leaders or people in charge of sanitation in Lusaka city and at the national level.
  - ✓ Questionnaires were used when standardized data was required from selected respondents.

Essentially, this research relied on data and information gathered through detailed desk reviews of available local documents on sanitation service delivery in PUAs of Lusaka. Analysis of primary data collected through the mapping of sanitation in Kanyama PUA of Lusaka. Interviews with key informants, FGDs and field observations were conducted to triangulate and validate the information gathered from the detailed desk reviews. Refer to Appendix 5, 6 and 7 for FGDs and KII notes. In addition, a validation workshop was conducted with experts in the sanitation sector to validate the assumptions made where they were data gaps. See the attendance list for the validation workshop in Appendix 4.

Therefore, the data collected included quantitative and qualitative data. Most of the quantitative data such as types and number of sanitation facilities, population figures and proportions using a type of sanitation facility and other sanitation-related statistics were obtained from the survey that was conducted in 2017 by GIZ. The survey data was cleaned and survey conducted by GIZ, this is justifiable as GIZ's aimed at getting an SFD for Kanyama PUA using the information collected verified through primary data collection methods such as interviews and observations in the field. This research focus was the same with what GIZ captured and GIZ hence no surveys were done as sanitation mapping and survey was conducted by GIZ. See appendix 8 for the survey data.

For qualitative data, reports from surveys and preliminary studies from LWSC on OSS produced under the LSP which aims at improving sanitation service delivery in the PUAs of Lusaka. FGDs, field observations and KIIs were also used to gather qualitative data that was used to validate the quantitative data in the surveys through triangulation as shown in Appendix 5 and 6. Further detailed desk studies of sector policy documents, plans and strategies were conducted to gain an understanding of the enabling environment and institutional setups when it comes to the management of sanitation services.

### **3.6 Dealing with uncertainty in the data**

According to the SFD manual, it is important to be aware that the actual situation on the ground might vary significantly with the data that is reported in formal documents. In this research data was collected from different sources with a combination of different methods to reduce the uncertainties and bias through cross-checking and triangulation. Where data gaps and uncertainties were high, the assumptions made which were discussed with the stakeholders during the validation workshop.

### **3.7 Qualitative Data**

The qualitative data was obtained from detailed desk studies of survey and study reports on sanitation service delivery in PUAs of Lusaka. Most of these reports were obtained from LWSC with the help of GIZ and they comprised mostly output reports from consultancy assignments under the OSS component of the LSP. The desk studies helped to gain a deep understanding of the sanitation service delivery status in most PUAs of Lusaka as well as insights into some of deficiencies or failures along the sanitation service chain including that of Kanyama PUA. Furthermore, KIIs, FDGs

and field-based observations were done to build further on the inferences gathered during the detailed desk reviews (refer to Appendix 8 for the data collection tools that were used). Table 5 summarises the sources of the qualitative data and the outcomes

*Table 5: Sources of Qualitative Data.*

<b>Sources of Information</b>	<b>Justification</b>	<b>Outcomes</b>
<p>Consultancy for FSM Business Development Support to LWSC.</p>	<p>The market assessment study conducted under this consultancy was instrumental in the understanding status of sanitation service delivery in PUAs of Lusaka. This study was conducted between February to June 2018 (up to date information for this research).</p> <p>Other reports such as FSM service delivery models were reviewed.</p>	<p>The identified FSM market failures in Lusaka are useful findings on the deficiencies or failures in the sanitation service chain.</p> <p>Findings on activities of informal pit emptiers were useful (this data is not easily found in most cities)</p> <p>Service levels of formal emptying and transportation teams.</p>

Table 6 continue.....

<b>Sources of Information</b>	<b>Justification</b>	<b>Outcomes</b>
Sanitation Marketing Consultancy Services Under the LSP.	<p>The formative research conducted under this consultancy was instrumental in understanding the local socio-economic and cultural connotations that affect access to improved sanitation services.</p> <p>Other reports such as the situational analysis and marketing strategy were also reviewed.</p>	<p>Consumers understand that lined pits are better than unlined, but do not know how to upgrade due to the lack of designs and trained masons in toilet construction. This leads to building the same latrine they had before, rather than upgrading when the opportunity comes along.</p> <p>Homeowners do not budget for sanitation expense, so upgrading is not an option when a pit is full, or the toilet has collapsed.</p>
Policy and regulatory Documents, Strategies and Planned Projects.	Understanding the enabling environment and planned interventions for service improvements.	<p>OSS/ FSM interventions and projects under the LSP</p> <p>Newly launched OSS/ FSM regulatory frameworks.</p>
FGDSs, KIIs, Field observations and Workshops	<p>These were conducted to build on the inferences from the desk reviews.</p> <p>These were also used to build stakeholder consensus and validation of the SFD development results.</p>	Insights on open defaecation in the study area were only determined through FDGs and KII with the residents and discussed with key stakeholders during the validation workshop.

The summary on the stakeholder mapping and engagement tracking is provided in Appendix 1 and 2. Field observations also formed an important data collection and research tool for this study. Several observations were made which included faecal sludge emptying and treatment processes (during field visits with the manual pit emptiers operating in Kanyama), types of sanitation facilities in Kanyama and the disposal of treated faecal sludge as a means of validating the data from the mapping exercise, see Appendix 4. Visits to public toilets were also conducted to understand the sanitation technologies in the research area, see Appendix 7.

### **3.8 Quantitative Data**

The quantitative data was gathered by GIZ through the sanitation mapping exercise. The mapping was conducted with the aim of trying to improve the pit emptying service in Kanyama by developing a registry or database of OSS facilities that can be used as a resource to predict demand, track customers and monitor service provision. This data formed the back-bone for development of the SFD for Kanyama PUA as it contained information on the different types of OSS systems and the number of users. Information related to the structural integrity, construction standards, design of the onsite containment systems were also collected. Data collected by GIZ in the mapping exercise was verified and qualified through several visits and engagement with stakeholders. The metadata in Appendix 8 describes the metadata of the toilet database in the mapping exercise.

### **3.9 Stakeholder Engagement**

The engagement with stakeholders was undertaken starting from the mapping exercise during which community engagement and sensitization exercise were carried out to ensure community participation and support during the field data collection phase. Key Informant Interviews were conducted with primary stakeholders including community members in relation to faecal sludge management in Kanyama. Telephone conversations with key stakeholders were made to explain the project and to arrange the days of the field trips and visits such as those conducted to KWT site offices and the FSTP. All interviews were conducted either in the offices of the stakeholders or during the visits to different places of interest such as the dumping site, wastewater treatment plant. Also, semi-structured interviews (refer to Appendix 6) were conducted with KWT FSM coordinator who provided information on operations of the treatment plants and pits emptying service provision. The KWT pit emptiers were also

interviewed and provided information whilst in the field explaining how the emptying process is done and service coverage.

In addition to these interviews, unstructured interviews and focus group discussions were conducted with different stakeholders and the residents of Kanyama to get more details on the status of sanitation in Kanyama and to verify among other things; the service satisfaction, socio-cultural issues related to sanitation such as open defecation and sanitation needs and preferences. Further, the FDGs and KIIs were also used as a means of validating the information gathered from the mapping exercise. Interviews were also conducted with stakeholders such as the LWSC – LSP and GIZ who provided most of the information on the planned activities and interventions aimed to improve OSS/ FSM services in peri-urban areas including Kanyama PUA.

A validation workshop (Appendix 4) was also held where Kanyama PUA SFD Graphic and all the assumptions made were presented and discussed with various stakeholders to build consensus on the results. The feedback gotten during the workshop was used to revise the SFD matrix. Important feedback was collected on the assumptions made on open defecation and treatment efficiencies of the treatment plant. The workshop was attended by participants from LWSC, GIZ, the Ministry of Water Development, Sanitation and Environmental Protection (MWDSEP), NWASCO, WSUP, ZEMA and members of the community see appendix 4. Furthermore, various secondary data was verified on the policy and legislation on FSM & OSS in Zambia with a specific focus of Lusaka covering Kanyama PUA.

## **CHAPTER 4: RESULTS**

### **4.1 Introduction**

This chapter presents the results of the research from the data analysis and inputting of the data in the SFD generator to produce the SFD graphic (excreta pathway). The chapter also presents the findings of the service delivery context assessment that was done to understand the enabling environment for service improvement through review of government policies and legislation on sanitation, current running programs, plans and interventions. This is followed by a presentation of the service outcomes of the Kanyama PUA service chain analysis. Lastly, based on the findings of the two assessments, the resulting SFD graphic for Kanyama is presented together with the assumptions that were made.

### **4.2 Sanitation Service Delivery Assessment**

This subsection presents the results of the sanitation service delivery assessment, focusing on the enabling environment for effective service provision.

#### **4.2.1 Enabling Environment**

National policies, legislation and regulation were reviewed that apply for Kanyama PUA. In addition, some more information is provided on the local level with regards to strategies and legislation in relation to the changes that were taking place in Lusaka city, related to OSS and FSM with the funding of OSS under the multi-donor funded LSP.

#### **4.2.2 Policy**

##### **4.2.2.1 The government of the Republic of Zambia has put up several policies on water Policies and strategies**

There is no specific policy on sanitation, but sector policies are there to provide guidance as reviewed under the literature review section.

The National Water Policy is the overall sector policy that sets a respective objective on water supply and sanitation which is “to promote sustainable water resources management and development with a view to facilitating an equitable provision of adequate quantity and quality of water for water supply and sanitation in a timely manner”. It is now under revision to include measures that will support the development of standards, strategies and guidelines for the regulation of onsite

sanitation service provision. The housing policy is the other sector policy that covers housing infrastructure development and specifies all the required services. The policy refers to road networks, waste disposal, sanitation, water supply, drainage, energy, communications and social facilities which are the basic infrastructure, whose availability enhances the quality and value of shelter. There is no clear coverage of onsite sanitation provision in both policies.

The national strategies and programmes include the Urban Water Supply and Sanitation Program (NUWSSP) (2011 – 2030) which aims at achieving universal access to sanitation and water supply services for all urban residents, institutions and industry for improved health, well-being and livelihood by 2030. Specifically, the National Urban and Peri-Urban Sanitation Strategy (2015- 2030) provides a framework for financing and implementing the sanitation component of the NUWSSP and has set a target to “provide adequate, safe and cost-effective sanitation services to 90 percent of the urban population by 2030”. At the local level, Lusaka Water and Sewerage Company’s (LWSC) ‘Onsite Sanitation Strategy Brief’ of 2017 provides for the most required support for OSS and FSM in Lusaka city, especially targeting the PUAs such as Kanyama.

The new urban onsite sanitation regulatory framework has proposed a robust institutional arrangement that clearly specifies the roles and responsibilities of all key sector players.

#### **4.2.3 Legislation**

There are four major legislative provisions at a national level which are important to OSS service provision as reviewed under the literature review section on this report. There is no specific legislation on OSS & FSM in Zambia. Government is working on developing standards and legislation on OSS.

Under the Water Supply and Sanitation Act (No. 28) of 1998, The Government of The Republic of Zambia has the regulator (NWASCO) on Water and sanitation provision. NWASCO has not been regulating OSS in the past (previous focus has been on water supply and sewer systems) and is now starting to consider regulating OSS and FSM following their recent launch of the Urban OSS and FSM regulatory framework in July 2018. Under this new framework, NWASCO shall regulate OSS and FSM through the existing licenses with the commercial utilities (CUs) and any private operator

operating within the service area of the CU shall have a management contract with the CU which will demand adherence to the requirements of the regulator in relation to standards and guidelines to be developed.

Under the Environmental Management Act no 12 of 2011, ZEMA also issues licenses for operations of sewer treatment plants and disposal of treated effluent into the environment. Under the new urban OSS and FSM regulatory framework, ZEMA is set to develop new standards for faecal sludge treatment, disposal and reuse. At the time this research was conducted, EMA act no 12 of 2011 did not have specific license requirement for FSTP's including Kanyama FSTP.

