SFD Promotion Initiative

Kisumu
Kenya

Final Report

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On behalf of Federal Ministry for Economic Cooperation and Development

UNIVERSITY OF LEEDS

WORLD BANK GROUP Water

wsp water and sanitation program

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SFD Report Kisumu, 2016

Produced by:

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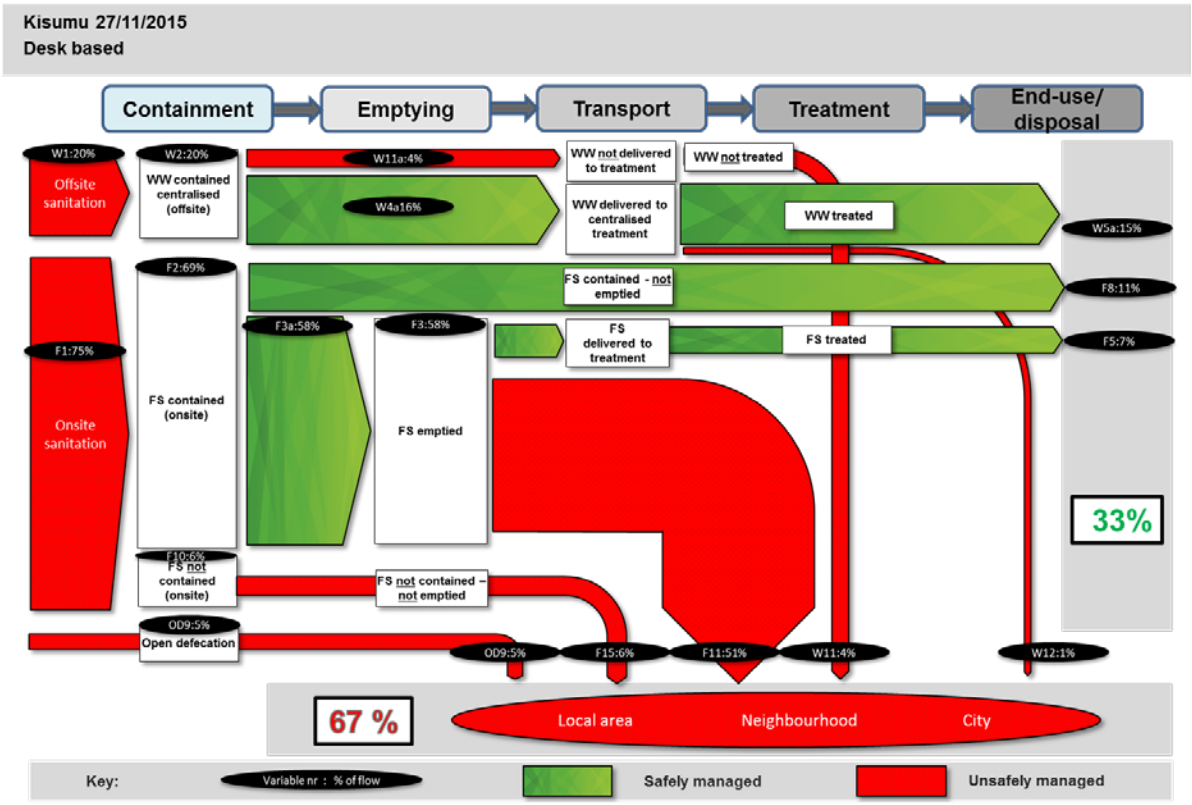
1. The Diagram



2. Diagram information

The excreta flow diagram (SFD) was created through field based research by WEDC (Water, Engineering and Development Centre) Loughborough University.

Collaborating partners:
Jaramogi Oginga Odinga University of Science and Technology (JOOUST)

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3. General city information

Kisumu is the principal city of western Kenya (Maoulidi, 2010). It is situated on the shores of Lake Victoria and is a transport and commercial hub. The city covers a land area of approximately 297 km^2 and has an average altitude of 1134 m above sea level (Awuor, 2014; Maoulidi, 2010).

The city has two rainy seasons; the main one from March to June, and a shorter one from November to December (Climate Data, 2015). Topographically the city is divided into two, the hilly north and the southern plain (UN-Habitat, 2005). The city slopes from east towards the lake in the west (Awuor, 2014). The city has black cotton soils with rocky outcrops, which affect both drainage and latrine construction (Maoulidi, 2010; Odiere et al., 2011). Three major low lying areas (Usoma, Manyatta and Nyalenda) are prone to flooding (Agong et al., 2014; Maoulidi, 2010).

The boundary used for the SFD was the administrative city boundary, as this predominantly encompasses the urban population. The current population is estimated to be 419,072 (Kisumu County, 2013). It is estimated that 60% of the population live in informal settlements or slums (Charles et al., 2013, Simiyu, 2015, World Bank, 2013). The population growth is 2.8% per year (Maoulidi, 2010).

4. Service delivery context

The right to sanitation is entrenched in the Constitution of Kenya (WASREB, 2014). Current policy, legislation, and institutions in Kenya are going through a transition period as

the Water Act (2002) is superseded by the pending National Water Bill (2014).