The Local Government Act provides LCC to make local laws that govern the city. There are no by-laws for OSS and FSM in Lusaka at the time this research was undertaken. However, LCC is in the process of drafting these by-laws. These by-laws once passed will aim at safe management of OSS and FSM to protect the environment and groundwater as well as safeguard public health and ensure access to adequate sanitation for all citizens in Lusaka city.

Under the Public Health Act, LCC has the mandate to approve any pit latrine especially in relation to groundwater resources.

#### **4.2.4 Institutional Roles**

The institutional roles for the sanitation sector are shared among different institutions providing sanitation service and guidance. Due to not having specific legislation on OSS and FSM in Zambia, it is a fragmented approach where institutions try to address OSS. Kanyama OSS requires more support like Kanyama Water Trust operations.

LCC issues business levy licenses to businesses operating in the city. However, there is weak enforcement by LCC when it comes to registration of business providing OSS and FSM services in the city.

NWASCO recently launched a new regulatory framework for urban OSS and FSM service provision. In this proposed framework, regulation of OSS and FSM will be done through the existing licenses with utility companies such as LWSC. Any private operator providing OSS and FSM services within the LWSC's designated service area will do so under a delegated management contract with LWSC (NWASCO, 2018). Private operators providing services outside the service areas of LWSC will obtain a permit directly from NWASCO. In this regard, the provision of FSM services to

Kanyama by LWSC though KWT is in line with the provisions of this new regulatory framework.

The autonomous nature with which FSM service providers in Lusaka conduct their operations is due to the lack of standards and enforcement of the existing regulation (licensing of all faecal sludge collection and transportation business) by ZEMA. For instance, the FSM market assessment revealed that ZEMA had only a list of eight registered FSM vacuum tanker operators out of the 38 that dispose of waste at Machinchi wastewater treatment plant (LWSC, 2018). The formal pit emptying team of KWT does not have a waste collection and transportation license as well as a license to operate an FSTP from ZEMA and are not regulated. However, it can be said that since they operate under a water trust, they are covered under the LWSC license to provide water and sanitation services to Lusaka residents which includes Kanyama PUA. Records to show ZEMA compliance check on the Kanyama FSTP were not there at the time this research was conducted. Since ZEMA has the overall responsibility of environmental protection, it is critical that it closely monitors the operations of businesses such as emptying and transportation of sludge whose operations pose an environmental risk. This includes discouraging or banning the use of informal pit emptying services who empty and bury the sludge onsite which poses a lot of environmental & health risks

Finally, the review on policy and legislation is given and clearly shows that there is a gap in addressing onsite sanitation service delivery in Zambia PUAs.

#### **4.2.5 Service Provision**

LWSC is the only institution which is mandated by law to provide water supply and sanitation (WSS) services to the residents of Lusaka city. However, due to technical operation challenges of providing the services to unplanned settlements, WSS for 11 of the PUAs found in Lusaka is managed by Water Trusts which operate decentralized systems for each of the areas. Thus for Kanyama ward, water supply service provision is split between LWSC (for the new Kanyama area) and KWT (for old Kanyama in which the area of concentration for the research). KWT supplies water through five boreholes that pump to five 100m<sup>3</sup> elevated tanks spread across the settlement. Water delivery to the residents is through 164 kiosks and about 3,000 individual metered connections (Kanyanga, 2018). Recently, KWT expanded its services to sanitation by

providing the residents of Kanyama with formalized safe FSM services that focus on emptying pit latrines and treatment of the faecal sludge. This made KWT the first to provide the onsite service delivery in Lusaka and Chazanga Water Trust was formed later.

Other service providers of the service include Informal Pit Emptiers and Vacuum Tanker Operators (VTOs). However, VTOs in Lusaka concentrate on emptying septic tanks and they target mostly residential and commercial customers in the affluent non-sewered areas of Lusaka. Therefore, their service coverage in areas such as Kanyama is limited. Informal Manual pit emptiers on the other hand are believed to offer the biggest competition to KWT in relation to pit latrine emptying service provision. Due to inadequate information on the informal sanitation service delivery in Kanyama, it is complex to determine their extent of service coverage; however, experts such as WSUP have reported that it could be above 50% based on their recent FSM service market assessment conducted in the first and second quarter of 2018. These services are unsafe and should be discouraged through community sensitization and enforcement as they are a danger to public health and the environment.

#### **4.2.6 Service standards**

Service standards for WSS services are set by NWASCO, the regulator who reports annually on the performance of all licensed service providers based on the set key performance indicators and service guarantees. However, NWASCO's reporting and monitoring of service provision have been focused on water supply and sewerage, leaving OSS and FSM for private service providers to operate in an unregulated environment. In the case of Kanyama, the formal pit emptiers are authorized and hired by KWT who have a delegated management service contract with LWSC. Despite this arrangement, there are no set service standards for monitoring their operations; hence, no reporting is done on their services by the regulator. Monitoring of the performance (both financial and service coverage) of these formal pit emptiers has been done through WSUP's technical assistance and support to LWSC under their FSM project funded by Comic Relief and the Bill and Melinda Gates Foundation.

Following the launch of the Urban OSS Regulatory framework by NWASCO and the plans by LWSC to scale up FSM service provision to a citywide level, the regulatory environment is changing. In the new framework, NWASCO will regulate OSS and

FSM services through the existing licenses with CUs, in this case, LWSC. Any private operator conducting OSS/ FSM services in Lusaka will do so under a delegated service management contract with LWSC. Under the FSM business development plan, LWSC will go into partnership arrangements with private service providers to reach citywide sanitation coverage through OSS/ FSM. In this regard, LWSC will work with NWASCO on Key Performance Indicators (KPI's) and service level indicators for the private operators, which will include the formal pit-emptiers. The process of coming up with service indicators has already started, with some proposed service indicators being drafted under the FSM business development plan for LWSC. The proposed indicators will ensure quality and affordability of services, public health, environmental protection as well as human rights on access to sanitation.

There was no evidence to show that the FS treatment by KWT is regulated by ZEMA. This research shows that to ensure that service standards are followed by FS operators, ZEMA requires intensifying compliance adherence.

#### **4.2.7 Service Expansion**

The demand creation and marketing activities for the formal pit emptying services conducted by KWT are supported by funding provided by WSUP through a grant from the Bill and Melinda Gates Foundation (BMGF). Demand creation is the task of the marketing officer (hired by KWT) and is completed through the door-to-door interactions with the households who are the potential customers. Large scale sensitization programs organised by WSUP are also conducted once a year that aims at stimulating demand for the services at a macro level. Generally, the demand creation has yielded fewer results because it is conducted by a single person and the approach targets general sensitization instead of customers that need the service (e.g. households with toilets that are near full). According to the market assessment report, the major identified threat to the expansion of the formal pit emptying services in Kanyama is the lack of being able to provide full emptying, as is done by the informal emptying teams (LWSC, 2018). Emptying of the toilets is done based on how much volume of sludge to empty one has paid for and not the activity of emptying all the sludge.

Going forward, LWSC under the LSP is developing a citywide sanitation marketing strategy that is aimed at increasing the demand for OSS/ FSM services targeting the PUAs such as Kanyama where most people in need of these services reside. Capacity

will also be built among the private service providers so that they are able to conduct below the line marketing for their services.

#### **4.2.8 Planning**

Some targets have been set to improve OSS under the LSP (2015 – 2021) which is being implemented by LWSC to improve OSS/ FSM in Lusaka. Some of the targets which Kanyama PUA will benefit from include:

- i.** Provide improved OSS facilities in public places and at household level targeting over 200,000 beneficiaries during the project period;
- ii.** Building capacity of private pit emptying service providers to target PUAs reaching 50,000 latrines or 900,000 people over the project period;
- iii.** Increase the city's capacity to treat faecal sludge generated in the city with the capacity of serving over 720,000 people; and
- iv.** Expansion of the sewer network to Kanyama with a target of 4,400 new household connections.
- v.** The LSP represents one of the first major investment that tries to respond to the Lusaka sanitation master plan. The interventions of the LSP that are most relevant and will lead to improved OSS/ FSM in Kanyama include:
  - a.** The construction of 12,000 OSS household facilities (toilets) at a subsidized cost (7,000 are planned to be built in Kanyama with the rest spread among other PUAs).
  - b.** Procurement of pit latrine emptying equipment for 18 emptying teams in PUAs (some equipment will be provided for the KWT emptying team and the additional teams to be formulated).
  - c.** Expansion of the sewer line system to part of Kanyama (this will cover new Kanyama area where LWSC currently supplies water).
  - d.** Design and construction of four faecal sludge treatment plants (one additional treatment plant will be built in Kanyama to increase the treatment capacity).
  - e.** Marketing of OSS/ FSM services to create demand at the household level; and
  - f.** Institutional strengthening of LWSC to provide the services as well as the development of sector guidelines and regulation for OSS.

### 4.3 Sanitation Service Chain Analysis

This subsection presents the service outcomes of Kanyama PUA service chain, focusing on types of sanitation facilities and the populations served as well as the access existing FSM services in the area.

#### 4.3.1 Access to Sanitation

The non-existence of a reticulation sewer network system in Kanyama means that 100 percent of Kanyama's population relies on OSS for their sanitation needs, with pit latrines being the most common. The 2018 population for Kanyama ward was estimated to be 224,000 people (estimated by using the exponential population projection formula and the average annual population growth rate for Lusaka city and using the 2010 census population for Kanyama ward as the base population). **Basic**

**Equation:  $N_t = P e^{r * t}$**

Number of people at a future time = Present Population \* (base of the natural logarithms raised to (rate of natural increase /100 \* time period))

This figure might not represent the real population for the area because the population growth rate at ward level is influenced by the population density. For highly built up and densely populated areas such as Kanyama, the actual population growth rate can be lower than assumed due to the lack of available space for the development of new residential dwellings i.e. the area can be assumed to have reached population saturation. Furthermore, it was assumed that close to 90 percent of Kanyama ward population live in the area where the sanitation mapping exercise was conducted, covering approximately 50 percent of the land. This is the most densely populated area in Kanyama ward. Based on this it was assumed that the population for the area of concentration for the SFD which is the same as the sanitation mapping exercise area could be estimated to 198,000 people. The remaining 50 percent of the ward land is covered by a mixture of an industrial area and some farming blocks hence, the resident population was assumed to be lower. Based on the results of the mapping exercise **170,000** people were associated with using some form of a sanitation facility (on average the facilities were shared among 3 households), indicating that close to 30,000 people do not have access to some form of sanitation and are thus using either a facility in a public place, bucket toilets or are practising open defecation.

#### 4.3.2 **Current choice of Sanitation services for Kanyama Residents**

OSS services and products supply chain is defragmented in Kanyama, with no designated suppliers or local business that households can engage or contact when they want to buy or build a toilet. The choice of OSS facility type that one can acquire is limited to rudimentary traditional technologies such as simple pit latrines and some instances are pour or full flush toilets connected to either septic or a cesspit.

When it comes to pit emptying services, the residents can choose either the KWT FSM service or the informal pit emptiers. The engagement of the informal pit emptiers is based on past customer relationship and the lack of awareness by most households on the existence of the formal service. However, some households have been reported to prefer the informal pit emptiers over the formal due to their ability to conduct full empties (as compared to the formal who do partial emptying) offering more value for their money. Vacuum tanker emptying services can also be accessed by a household who can afford the charges. Mostly the VTOs charge higher tariffs for emptying pit latrines due to the challenges associated with emptying latrines using vacuum tankers. The charges are said to be too high for most residents to afford. Disposal of the faecal sludge is either at Kanyama FSTP or Manchichi treatment plant.

#### 4.3.3 **Plans to Reduce Access to Sanitation Inequity**

Some plans and measures have been set by LWSC through the interventions under the LSP that will aim at addressing the affordability of the assessing OSS services especially by the urban poor who live in PUAs such as Kanyama. Some of the immediate measures and plans include:

- i. Introduction of a sanitation levy on water bills which will apply to all LWSC customers with a water connection but are not connected to the sewer line. The revenues collected will be used to cross-subsidize the cost of emptying and transportation of faecal sludge collected by private service providers operating in PUAs including Kanyama. This will result in increased access to safe emptying services (including VTOs) and reduced use of informal pit emptiers.
- ii. Construction of subsidized household sanitation facilities (7,000 in Kanyama). Households who will sign-up for the construction of these improved sanitation facilities be given a discount of between 70 – 80% of the total unit cost. The design of these facilities also followed a human-centred design approach that ensured that the

sanitation preferences of the target users are incorporated. Efforts will be made under the project to ensure the most vulnerable households of the community who do not have access to sanitation benefit from this incentive.

#### **4.3.4 Monitoring and Reporting Access to Sanitation**

There is no formal monitoring and reporting on access to OSS services both at the local and national level. The sector regulator (NWASCO) only monitors and reports on access to water supply and sewerage services. Under the new proposed regulatory framework for urban OSS services, NWASCO will monitor and report access to both offsite and onsite services through the existing license with LWSC. This means LWSC will be responsible for all sanitation service delivery and it will be in its interest to monitor the activities of the private service providers (including those operating in Kanyama) to ensure that they are adhering to the service standards that will be set by the regulator. It is for this reason that LWSC is now developing a Monitoring and Evaluation/ Management Information System (M&E MIS) that will be used for monitoring all LWSC services including OSS. The system will be able to generate reports based on set service indicators, hence enabling reporting on access to services.

Some form of monitoring of the performance of the formal pit emptiers operating in Kanyama (both financial and service coverage) has been done by LWSC with technical assistance and support from WSUP under the FSM project funded by Comic Relief and the Bill and Melinda Gates Foundation. KWT creates monthly reports that identify both costs and revenues which are submitted for review by both WSUP and LWSC. The financial performance monitoring shows that the pit emptying service is subsidized by revenues from the KWT's water sales as the current service charges are unable to cover the full cost of emptying, transportation and treatment of sludge. The service charges were set deliberately low by LWSC upon the introduction of the services and have not been revised upwards since 2013 due to the inability of the households to pay. Service coverage is also reported by KWT as each emptying job is recorded on a log sheet filed by the emptiers and returned to KWT where the information is transferred into an excel spreadsheet. Some of the information captured includes; geographical coordinates of the location where the service was offered, a number of barrels emptied as well as some household demographic information.

### 4.3.5 Types of Sanitation Facilities

Since there are no reticulated sewer network connections in Kanyama PUA, the residents rely entirely on OSS systems mostly pit latrines for their sanitation needs. Table 6 below shows the type and percentage of the sanitation systems that are found in Kanyama PUA based on the outcomes of the sanitation mapping exercise.

Table 6: Types of Sanitation Facilities in Kanyama Based on the sanitation mapping exercise data, as of June 2017(source: GIZ, 2017).

Type of Facility	Number	Type of Containment	% of Facilities
Full/ Pour Flush <sup>3</sup>	3456	Septic tanks/ Cesspits	25.2
Pit Latrines <sup>4</sup>	9878	Lined/ unlined pits	72
UDDTs	65	Lined Pit	0.5
Others <sup>5</sup>	325	-	2.3

Most of the sanitation facilities in Kanyama are located on residential plots. Thus, public or communal facilities are not so common in the area. However, public or communal sanitation facilities are found in commercial places and public institutions such as markets, schools, churches and bars. Based on the sanitation mapping exercise data, as of June 2017, they were a total of 314 public sanitation facilities in Kanyama, the majority of which were in public institutions (300 facilities) such as schools and churches. Furthermore, 51percent of these public facilities were pit latrines and 46 percent were waterborne facilities connected to either a septic tank or a cesspit. The toilet database also showed that of the 72 percent pit latrines, 5 percent (estimated based on the size of the area) were in zones that are severely flooded during the rainy

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<sup>3</sup> Includes all water borne toilets connected to proper septic tanks, cesspits and conservancy tanks.

<sup>4</sup> Includes a combination of improved pit latrines (lined and unlined pits) and tradition pit latrines.

<sup>5</sup> Includes other forms used by residents such as bucket toilets.

season; hence they are classified as flooded latrines. Figure 11 on the next page shows the areas that are prone to seasonal flooding in Kanyama PUA.



### 4.3.6 Containment Systems

Table 7 describes the types of faecal sludge containment systems found in Kanyama and their conditions based on the technical assessment done during the mapping exercise.

Table 7: Types of Containment Systems Common in Kanyama PUA

s/n	Type of containment	Comments
1	Lined Pit	<ul style="list-style-type: none"> <li>•A shallow pit (not more than 2.5 m deep) usually built above ground due to difficulty of excavating in hard rock outcrop and lined with concrete block on the sides.</li> </ul> <p>The bottom of the pit is usually unlined and therefore prone to flooding during the rainy season.</p>
2	Unlined Pit	<ul style="list-style-type: none"> <li>•A shallow pit (not more than 2.5 m deep) which is entirely unlined and the natural rock acts as a firm lining for the pit sides preventing it from collapsing.</li> <li>•Usually common with traditional or unimproved pit latrines.</li> </ul>
3	Cesspit	<ul style="list-style-type: none"> <li>•A fully lined tank (usually offset from the toilet superstructure) which is built above ground with concrete blocks lining and concrete top cover.</li> <li>•The most common form of containment associated with most waterborne toilets in Kanyama and in most cases not connected to a drain field or a soak-away.</li> <li>•Mostly not watertight and is prone to flooding during the rainy season due to infiltration of groundwater.</li> </ul>

Table 7 continues ....

4	Septic tank and soakaway	<ul style="list-style-type: none"> <li>•A properly constructed double chamber septic tank with a soakaway, built with concrete blocks, a bottom concrete base and a top concrete cover.</li> <li>•Most of these are not watertight and are flooded during the rainy season due to infiltration of groundwater.</li> <li>•Most common form of containment associated with waterborne sanitation facilities found in institutions such as schools and clinics.</li> </ul>
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Generally, the containment systems in Kanyama are shallow i.e. usually not more than 2.5 m in depth and are built above normal ground level due to challenges of excavating in the underlying hard dolomite rock outcrop. Furthermore, most of these containment systems are not watertight, extremely increasing the risk of groundwater contamination with faecal matter especially during the rainy season when the groundwater table rises to almost a meter from the ground surface. During the site observations and interviews with the residents of Kanyama, it was confirmed that the water table depth during the rainy season based on their local knowledge gathered through excavations for pits and foundation trenches for buildings rise to almost less than 1 meter. It is also common for these containment systems to be flooded during the rainy season causing an overflow of faecal matter into the surrounding environment.

Results of the technical assessment of sanitation facilities conducted during the mapping exercise showed that about 72 percent of the septic tanks and cesspits were in poor condition. As for pit latrines, it was recorded that about 32 percent are in a bad state; however, this number might be higher than recorded. Figure 12 on the next page shows the distribution of the conditions of containment systems, with those rated 3 – 5 being in worse conditions and not fit for containing faecal sludge and 1 – 3 as good. Furthermore, detailed analysis of the mapping data and field inspections of the types of sanitation facilities in Kanyama revealed that most of the facilities that were mapped as septic tanks are in the actual sense, not septic tanks since they are not connected to a drain-field and are usually just a single compartment fully lined tank. For the

purposes of the SFD these were categorized as cesspits (usually not watertight) while proper septic tanks were estimated to be less than 1 percent (comprising of facilities which are located at institutions such as schools and clinics). Figure 12 below shows the percent of sanitation facilities that are in good and bad states based on an analysis done by the author using the technical information collected during the mapping exercise.

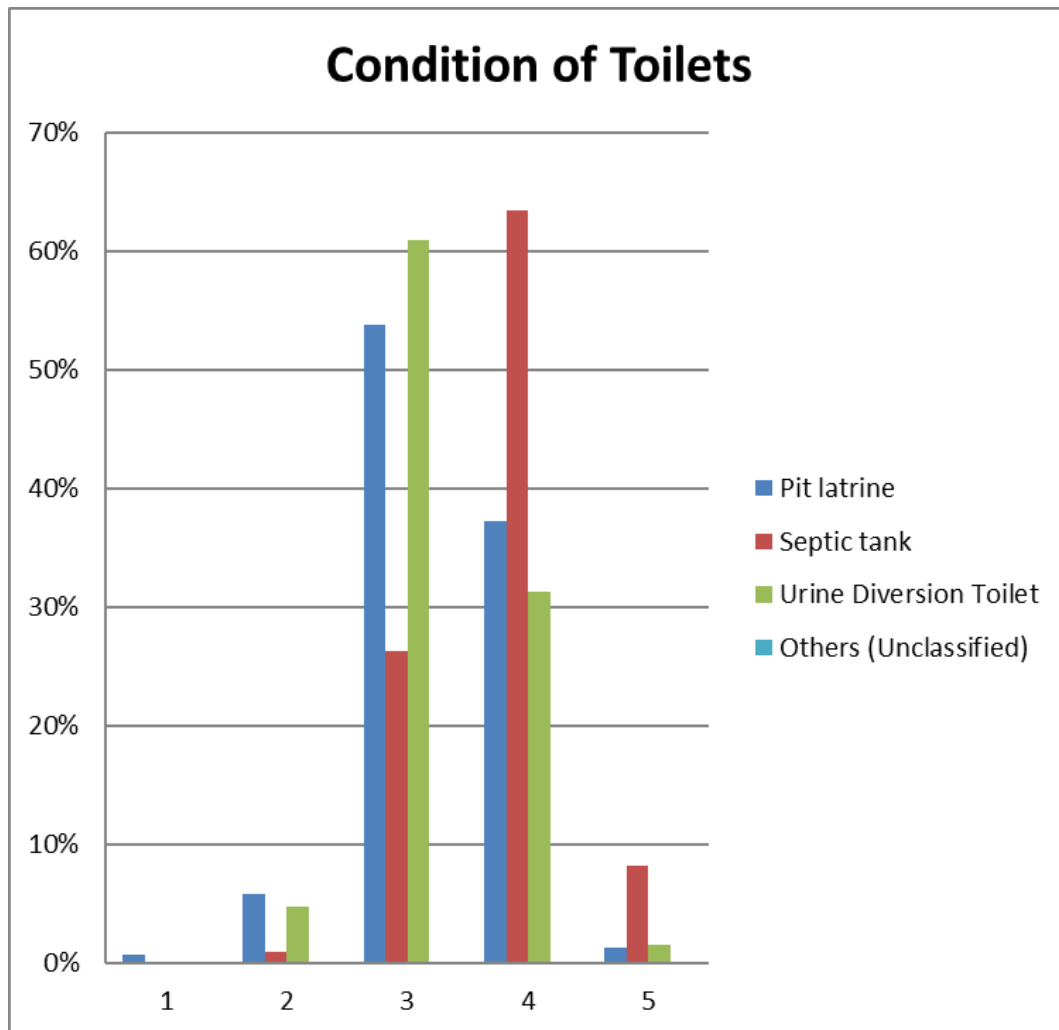


Figure 12: Conditions of Containment Systems

#### 4.3.7 Sludge Accumulation in Containment Systems

For the purposes of this study, it was assumed that the amount of sludge generated in Kanyama is equivalent to that accumulated in containment systems of the facilities. The 2018 market assessment (LWSC, 2018) considered the sludge accumulation rates to be 72 litres per person per annum (72 L/pp/annum) for pit latrines and 90 litres per person per annum (90 L/pp/annum) for septic tanks and cesspits. Based on this, the

sludge accumulated in containment systems in Kanyama is estimated to be close to 13,000m<sup>3</sup> per year. Approximately 320m<sup>3</sup> of sludge per year is collected and transported to the treatment plant by the formal pit emptiers, representing less than 3 percent of the total sludge accumulated.