National **policies** for sanitation in Kenya are formed in the Ministry of Water and Irrigation which focuses on offsite urban sanitation. In 2008 the Ministry of Public Health and Sanitation was formed, and was given the remit for onsite sanitation in rural areas. This means there is a historic policy gap as onsite urban sanitation is not covered by either ministry. This sector is regulated through polices from the National Environmental Management Authority (NEMA).

The Water Act (2002) emerged from constitutional reform in Kenya. Under this Act the current regulatory framework for water and sanitation (offsite urban only) was established. It also initiated the devolution of these services from central government.

The National Environmental Sanitation and Hygiene Policy (NESHP) focuses on the coordination of stakeholders in the sanitation and hygiene sector in attaining the MDG target for sanitation (Umande & Practical Action, 2012).

The current **institutions** were formed under the Water Act (2002). The Water Services Regulatory Board (WASREB) independently regulates the sector. Under this Act, the ownership of assets was devolved to regional levels through the Water Service Boards (WSBs) who then contracted them to Water Service Providers (WSPs). WSPs are able to access funds for improving water and sanitation in LIAs through the Water Services Trust Fund (WSTF) (WSP, 2011).

Under this system the national Water Services Regulatory Board (WASREB) does not have total authority over regulating the WSPs, and there is duplication of responsibilities with WSBs and the Ministry of water and Irrigation (MoWI) (WSP, 2011). WASREB prosecuting powers have never been fully exercised (WSP, 2011). After the devolution of power the WSBs took administrative responsibility for most assets formerly belonging to the MoWI, but have not received the deeds of ownership.

Under the pending National Water Bill (2014) there will be significant institutional changes. Kisumu County government will gain ownership of water and sanitation assets, but will license them to the WSPs. This means that the Kisumu County can be held accountable if the Water Bill is not enforced. This creates a conflict of interest as the Kisumu County government will also own and regulate them. When the Water Bill is enacted, it will initially run alongside the Water Act. This will create a dual regulatory regime that could cause confusion and conflict between county and national government.

Spending on sanitation is difficult to assess, as budgets are not easily disaggregated (Washwatch, 2013). The funds for WSTF dropped by 14% from 2011/2012 to 2012/2013, partly due to the stabilisation of the Kenyan Shilling (WSTF, 2013). The water sector in Kenya is mainly funded by the government, through levies and investment from development partners. Householders are expected to cover the hardware, operation and maintenance costs. A majority of the sanitation software budget pays the salaries of the environmental health workers, but it is unclear what percentage of their time is dedicated to sanitation (WSP, 2011).

Kenya has a history of **private sector** investment in the sanitation sector dating from 1996 (PPP Unit, 2013). The government has strengthened the legal and regulatory framework to improve private sector involvement in this sector.

The **monitoring and evaluation** cycle in the Kenyan water sector emulates a project cycle. WASREB currently monitors and evaluates the performance of the WSBs and WSPs through gathering, collating and disseminating data in their annual *Impact Report*. There are only five parameters included in these reports which directly relate to sanitation. There is no obligation to report on effluent quality via the Water Regulation Information System (WARIS), although effluent quality data are reported to WASREB on a monthly and annual

basis under the Environmental Management and Co-ordination (Water Quality) Regulations 2006.

5. Service outcomes

There is a diverse technology landscape in Kisumu, which includes two sewage treatment plants (STPs) and a number of onsite technologies. The data used to generate the SFD were from Kenya National Bureau of Statistics (KNBS, 2009) as it held the only recent large data set which covered the entire city. These data was combined with the most recent offsite sanitation coverage (WASREB, 2014).

An area of 10km^2 of Kisumu city is sewered (World Bank, 2013). In the SFD the sewer system is considered to be a combined system with a leakage rate of 20%. The percentage of the population using this network was thought to be 20% (WASREB, 2014). Kisat STP serves the central and north western parts of the city, while Nyalenda STP serves the central and eastern city (Letema, 2012; World Bank, 2013). Both were refurbished in 2014 and are operating at less than their design capacity (Obunde, 2015). The effluent from Nyalenda STP meets the National Environmental Management Authority (NEMA) standards. The average monthly COD in the effluent from Kisat STP exceeds the NEMA limit by 15 mg/l (KIWASCO, 2015). Therefore in the SFD the waste is considered to be 95% treated.

The most common onsite sanitation technology type used is basic unlined pit latrines (66%), with a split of 50% and 16% between those that are manually emptied and those that are not. The majority are manually emptied, due to the lack of motorised emptiers and space to dig new pits. The majority (50%) of faecal sludge from these pits is discharged into the local environment via drainage channels. The remainder of the basic latrines are either safely (10%) or unsafely abandoned (6%). A small percent of the population use improved pit latrines (4%) which are emptied by motorised emptiers (*exhausters*). 5% of the population use septic tanks, but only 1% actually function at septic tanks (with chambers and soakaways). The majority (the other 4%) are just sealed tanks. These are also emptied using *exhausters*. Only 5% of the population practice open defecation.