#### **4.3.8 Ground Water Vulnerability Due to Poor Containment Systems**

Kanyama PUA sits on the western side of Lusaka city which is categorized as severely vulnerable to groundwater contamination with reference to the groundwater vulnerability map for Lusaka prepared by BGR. As can be seen in figure 13 on the next page, the western and southern parts of Lusaka are categorized as extremely vulnerable to groundwater contamination because they sit on an extensive and highly productive shallow aquifer. The majority of the OSS containment systems in Kanyama are not watertight. Thus, the percent of containment systems that are not able to effectively contain faecal sludge was assumed at 100 percent due to the high risk they pose on groundwater contamination. Shallow wells and boreholes in Kanyama are near pit latrines posing very severe and dangerous levels of water contamination by faecal matter. There is no proper consideration of the distance that should be maintained between water sources and sanitation facilities. Households in Kanyama install both facilities as they wish as the area is unplanned and space is limited. Groundwater contamination in Kanyama has further been proven by water quality tests that were conducted during the 2017/2018 cholera outbreak on samples picked from shallow wells and boreholes which tested positive faecal coliforms and vibrio cholera.

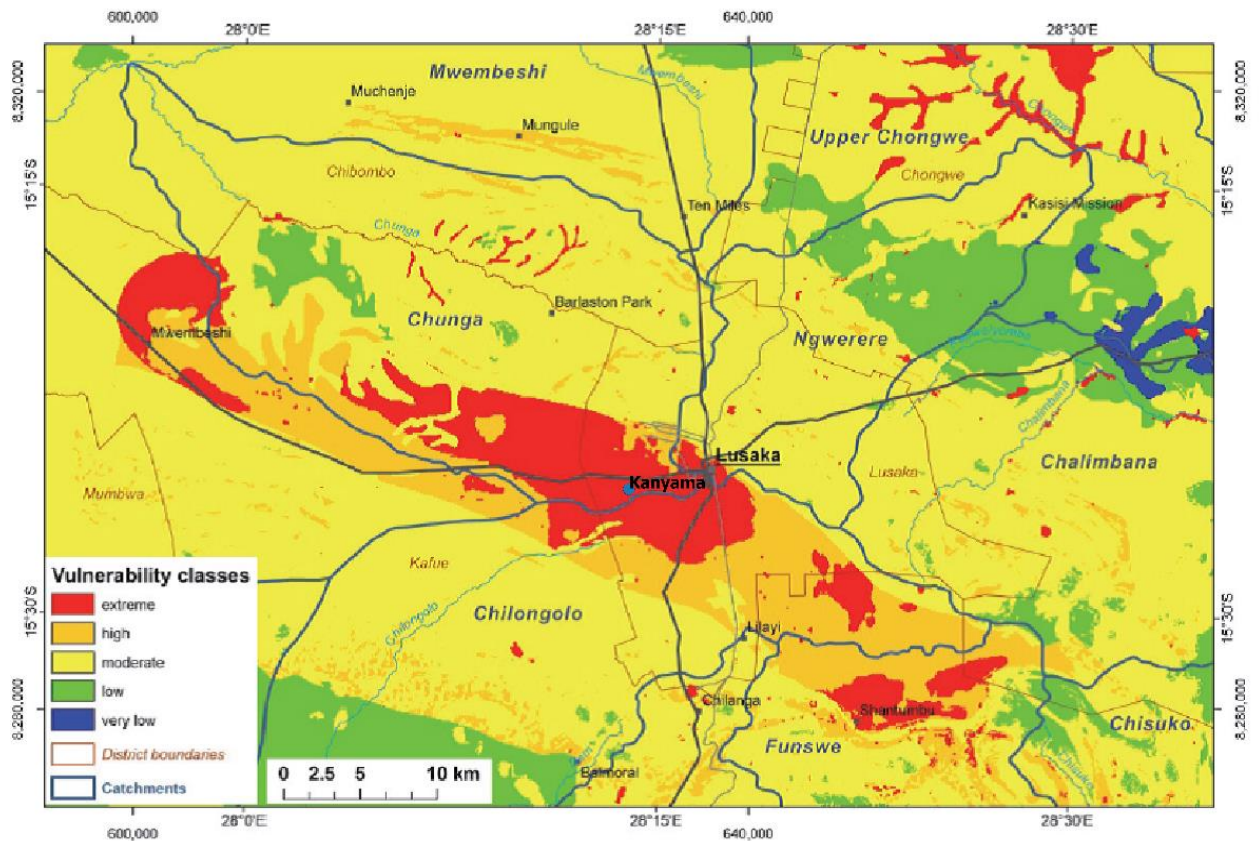


Figure 13: Groundwater Vulnerability Map for Lusaka (Source: Nick , 2012)

#### 4.4 Existing FSM Service Providers

Pit emptying or desludging services in Kanyama are provided by both formal and informal manual pit emptiers operating exclusively in Kanyama and servicing some households from neighbouring PUAs such as John Laing and Chibolya. Kanyama represents the first PUA where a formalized pit emptying service that targeted pit latrine users was introduced in Lusaka.

##### 4.4.1 Formal Pit Emptying Service Providers

Formal pit emptying services were introduced through the KWT by LWSC in 2013. The services are provided by two teams of professionally trained manual emptiers hired by KWT and are paid a monthly commission based on the revenues raised from pit emptying services. The Water Trust (KWT) also employs a full-time marketing officer who is tasked with marketing the services and acquiring customers in their operation.

Over 1,300 pit latrines have been emptied by the KWT emptying teams in the period from January 2014 to December 2017. Analysis of the emptying service records of KWT shows that less than 5 Percent of these customers have gone back to KWT to seek for the service again (i.e. repeat customers). In Kanyama where pits are shallow (i.e. the lithology and geology of the area hinders deep excavations) and prone to flooding due to groundwater infiltration (due to high groundwater table during the rainy season), it is expected that facilities require to be emptied every one to two years as determined through expert judgement as well as consultations with various stakeholders. Thus, the recorded 5 Percent FSM service repeat customers at KWT suggests that customers are not entirely satisfied with the model on offer and may have engaged informal pit emptiers on other occasions when they required the service (LWSC, 2018).

There are three levels of service offerings that the customers can choose from, i.e. to empty 12, 24 or 32, 60 Litres barrels from their containment facility (toilet). The charges are USD 30 for 12 barrels, USD 40 for 24 barrels and USD 50 for 32 barrels. Depending on the travel distance and size of the job, KWT sometimes charges a transport fee of USD 5 to USD 10. On average, the cost of FSM services charged by KWT is about USD 38 per m<sup>3</sup> of sludge emptied and transported to the treatment facility. To empty the pits, KWT emptying teams employ manual methods of pit emptying with the use of modified garden tools such as elongated shovels and scoops. The use of these simple tools has proved efficient in coping with some of the challenges of pit latrine emptying such as the presence of solid waste in pits, thick dry sludge and access limitations. To access the containment system and empty the sludge, the emptiers create access on the side of the pit by puncturing a hole through it. The emptiers then use a scoop with an elongated handle to scoop the sludge from the pit and fill the 60 Litres barrels which are then loaded on a 2-ton light truck and transported to the treatment facility located at the KWT office premises. During the emptying process, the emptiers observe strict safety protocols and wear full PPE to protect them from exposure to faecal matter.



Figure 14: Formal Pit Emptying Services (Source: GIZ, 2018)

According to the 2014 – 2017 operational data for KWT emptying teams, an average of 38 sanitation facilities are emptied per month. Refer to Figures 15 and 16 below on the operation records of KWT.

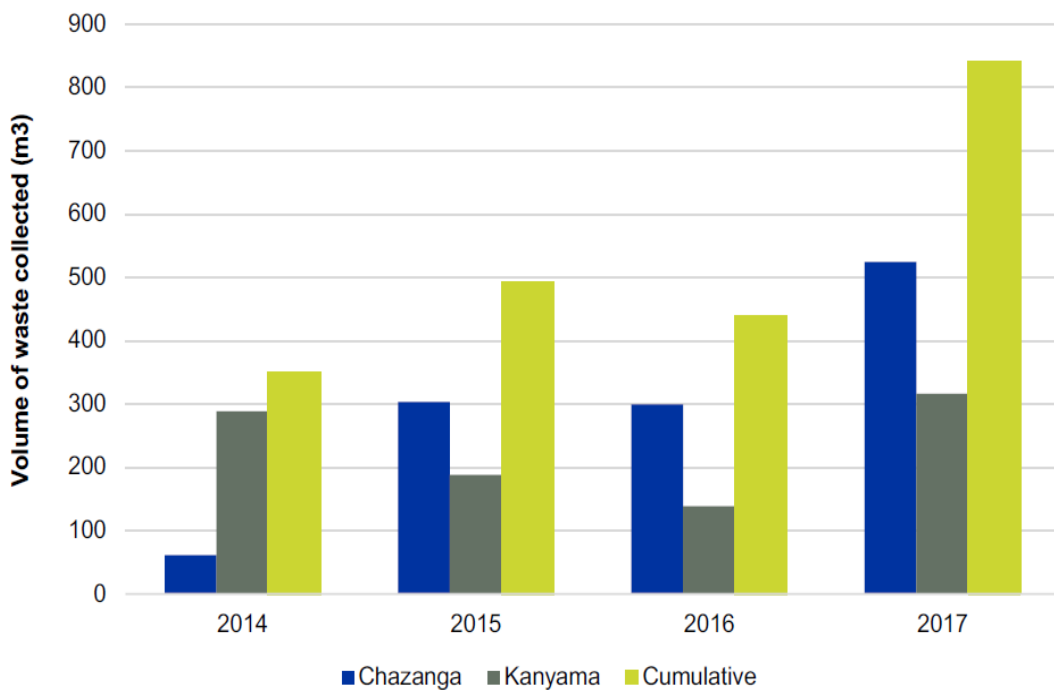


Figure 15: Volumes of Sludge Collected by Formal Service Providers (Source: LWSC, 2018)

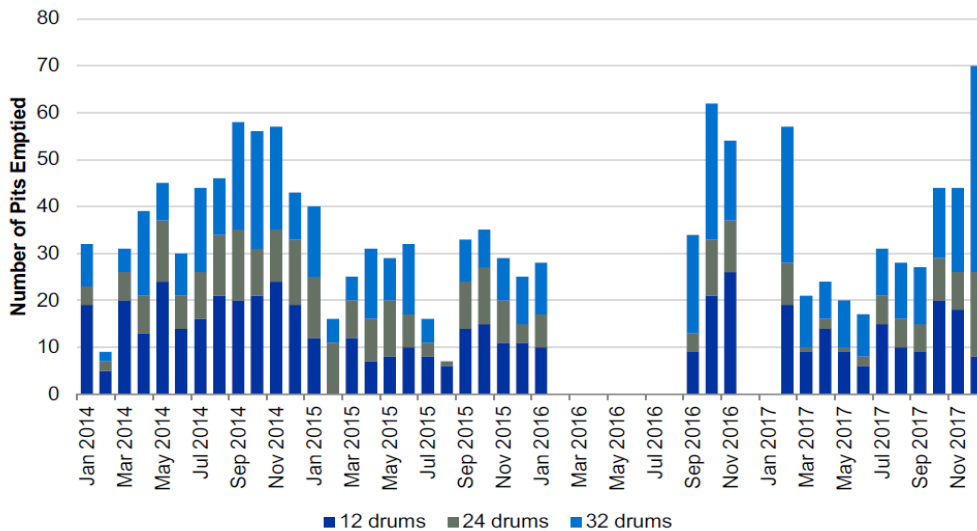


Figure 16: Pits Emptied by KWT Emptying Team (Source: KWT Operational Data, 2017)

#### 4.4.2 Informal Pit Emptying Service Providers

According to LWSC (2018), informal pit emptying services dominate the pit latrine emptying market at the city level. Verification of this finding through FGDs and KIIs with the residents of Kanyama revealed that the same can be said for Kanyama PUA based on the low service coverage of KWT formal pit emptiers that operate in the area. During the FGDs, some participants acknowledged the existence of the informal service providers; however, they could not mention them for fear of being victimized. The actual service coverage captured by the informal pit emptiers is unknown as these operate illegally and often not easily identified since their services are not offered in daylight (usually they work in the night for fear of being victimized). It is assumed that the facilities which are not emptied by the formal teams are one way or the other either serviced by the informal pit emptiers, abandoned or the users pour chemicals into the containment system that digest the organic content of the sludge creating additional space for further use. The proportions of households using these chemicals are not known or easily quantifiable. However, the findings of the FSM market assessment and FGDs showed that there is a growing trend of household using such chemicals in Lusaka.

The emptying methods employed by the informal emptying teams are manual methods of pit emptying like that used by the formal teams. They use basic simple tools to do the emptying like the modified garden tools employed by the formal teams and sometimes can also consist of jerry cans/ buckets with ropes. The sludge once emptied

is either buried onsite or transported and dumped illegally elsewhere such as at the illegal solid waste dumpsite located within Kanyama area.

There is no proper indication of the number of informal pit emptiers that exist in Kanyama. KWT on average services about 500 pits per year (which translates into less than 3 percent service coverage), it was assumed that the informal service providers capture about 50 percent of the remaining uncovered households at a minimum.

#### **4.4.3 Vacuum Tanker Operators**

Findings of the FSM market assessment showed that vacuum tanker operators concentrate on servicing the population with septic tanks and target mostly those found in affluent areas with middle and high-cost housing units which are not connected to the sewer line (LWSC, 2018). Vacuum tankers often shun away from servicing pit latrines due to the thick dry sludge which in most cases contains solid waste that is accumulated which makes it difficult to pump.

#### **4.4.4 Capacity of Service Providers to meet demand**

Currently, there is not enough the capacity to meet the service needs, demands and targets are not adequate to provide 100 percent sanitation coverage for Kanyama. Overall, the capacity to meet the demand will be dependent on LWSC's capacity to manage non-sewered sanitation services in the city. A component is included under the LSP that aims at building the capacity of both the LWSC and the private service providers (e.g. pit emptiers and vacuum tanker operators) to manage and effectively deliver sanitation services to residents of the city. In this regard capacity will also be built for KWT to expand their formal pit emptying service coverage in Kanyama leveraging the already existing structures, knowledge and FSM lessons gathered so far.

#### **4.4.5 FS Treatment and Disposal**

There are two faecal sludge treatment facilities in Kanyama PUA which are operated and managed by KWT. Only one facility is actively used by the KWT emptying team and it comprises of a 50m<sup>3</sup> capacity bio-digester, an anaerobic baffled reactor (ABR) and planted gravel filters (PGR). This plant was designed to treat 3m<sup>3</sup> of sludge per day; however, the plant is usually overfed with sludge while at the same time poorly operated and maintained. This situation brings about frequent breakdowns of the primary treatment modules such as the bio-digester impacting on the emptying service

provision and treatment efficiency (on average it takes a month for the plant to be restored). When the bio-digester is full of sludge, it is emptied using a vacuum tanker and the stabilized sludge is transported to the drying beds which are located at a different site for secondary and final treatment. Thus, this plant operates as a transfer station. The dried sludge (bio-solids) are packaged and sold as a soil conditioner to farmers and public institutions for application on lawns. The second plant is a transfer station with a 70 m<sup>3</sup> capacity sludge underground holding tank and is not used often due to operational challenges associated with the lack of frequent desludging of the tank. Recently some upgrades and modification works were done at the plant by WSUP, however, due to poor operation and maintenance by the emptying teams. The plant was only in operation for a few months in 2017 before it broke down.

Treatment efficiency of the FSTP in Kanyama PUA was estimated at 66 percent based on the downtime of the bio-digester. The estimation was arrived based on poor operations and maintenance data that was shared by KWT (i.e. bio-digester maintenance delays service and treatment efficiency). On average, the bio-digester is shut down twice every year for at least 4 weeks, reducing the treatment efficiency of about 43m<sup>3</sup> of sludge. The assumed treatment efficiency could be higher than the actual because the bio-digester is not properly maintained and operated. The Plant is continuously fed with FS with no frequent desludging of the bio-digester chamber thus reducing the hydraulic retention time for the effluent.

Overall the treatment capacity in Kanyama PUA is inadequately able to treat all the sludge generated in Kanyama if for argument sake the KWT emptying was able to service most of the latrines in Kanyama. This was evident during the 2017/ 2018 cholera outbreak during the pit latrine emptying rapid response program that was funded by the central government. During this time, KWT was tasked to empty latrines as a measure to contain the spread of cholera. Due to limited treatment capacity in Kanyama, the emptiers were forced to transport the emptied sludge to Manchinchi wastewater treatment plant (WWTP), the first septage disposal facility in Lusaka where vacuum tankers dump septage emptied from septic tanks.

#### **4.5 SFD Graphic for Kanyama PUA**

The outcomes of the sanitation service chain analysis in the subsection above were used as the backbone to develop the SFD graphic for Kanyama PUA. To generate the

SFD graphic, the data aggregated from the mapping exercise in June 2017 by GIZ (as given in Table 8) was used as input data for the SFD matrix and generator.

#### 4.5.1 Data Aggregation for SFD Graphic

Table 8 shows the type of containment system and the percent of Kanyama population using each facility type that was used to develop the SFD graphic. The following were the assumptions made when calculating the percent of people using each facility and those practising OD.

- Only sanitation facilities located on residential plots and the associated number of users were included in the analysis to avoid double counting (since SFDs based on populations) and the lack of data on the actual number of people that are associated with using public sanitation facilities.
- Sanitation facilities are shared by a maximum of three households (average household size of 6), all the remaining households who could not be associated with any sanitation facility were considered under OD.
- Sanitation facilities that are in zones that are prone to floods during the rainy season were considered as flooded tanks/ or latrines.

*Table 8: Percent of Population using Different Sanitation Systems*

Containment system	System Label according to SFD matrix	Population Served		Source
		(%)	(No. of ppl)	
Septic Tanks	T2A5C10	1%	1,980	Mapping Exercise, 2017
Cesspits	T2A5C10, T1B10C10	22%	43,560	
Flooded Tanks/ Latrines	T1B10C10	5%	9,900	
Pit Latrines	T2A6C10, T2B7C10	57%	112,860	
Open Defecation	T1B11 C7 TO C9	15%	29,700	SFD validation workshop & community interviews
<b>TOTAL</b>		<b>100%</b>	<b>198,000</b>	

Table 9 below shows the SFD matrix for Kanyama PUA as extracted from the web-based SFD graphic generation tool.

Table 9: SFD Matrix for Kanyama PUA10

Kanyama, Lusaka, Zambia, 2 Aug 2018. SFD Level: 3 - Comprehensive SFD				
Population: 170000				
Proportion of tanks: septic tanks: 100%, fully lined tanks: 100%, lined, open bottom tanks: 5				
System label	Pop	F3	F4	F5
System description	Proportion of population using this type of system	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
<b>T1B10C10</b> Containment (fully lined tanks, partially lined tanks and pits, and unlined pits) failed, damaged, collapsed or flooded - with no outlet or overflow	14.0	50.0	1.0	66.0
<b>T1B11 C7 TO C9</b> Open defecation	15.0			
<b>T2A5C10</b> Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	13.0	95.0	5.0	66.0
<b>T2A6C10</b> Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	15.0	100.0	0.0	0.0
<b>T2B7C10</b> Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	43.0			

Most of the sludge collected by the formal pit emptiers of KWT comes from pit latrines (i.e. systems T2A5C10 and T2A6C10 with reference to the SFD matrix in Table 9). In addition, based on the records of septage delivered to Manchinchi by vacuum tanker operators (16 percent of the total septage produced in Lusaka is delivered to Manchinchi), it was assumed that about 2 percent of this septage comes from systems (i.e. T1B10C10 and T2A5C10 with reference to the SFD matrix – Table 9) located in PUAs such Kanyama.

According to the findings of the Vision RI's 'baseline, socio-economic and health assessment, and willingness to pay study, 40 percent of the households responded that they would replace their sanitation facility once it's full with a new one and only 30 percent said they would empty it (LWSC, 2016a). Based on this finding, it was also assumed for the SFD that 43 percent of the sanitation facilities in Kanyama is not emptied but rather abandoned when full i.e. system T2B7C10. During the field visits in the study area, interviews with residents confirmed that abandonment of toilets was happening.

The proportion of facilities emptied (i.e. those that are not abandoned when full) was assumed to be between 95 – 100 percent for systems T2A5C10 and T2A6C10 with reference to the SFD matrix. The estimation was based on analysis of the sanitation data which showed that 85 – 90 percent of facilities are accessible for emptying by either manual or mechanized emptying methods. However, when it comes to facilities which are in flood-prone zones, the sanitation mapping data revealed that only about 50 percent of these facilities are accessible for emptying in the dry season. According to the SFD matrix even though the proportions of the systems emptied is high in the mentioned systems only about 1 percent of the sludge emptied is delivered to treatment facilities (those emptied by formal emptying teams) indicating that the larger proportion is emptied by informal or illegal emptiers who do not transport the sludge to any treatment facility.

The percent of the population practising open defecation (OD) was estimated at 15 percent and agreed with the stakeholders during the validation workshop and FGDs with the residents of Kanyama. During the FGDs, the participants revealed that even though there is no visible indication of OD in Kanyama (i.e. visible faecal matter in the surroundings), it is common practice for the residents without toilet facilities to defecate in plastic bags (commonly known as flying toilets) which are thrown in indiscriminate solid waste dumping places within Kanyama PUA as well as open stormwater drains. Baby diapers nappies which are disposed of together with household solid waste was also considered as OD. This was further validated by the high user to toilet ratios (on average each household toilet is shared among four households i.e. about 18 people). Some of the facilities have limited access since they are locked by the owners thus prompting the other users to find alternative means especially at night.

After inputting the data shown in the SFD matrix above into the graphic generator, the following figures 17 and 18 below shows the resulting SFD graphic or diagram for Kanyama PUA.

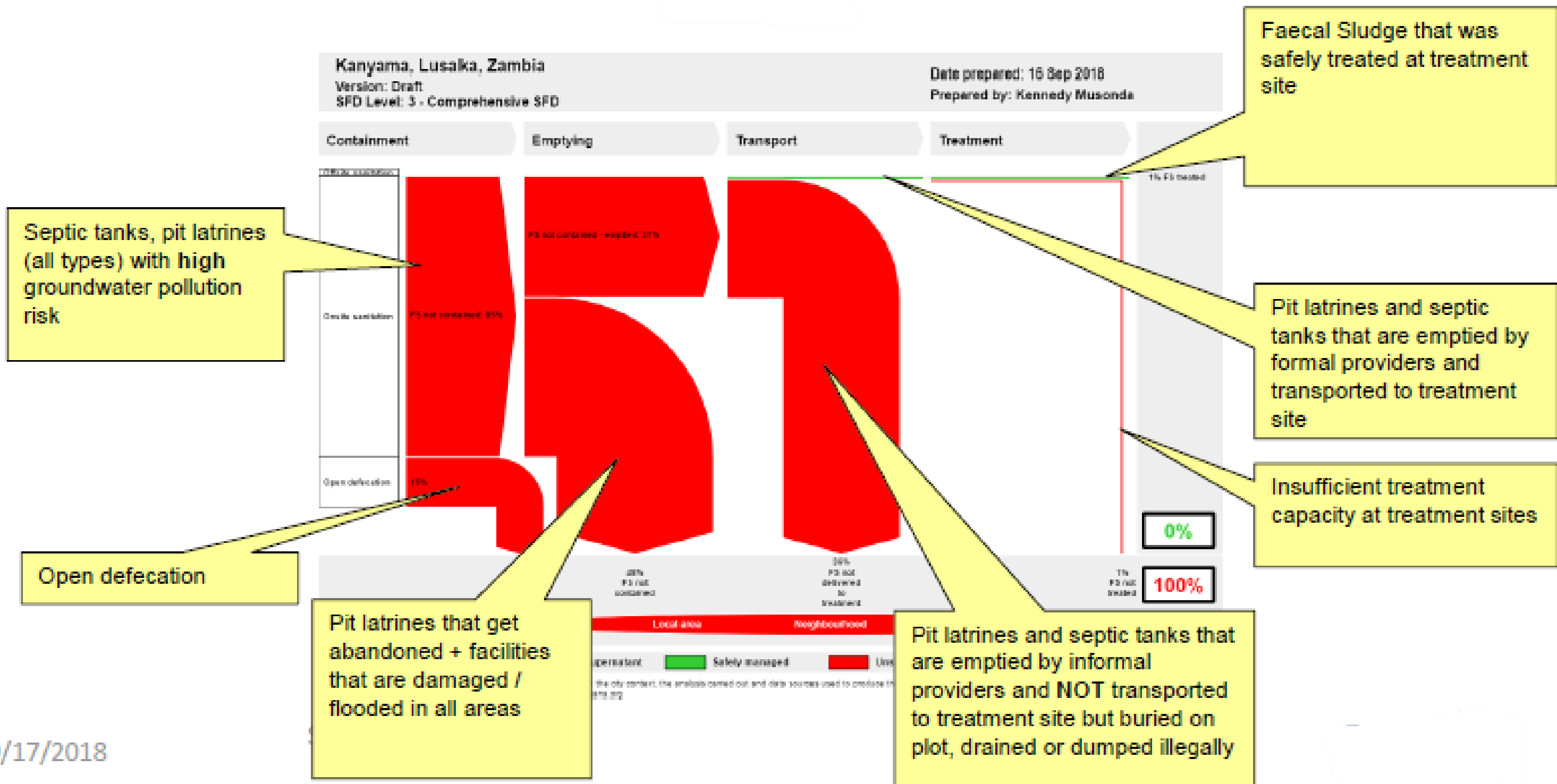
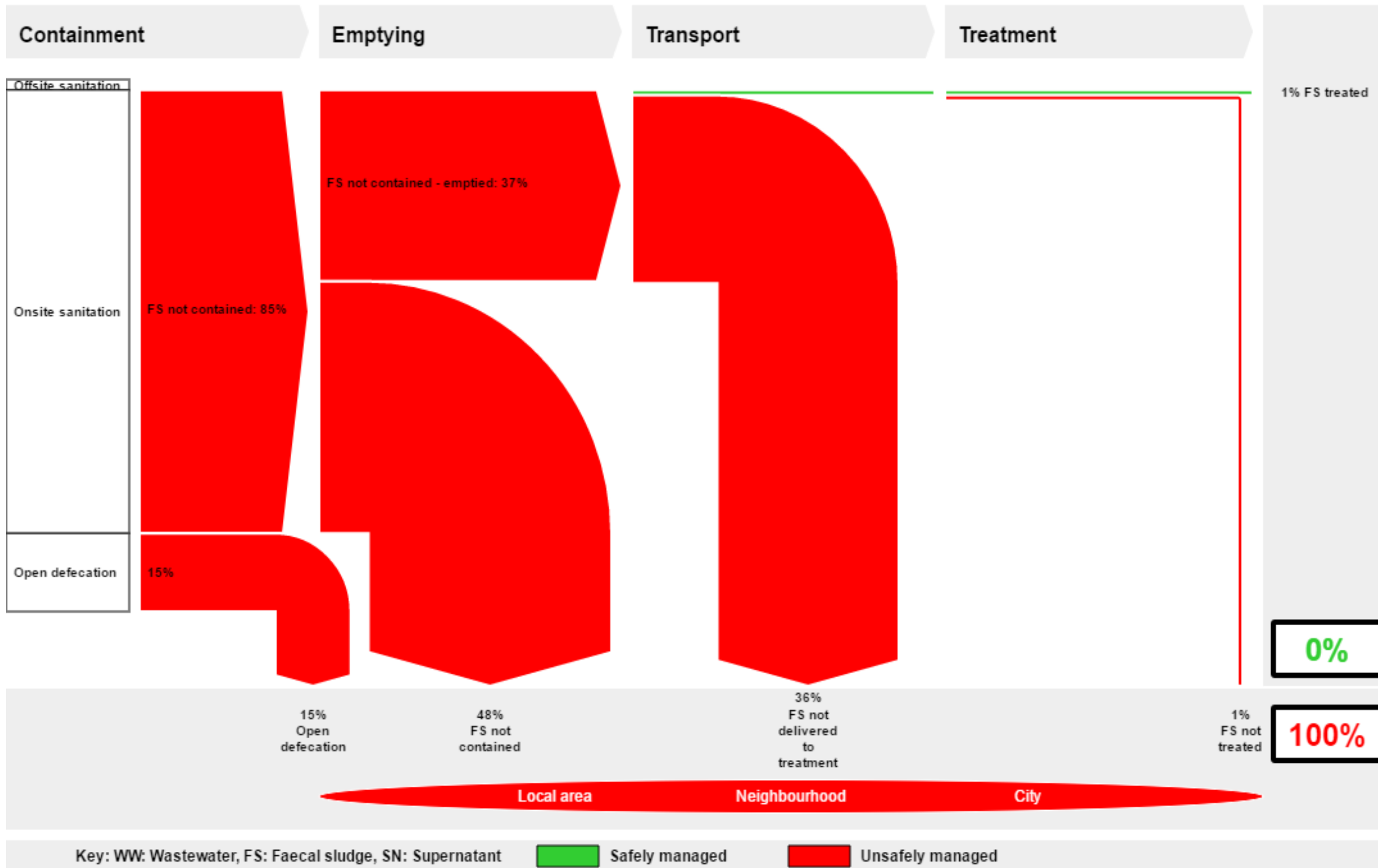


Figure 17: Kanyama SFD Graphic Explained



The SFD Promotion Initiative recommends preparation of a report on the city context, the analysis carried out and data sources used to produce this graphic. Full details on how to create an SFD Report are available at: [sfd.susana.org](http://sfd.susana.org)

Figure 18: Kanyama SFD Graphic

The following were the main assumptions made to produce the graphic:

- Groundwater pollution risk as assumed at 100 percent based on Groundwater Vulnerability Map for Lusaka and the poor containment system structures found in Kanyama (i.e. most of the containment systems are unlined, hence they leak faecal matter into the environment).
- The treatment efficiency of the faecal sludge treatment facility in Kanyama was estimated to be 66 percent (it is percent (operational for 11 out of 12 months in a year). Due to limited information on the treatment performance of the plant, a time when the plant is operational was the only parameter that was used. This is a limitation as the actual treatment efficiency can be lower than the value assumed in this study.

## **CHAPTER 5: DISCUSSION**

### **5.0 Introduction**

This chapter presents detailed discussions of the results of this study. It discusses the weak links along the sanitation service chain that leads to the status quo in terms of effective management of excreta along the service chain. The chapter also presents how the resulting SFD for Kanyama could be applied by decision-makers, planners and engineers in planning sanitation interventions and programs for Kanyama PUA.

### **5.1 Deficiencies Along the Sanitation Service Chain for Kanyama PUA.**

The resulting SFD for Kanyama shows that less than 1 percent SFD's are a new tool used for explaining the sanitation picture of an area using the percentages of services and population of people in the area. As done in this research, the census was conducted and survey on the sanitation facilities in Kanyama. This data was very cardinal for the production of the SFD. The resulting SFD for Kanyama shows that less than 1 percent of the total sludge produced in the area is safely managed. This shows that there are bottlenecks along the service chain that needs to be addressed to improve the situation in the area. The overarching issues that require immediate solutions or interventions (in order of priority) to achieve the greatest impact include:

- ***Poor Faecal Sludge Management***

The resulting SFD for Kanyama shows that less than 1 percent of the total sludge produced in Kanyama is safely managed. This means that overall, there is poor FSM in Kanyama. There are many reasons that can be attributed to this, with the major ones being lack of awareness among the public on FSM and low service coverage of the existing formal FSM service providers. There is also a need to scale up FSM services in the area, as the existing services were pilot projects that were aimed at introducing FSM services in the peri-urban areas of Lusaka. Plans are underway to scale up the services under the OSS component of the Lusaka sanitation program that will lead to improved service delivery through public-private partnership arrangements.

- ***Poor Regulation of FSM Services***

At the time the study was being conducted there was no formal monitoring and reporting for OSS services in Lusaka. This situation coupled with the lack of enforcement has led to informal pit emptying services that greatly compete and out shun the formal emptying services. The informal services should be discouraged

through enforcement and monitoring measures by the regulatory authorities (i.e. ZEMA, NWASCO and LCC) as they act as a pathway of excreta into the environment (i.e. the sludge emptied is not transported to a treatment plant for treatment and safe disposal). There is a need to come up with joint monitoring/ or enforcement programs as well as awareness campaigns to discourage such illegal services. The authorities should also work towards identifying the informal service providers and set up deliberate programs to support the formalization of these services rather than working to eliminate them from the market.

- ***Technical Issues***

From the analysis of the sanitation service chain for production of the SFD, the following technical bottlenecks stood out as the major factors that are leading to poor FSM services in Kanyama:

**i. The quality of design and construction of OSS containment systems in Kanyama**

**is not adequate** to effectively contain the faecal matter and protect groundwater contamination. This situation is exacerbated by the hydrogeology of Kanyama as explained in section 3.6.7 (Risks to groundwater contamination). The construction of the facilities does not also take emptying into account, leading to unsafely abandoning (with risks to the environment and public health) once full by the households. As a starting point, more effort and resources should be invested in helping the households to constructed proper well-designed sanitation facilities that protect groundwater from contamination. This has already started as part of the interventions under the LSP. About 6,000 household sanitation facilities (designed to enhance protection of groundwater contamination and easy to empty) will be constructed in Kanyama under the LSP. However, the 6,000 is not enough as close to 30,000 sanitation facilities will be required to achieve meaningful change.

**ii. There is a lack of adequate treatment capacity** to safely treat and disposal all the sludge generated in Kanyama. The existing treatment facility has a design capacity to treat only 3m<sup>3</sup> of sludge per day against a required 2018 treatment capacity of about 12m<sup>3</sup>/ day (as reported by Gauff, 2018). There is a need to increase the treatment capacity in Kanyama and plans are there to increase the capacity of the existing plant to 18m<sup>3</sup>/day under the LSP interventions. Under the LSP, the treatment plant capacity in Kanyama will be increased to 18m<sup>3</sup> per day by constructing additional treatment modules.

**iii. There is no proper equipment for use to empty most pit latrines as** the current pit emptiers use manual tools which is labour intensive and increases the exposure risks to faecal matter. There is a need to promote the use of mechanical methods of pit emptying by adapting equipment trialled in other cities (such as the eVAC from South Africa) to enhance service delivery. Three pit emptying equipment (i.e. the eVAC, Gauper and Flexcravator) were tested and trailed in Lusaka by GIZ and they all faced similar challenges when it comes to emptying pit latrines in Lusaka due to the high solid waste content in pits. One of the recommendations was to adapt or modify the equipment to suit the Lusaka scenario.

- ***Poor Latrine Usage.***

Most households in the peri-urban areas have a tendency of using their latrine as a solid-waste dump. The problem of solid-waste in latrines greatly impacts the emptying and treatment process of sludge. Some latrines become un-emptiable due to high solid-waste content and it also becomes difficult to empty using mechanical methods as shown in figure 19. Thus, households need to be sensitized on proper latrine usage. At the same time, LCC should also improve the collection of solid waste as a measure to prevent households from throwing it in latrines.

The points highlighted above are some of the major weak links along with the sanitation service for Kanyama (they also apply for most PUA in Lusaka) that were identified during the study. Decision-makers and planners can start by addressing these issues or bottlenecks in the service chain for improved FSM service delivery.



*Figure 19: Latrine being demolished during emptying, an example of poor design (Source: Author, 2018)*

## **5.2 Application of Kanyama SFD Results**

The following are the potential areas where the findings of this study can be applied:

- **Baseline to monitor progress and impact of interventions:** The results of this study (Kanyama SFD) can be used to monitor the progress and impacts of sanitation interventions implemented in Kanyama PUA. This could be started after the implementation of projects under the LSP. This can be done by simply updating the parameters used to produce this SFD to determine the how the situation might have changed and measured the progress towards achieving the 100 percent coverage and safely FSM service chain target by 2030.
- **Source for Funding Sanitation Infrastructure:** The funding under the LSP is not enough to achieve the goal of a safely managed sanitation service chain. There is a need for more funding into the sanitation sector post LSP to improve the sanitation situation in Kanyama. For example, the SFD can be used by LWSC to pitch for additional funding from the financiers of the LSP to build more proper toilets in Kanyama based on the risks posed by the existing facilities on the environment and public health as highlighted by the findings of this study.

- **Initiate Planning at Local Level:** Most of the sanitation improvement plans as well as SFDs are developed with the focus on the city or town level. Due to limited resources, some local areas or parts of the city which require huge investments are not prioritized as the extent of the problem is not well understood or appreciated. This local SFD for Kanyama offers an opportunity for the policymakers to appreciate the full extent of the situation zooming into the Kanyama alone and understanding the situation with regards to sanitation service delivery. Thus, the SFD can be used to come up with a sanitation plan for Kanyama PUA which can be developed together with the local leadership with inputs from the area residents. Such a plan can be used by the leaders (including the area Member of Parliament) to set up and finance sanitation programs for Kanyama (e.g. the constituency development fund can be used to finance some sanitation programmes).
- **Gain Political Support:** the sanitation plans as mentioned in bullet point number 3 above can be used together with this SFD results to engage central government and the policymakers for support. It can also be used to coordinate the different actors along the sanitation service chain for improved service delivery.

## **CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS**

### **RECOMMENDATION**

#### **6.0 Introduction**

This chapter makes conclusions and recommendations about the results of the Kanyama SFD development Process.

#### **6.1 Conclusions**

The aim of this study as outlined in chapter 1 was met, however not without limitations and challenges. To make meaningful conclusions, the specific objectives of the study are referred to as outlined below:

- To establish whether the existing policy, legislative and institutional frameworks are supportive of the implementation of faecal sludge management and OSS in Lusaka
- To establish the proportions of excreta that are safely or unsafely managed through the sanitation service chain in Kanyama by using an SFD.

After analysis of all the data gathered, the following conclusions can be made about the status of sanitation service delivery in Kanyama as well as the proportions of sludge that is safely and unsafely managed and whether the existing government policies and legislation with institution frameworks are supportive in the management of FS and OSS:

- i** The sanitation service chain is not well organized and coordinated.
- ii** Only less than 1 percent of the sludge produced in Kanyama is safely managed as shown by the SFD.
- iii** Informal pit emptying services outshine the formal service providers in terms of coverage of the services in Kanyama.
- iv** There is a lack of awareness among the majority of households about the existence of formal FSM services.
- v** Most sanitation facilities are abandoned once full and these are considered unsafely managed due to the risks they pose to groundwater.
- vi** Most sanitation facilities are not well designed and constructed for easy FSM service delivery.
- vii** There is a lack of regulation of the service providers and enforcement to discourage the use of informal services.

viii There is a lack of knowledge and awareness among households on proper latrine usage practices i.e. most households use latrines as rubbish dumps.

## **6.2 Limitations faced during the research process**

The SFD produced during the study is credible as it followed a comprehensive data collection process, however, it was not without limitations and challenges. Some of the limitations faced included:

- No credible data or information was collected on the actual number of people practising open defecation. What was collected was views and observations from interviews of residents in Kanyama and concerned stakeholders. Therefore, in this study, it was assumed that the population of Kanyama that was not associated with using any form of sanitation was practising open defaecation and assumed to be 15 percent. This data requires detailed research to come up with the most accurate and realistic figure.
- The other data that was hard to determine was the activities of the informal pit emptiers. Though the residents confirmed their existence during the focus group discussions, no information could be found on their activities i.e. how many they are and service coverage.
- The boundary for development of the SFD was another limitation. Different stakeholders have a different understanding of what Kanyama area is. However, for this study, the study area boundary was the same as that covered during the sanitation mapping exercise.

## **6.3 Recommendations for future studies**

The following points are recommended if future research needs to be conducted on sanitation service provision and SFDs in Kanyama or any other PUA in Zambia:

- Try to model the impacts sanitation interventions such as those under the Lusaka sanitation program (LSP) on the sanitation situation in any target peri-urban area.
- Conduct more research on open defaecation in peri-urban areas of Lusaka.
- Conduct detailed research on the activities of informal service providers with a focus on their service coverage or market niche.
- Research to investigate the extent of contamination of groundwater in PUA's of Lusaka be conducted.

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## APPENDICES

### Appendix 1: Stakeholder identification

<b>Name of Organization</b>	<b>Name of Contact Person</b>	<b>Position</b>	<b>Influence (High/Medium/Low)</b>	<b>Interest (High/Medium/Low)</b>
GIZ – LSP	Kapanda Kapanda	Junior Advisor	Medium	High
LWSC- LSP	Mwansa Nachula	Onsite Sanitation Specialist	High	High
LSP- PIC	Abhinar Goel	Programme Management Specialist	High	High
LWSC	Justine Mbewe	Superintendent	High	High
LWSC	Fred Chimpukutu	Senior Chemist		
KWT	Kanyanga	KWT coordinator	High	High
LCC	Grace Mwanza	Senior Health Inspector	Medium	High
LCC	Nachombe Nangamba	Senior Health Inspector	Medium	High
GIZ – CFS	Chaiwe Mushauko Senderse	CFS Advisor	High	High

<b>Name of Organization</b>	<b>Name of Contact Person</b>	<b>Position</b>	<b>Influence (High/Medium/Low)</b>	<b>Interest (High/Medium/Low)</b>
WSUP	Kameya Kashweka	Engineer	High	High
WSUP	Perrick Chapendeka	Program Engineer	High	High
BORDA	Angela Kapembwa	Civil Engineer	Medium	High
NWASCO	Peter Mutale	Chief Inspector	High	High
MWDSEP	Charles Simabwachi	Sanitation Officer	High	Medium
ZEMA	Webby Simwayi	ZEMA official	Medium	High
GFA Consulting	Margaret Nkoshi	Junior Advisor	Low	High
Open Street Mapping Zambia	Gertrude Namitala	Mapping Project Manager	High	High
Kanyama Community Development committee	David Mwelwa	Committee member	Low	Medium

## Appendix 2: Tracking of Engagement

List of stakeholders that were directly engaged in the study	Date of Engagement	Purpose of Engagement	Summary of outcomes
Sanitation experts of different organisations, mainly from Lusaka	31.07.2018	Workshop presentation of Draft Version	Platform of SFD workshop used for presenting and discussing results with sanitation experts
Albert Mulungu	3.05.2018	Understanding the level of services	Information on onsite and offsite services in the area was provided
Mr. Chibwete Hamweemba	12.08.2018	Operations of KWT	Interview was conducted and information provided how KWT operates with support by other organisations
Mr. Kanyanga	31.08.2018	Understanding and verifying OSS data for Kanyama	Interviews on FSTP and operations and coverage of services in the area by KWT

Appendix 2 continues ....

<b>List of stakeholders that were directly engaged in the study</b>	<b>Date of Engagement</b>	<b>Purpose of Engagement</b>	<b>Summary of outcomes</b>
Pit Emptier of KWT emptier team	31.08.2018	Understanding and verifying OSS data for Kanyama	Interview on service provision, FSTP operation, customers, containment systems in the area by KWT
Residents of Kanyama (women)	31.08.2018	Information about OD, hygiene, inequities, safety, knowledge about emptying services etc.	FGD on behaviour patterns and service acceptance
Mr. Fred Chimpukutu	12.09.2018	Treatment of Manchinchu WWTP	Interview on treatment process and efficiency of Manchinchu WWTP
Philip Soboya, Emptiers Association	14.09.2018	Operations of VTOs	Interview on service provision, coverage, other VTOs
All important stakeholder	17.09.2018	Discussion about graphic, assumptions and critical points	SFD validation workshop for all SFDs prepared in Lusaka (city-wide, Localised for Kanyama, Chawama, Chazanga, George, and

Appendix 2 continues ....

			LSP intervention area) with all important stakeholders
Community members meeting in Kanyama	10.10.2018	Verifying some assumptions made for the development of the Excreta-Flow-Diagram (SFD)	Assumptions related to the Shit Flow Diagram (OD, Sharing of toilets , type of containment systems conditions etc )were qualified by the community

### Appendix 3: Stakeholder Mapping

	Stakeholder	Containment	Emptying	Transport	Treatment	Reuse / Disposal
1	LWSC					
2	LCC					
4	KWT					
5	VTO / Emptiers Association					
6	WSUP					
7	WASH Committee Kanyama					
8	Community					
9	ZEMA					
10	NECOS (UDDT constructor)					
11	MWDSEP					
12	Schools and other institutions					
13	BORDA					

## Appendix 4: Stakeholders Meeting / Workshops

### SFD Workshop – presenting results, validation and discussion on assumption and data

Climate Friendly Sanitation Project

## Participants' List

Meeting: SFD Validation Workshop  
Venue: Southern Sun Hotel Lusaka  
Date: 17th September 2018

### Participants' Details

No	Name	Gender		Organization	Contact (phone and e-mail)	Signature
		M	F			
1	GEORGINAH MAWANBA		F	WDC	0979675307 / 0969252076	
2	WEBBY M. SIMWAYI	M		ZEMA	0976973492 / wmsimwayi@gmail.com	
3	Angela Kapembwa		F	BORDA	0960432111 Kapembwa@borda-africa.org	
4	Komidy Misonja	M		Consultant	0966870257	
5	Kapanda Kapanda	M		GIZ	0976056749	
6	AEKSON S. PHIRI	M		WATER TRUST	ackson.phiri@yahoo.com	
7	SAMUEL LUFUNGULO	M		WDC CHAIRPERSON	0977812588 roofs8040@gmail.com	
8	SHAURECK LICHE	M		CHAIRPERSON WATER COMMITTEE	0977489228	
9	Sankwe M Kambole	M		GFA/GIZ	0977850153 Sankwe.Kambole@gfa-group.de	
10	Chimukw Hazwela	F		GIZ	0974184559	

Climate Friendly Sanitation Project

No	Name	Gender		Organization & Position	Contact (phone/e-mail)	Signature
		M	F			
11	Nachombe Nangamba Kamukola		✓	Lusaka City Council - Public Health	0969311635 / nachombe@gmail.com	
12	Peter Mutate		✓	Nwaseco - Acting CEO	0977702013 / pmutate@nwaseco.org.zm	
13	CHAIWE M. SANDERESE		✓	ADVISOR CHAIWE SANDERESE - mwshauko	0977597077 / chaiwe.sandere-mwshauko@giz.de	
14	PERRICK B. CHAPENDEKA		✓	WATER IS SANITATION FOR THE POOR - PROGRAMME ENHANCER	0967458903 / pctapendeka@wsup.com	
15	Zandulayo Ngulube		✓	MINISTRY OF LEADERSHIP & ENVIRONMENT PROTECTA	0978958678 / ngulube.zandulayo@gmail.com	
16	MWAANGA HERBERT		✓	GIZ/GFA CAPACITY DEV UNIT	0977996683, herbert.mwaanga@gfa-group.de	
17	FRED CHIMPUKUTU		✓	LWSC / Senior Chemist	0977314997 fredchimpukutu@gmail.com	
18	FRANCIS MUBUNDI		✓	G.W. COMMITTEE	0971790804	
19	Charles - C.S. Mwanza		✓	LCC - PHD	0979174764 charles.mwanza@gmail.com	
20	MWENA MAMBWE		✓	MWDSEP	0976367304 mambwewa@gmail.com	
21	CHARLES JIMABWACHII		✓	MWDSEP	0967584764 - Charlesimbwachi@gmail.com	
22	Margaret Nkhosi		✓	GFA / Junior Engineer	0978903239 - mndukhosi@gmail.com	
23						
24						
25						

CHECKED & VERIFIED BY FACILITATOR: CHAIWE M. SANDERESE

DATE: 18/09/2018 SIGNATURE:

## **Appendix 5: Kanyama FGD Notes**

### **Focus Group discussion with women in Kanyama PUA area Notes**

#### **Discussions held at KWT premises**

The meeting started at 10:45hrs. The meeting was opened by Mr. Kanyanga who later handed over to the researcher Kennedy Musonda to chair the meeting with Tilman an Intern from GIZ. The total number of participants was 21 (20 female and 1 male). Below are the questions that were answered.

1. What toilets are you using in Kanyama? **Ans.** Pit Latrines, Flushing toilets connected to the septic tanks,
2. Who constructs the toilets? **Ans.** The owners build on their own
3. What toilet containment do your toilets have? **Ans.** A hole with partially sealed with cement concrete.
4. Who empties your toilets? **Ans.** Kanyama Water Trust and illegal emptiers . some use vacuum tankers.
5. Do you construct new toilets when your toilets are full? **Ans.** They are mostly abandoned
6. How accessible are the toilets to the elderly/poor? **Ans.** Not very accessible.
7. Do kids use the same toilets? **Ans.** No. Most of them use plastic chambers and faecal matter is disposed off into the toilet
8. How many people use one toilet? **Ans.** Average of 20 to 30 people because most houses host more than three families?
9. Do you have flying toilets or open defecation in Kanyama. **Ans.** Yes, it happens every day because some people do not have toilets. People use plastic bags, shake shake(empty opaque beer packaging) containers and they do it in the night and very early in the morning.



*Figure 20: FGD Session at KWT.*

## **Appendix 6: KII Notes with KWT FSM Coordinator**

### **Interview Mr. Kanyanga**

#### **How many pit emptier are currently working for the KWT?**

- 6 persons, all in one team but they usually split in two groups à 3 people
- Operating in Kanyama, John Laing, Chawama, George.

#### **How many pits do they usually empty?**

- Max 3-4 per day

#### **How is the construction of the septic tanks done?**

- Just follow the line of the stone, gaps (with no stone) are filled with some cement/bricks

#### **Abandoned vs emptying**

- Around 10 % of pits abandoned when full, rest meant to be emptied
- UDDTs also called ECOSAN. Some were built in private HH

#### **What is the coverage of emptying services**

- More than half is done by KWT and Vacuum Trucks

#### **KWT pit emptier:**

- Equipped with PPE (gloves, rubber boots, ...)
- One Truck for transport

#### **Max people using one toilet**

- Ca. 25 (average 10-18 ppl)

#### **Treatment facilities**

- Two in Kanyama: one FSTP, one biological treatment / storage

#### ***FSTP:***

-50 m<sup>3</sup> bio digester

-Since March not operating because of too much sand in bio digester

-Probably working again in September/October 2018

-Unusual long time for maintenance, normal it is clogged once a year, but operation is stopped only for about a month or two

-Samples are taken by Mr. Tembo (UNZA) 4-5 times a year from toilets, bio digester, septic tank

## **2<sup>ND</sup> PLANT (STORAGE)**

- Not operating for 2 years
- Desludged only once since start of operation (2013)
- Desludging takes about 2 months

### **Plans / targets**

- The one of the LSP:
  - o 10,000 toilets in Kanyama
  - o Expansion of bio digester (so that VT can bring FS to FSTP, too)
  - o Marketing strategy next week

### **Community engagement:**

- WDC: Water Development Committee
- WCM: Water Community Members
- WDC & WCM working hand in hand
- LWSC uses these structures for sensitisation of people

### **Flooded area:**

- Nearly whole Kanyama
- Maybe 75-80%
- You need rain boots when leaving your house, everything is under water
- Pits overflowing, faecal matter mixed with rainwater
- “you need to come here in November”
- Drainage would help to reduce the flooding

### **Coverage / market share**

- Ca. 60% KWT
- 20% VT
- 20% informal / illegal emptiers

### **Source of FS**

- Ca. 90% of collected FS from Kanyama,
- Rest from other areas (also operating in John Laing, Chawama, George,...)

## **Appendix 7: Kanyama Field Visit Observations**

### **Field visit to Kanyama / Observations**

#### **1. Study Area Boundary**

##### **Western Direction**

- Mumbwa Road
- Some industry along the road (aluminium, battery recycling?, milling, brewery,...)

##### **Southern Direction**

- Los Angeles Road (separating Kanyama, Chibolya, John Laing)
- Commercial area (groceries, shops, restaurants, bars, carpenter,)

##### **Eastern Direction**

- Fifty five Road
- Less populated, some farm land

#### **2. Types of Sanitation Systems**

- First impression: quite new, good maintained, structure in good condition
- 2 pour flush toilets connected to one septic tank
- Septic tank: Was built after old pit was full (just abandoned)
- Septic tank one chamber, no outlet, sealed walls, open bottom (just 2.5 x 2.5 m, depth?)
- shall be extended (second septic tank next to it with infiltration system)
- surrounded by older simple pit latrine (used by neighbours), little garden, water tap (by Water Trust) in front of the house
- bill for WT (20 ZMW Water, 30 ZMW SW per month)

##### ***UDDTs alias ECOSAN***

- 60 UDDTs were built up in 2000 (different HH in Kanyama)
- Was meant to be a pilot test by LWSC sponsored by EU
- Now mainly not working anymore due to bad maintenance / property sold...
- The observed UDDT was only emptied once since construction
- Urine is directly going to open ground next to the facility → many flies
- User were confident about toilet (take care of it, e.g. lock it, clean it,..)
- Instructions with pictures of how to use in English and Nyanga were inside
- But not for elderly people (stairs with many steps, ...)



*Figure 21: Pouflush Toilet in Kanyama*



*Figure 22: Raised Latrine in Kanyama*

### 3. Solid-waste Management

- Big illegal dumpsite just across the road (boundary)
- some accumulation of water in dumpsite, faecal matter?
- GROUNDWATER POLLUTION!!



*Figure 23: Illegal Solid-waste Dump Site in Kanyama*

#### 4. Kanyama Faecal Sludge Treatment Facility

##### System Modules:

- First screen, second screen: solid waste dries on shelf
- FS is flowing through sand and grit chambers
- Then feeds 50 m<sup>3</sup> bio digester
- When certain volume of biogas is produced, it forces FS to flow out (pressure) into septic tank
- Septic tank: separation between effluent / supernatant and FS
- FS is transported to drying beds (with a vacuum truck)
- Supernatant is flowing through further settlers and horizontal flow beds (filled with small stones) and then disposed to open ground



*Figure 24: Kanyama FSTP*

##### ***Drying beds KWT***

- 12 beds each about 60m<sup>2</sup>
- Built in 2012

-On same property is main borehole for Kanyama domestic water supply (since 2002, 55m<sup>3</sup>/min)

- FS treatment is not operating since end of last year

-Ministry stopped the operation during cholera because they were afraid of contamination of the water of the borehole

- Samples of the water were taken without any contamination

- Operator of the plant is not expecting it to work again



*Figure 25: Kanyama Drying Beds*

- Peak volume per day: 3m<sup>3</sup>

- Sludge need to be dried for about 2 weeks

- Dried FS was bagged and sold as fertilizer (25kg for 12.5 ZMW)

- Demand was high (everything was sold)



*Figure 26: Treated Faecal Sludge (Biosolids)*

### **FS Storage KWT**

- VTs directly emptied in septic tank, FS from pit emptiers first screened than flowing into septic tank
- Septic tank: 3 chambers à ca. 20m<sup>3</sup>
- Effluent is flowing into storage tank and is used for gardening directly



*Figure 27: Kanyama Underground Water Trust*

**Currently:**

- Plant not working
- Bio digester was clogged by sand (overloading during cholera outbreak)
- Sand was recently removed
- Expect to be running again by end of September/October (Mr. Kanyanga)

## **Appendix 8: Metadata for toilet database**

### **Introduction**

The spatial data was captured under the project: “Climate-friendly Sanitation in Peri-Urban areas of Lusaka (CFS-Lusaka)” – Mapping of Sanitation Facilities in Kanyama, Chawama, Chazanga and George. CFS-Lusaka is providing advisory and capacity development services to stakeholders associated with on-site sanitation and faecal sludge management facilities, including government, regulators and service providers. This project component has addressed the lack of a reliable customer and infrastructure database for on-site sanitation facilities users (in the selected areas).

The project was financed by GIZ.

The data was collected by Fibonacci Engineering Ltd in association with OpenstreetMap Zambia for Chawama, Chazanga and George. The Kanyama data was collected by SBK Consulting Ltd with OpenstreetMap Zambia. The mapping was done using TruField software owned by OpenStreetMap Zambia. The field data collection was done over a period of 2 months from May to June 2018.

The spatial data is in the following coordinate system:

Projected Coordinate System:Arc\_1950\_UTM\_zone\_35S

Projection:Transverse\_Mercator

false\_easting:500000.00000000

false\_northing:10000000.00000000

central\_meridian:27.00000000

scale\_factor:0.99960000

latitude\_of\_origin:0.00000000

Linear Unit: Meter

Geographic Coordinate System:GCS\_Arc 1950

Datum: D\_Arc\_1950

Prime Meridian: Greenwich

Table 10: Toilet Database Attribute Table Fields

		Order	Description
<b>OBJECTID</b>	OBJECTID	1	Internal software field for identified the feature
<b>LAYER</b>	LAYER	2	Internal software field for identifying the original layer the feature was on in other software
<b>proj_area</b>	project area	3	The project area the feature falls
<b>location</b>	plot category	4	Category of plot where the toilet is located
<b>custodian</b>	Are you the owner?	5	To establish whether person interviewed is the owner of the toilet
<b>owner_name</b>	owner's name	6	The name of the owner of the toilet
<b>phone_num</b>	owner's number	7	The phone number of the owner
<b>plot_house</b>	plot or house no.	8	The house of plot number of the plot where the toilet is located
<b>type_toile</b>	toilet type	9	The type of toilet

		Order	Description
<b>interface_</b>	user interface type	10	The user interface in the toilet
<b>HH_per_Toilet</b>	number of households per toilet	11	The number of households using the toilet
<b>cont_type</b>	containment type	12	The type of containment that receives the human excreta
<b>co_depth</b>	containment depth	13	The depth of the containment
<b>co_length</b>	containment length	14	The length of the containment
<b>co_width</b>	containment width	15	The width of the containment
<b>sludge_lev</b>	sludge level	16	The level of sludge in the containment at the time of data collection
<b>filled_yn</b>	has it ever filled?	17	A question on whether the toilet has ever filled or not
<b>last_time_</b>	last time it filled	18	When it last filled
<b>act_when_f</b>	action when filled	19	The action taken when the containment filled

		Order	Description
<b>interf_y_n</b>	is there desludging interface	20	The presence or absence a provision feature for desludging the containment
<b>empty_freq</b>	emptying frequency	21	The frequency with which the toilet has been emptied
<b>disl_inter</b>	desludging interface	22	If available, the interface used for emptying the containment
<b>type_walls</b>	walls type	23	The type of walls of the toilet superstructure
<b>floor_type</b>	floor type	24	The type of floor in the toilet
<b>door_type</b>	door type	25	The type of door on the toilet
<b>roofing</b>	roof type	26	The type of roof over the toilet superstructure
<b>concrete</b>	is there a concrete slab?	27	The presence or absence of a concrete slab in the toilet
<b>lighting</b>	is there lighting?	28	The presence or absence of lighting in the toilet for night access

		Order	Description
<b>lock</b>	is it lockable?	29	The presence or absence of a locking mechanism for the door to the toilet
<b>ramp_publi</b>	is there a ramp?	30	The presence or absence of a ramp on public toilets
<b>accessibil</b>	is it accessible?	31	Accessibility to the toilet facility for emptying purposes
<b>road_type</b>	road type	32	The type of road leading to the toilet facility
<b>vehicle</b>	access vehicle	33	The kind of vehicle that can be used to access the toilet for emptying purposes
<b>id</b>	Id	34	Internal identification
<b>xcoord</b>	Xcoord	35	Geolocation x-coordinate
<b>ycoord</b>	Ycoord	36	Geolocation y-coordinate
<b>ELEVATION</b>	Zcoord	37	Geolocation z-coordinate

		Order	Description
<b>ward</b>	Ward	38	Ward in which the toilet is located