There are a limited number of both public and private motorised emptiers in Kisumu. Only six private *exhasters* are licensed to dispose of their waste at the STP (Jura, 2015). Although the number of manual emptiers is unknown, they are known to operate in Low Income Areas (LIAs) (Charles et al., 2013; Letema, 2012; Simiyu, 2015; Tsinda 2015). As manual emptying is illegal, the faecal sludge is released into the environment.

A possible further contributor to excreta flow in Kisumu is school sanitation facilities. There were 224 schools in Kisumu City in 2007, and 70,599 pupils (Opendata 2015a, Opendata 2015b). Therefore 27% of the population were attending school in 2007. The SFD does not include data from schools, as major assumptions are required to confirm how much these facilities are used.

6. Overview of stakeholders

Kisumu City Council is currently responsible for service provision and regulating sanitation.

Offsite sanitation is provided by Kisumu Water and Sewerage Company (KIWASCO). KIWASCO is owned by the local council, and regulated by the Lake Victoria South Water Service Board. Both the city council and the Lake Victoria South Water Service Board report to the Water Services Regulatory Board.

Onsite sanitation is regulated by NEMA and through local laws which are enforced by local environmental health officers.

There is public sector involvement in the emptying of onsite sanitation systems. There are six privately owned vacuum tankers operating in Kisumu and many manual emptiers, even though the practice of manual emptying is currently illegal (Jura, 2015).

There are a number of national and international NGOs working in the sanitation

sector in the city including Care Kenya, Plan Kenya, World Vision, the Unmade Trust and SANA International (Adongo & Okotto, 2012).

7. Credibility of data

The SFD is based on the data from the 2009 census (KNBS, 2009) combined with most recent off site sanitation data (WASREB, 2014). The assumptions made on usage, emptying and disposal were then triangulated through interviews and observations, and negotiated with key stakeholders.

The service delivery context has been developed through a literature review and from reviewing nationally important policies and plans available in the public domain.

8. Process of development

The fate of infiltrate from soakaways and pit latrines has been disregarded in the SFD. It was deemed to have little, if any, adverse impact on health or the local environment (through ground water pollution). Therefore it is considered to be safely managed. The SFD therefore represents only the flows of wastewater and faecal sludge through the sanitation service chain.

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SFD Kisumu, Kenya, 2016

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Table of contents

List of tables

List of figures

Abbreviations

BOD	Biochemical Oxygen Demand
CCK	City Council of Kisumu
COD	Chemical Oxygen Demand
ESAWAS	Eastern African Water and Sanitation Regulators
GDP	Gross Domestic Product
JOOUST	Jaramogi Oginga Odinga University of Science and Technology
KIWASCO	Kisumu Water and Sewerage Company
KNBS	Kenya National Bureau of Statistics
LIA	Low Income Area
LVSWSB	Lake Victoria South Water Services Board
MDG	Millennium Development Goal
MoPHS	Ministry of Public Health and Sanitation
MoWI	Ministry of Water and Irrigation
MTEFs	Medium Term Expenditure Framework
NEMA	National Environmental Management Authority
NESHP	National Environmental Sanitation and Hygiene Policy
NGO	Non-Governmental Organisation
PPP	Public Private partnership
SANA	Sustainable Aid in Africa
SFD	Excreta Flow Diagram
STP	Sewage Treatment Plant
SUO	Sewer Use Ordinance
WARIS	Water Regulation Information System
WASREB	Water Services Regulatory Board
WEDC	Water, Engineering and Development Centre
WSB	Water Service Board
WSP	Water Service Provider
WSTF	Water Service Trust Fund

1 City context

Kisumu is the principal city of western Kenya and the third largest city in Kenya (Maoulidi, 2010). It is situated on the shores of Lake Victoria. Kisumu acts as a commercial and transportation hub for the region (Agong et al., 2014; UN-Habitat, 2005). The city has a land area of 297 km^2 and has an average altitude of 1134 m above sea level (Awuor 2014; Maoulidi, 2010). The city is divided into ten administrative areas, which can be seen in Figure 1 (Maoulidi, 2010). Slums cover approximately 19% of the city (Charles et al., 2013). The main informal settlements are found in Bandani, Obunga, Nyalenda A., Nyalenda B, Manyatta B, Manyatta Arab, Kalonleni, Kibos and Nyamasaria (Simiyu, 2015a), as seen in Figure 1 .

Figure 1: Map of Kisumu with sub locations (Maoulidi, 2010)

1.1 *Geography*

Topographically the city is divided into two, the hilly north and the southern plain (UN-Habitat, 2005). The city slopes from the east towards Lake Victoria in the west (Awuor, 2014). This topography leads to strong winds, surface runoff, siltation and floods (Adogo and Okotto, 2012). The underlying geology is fractured basalt, covered with a thin layer of soil (Wright et al., 2015). The city has black cotton soils with rocky outcrops, which affect both drainage and latrine construction (Maoulidi, 2010; Odiere et al., 2011).

Groundwater is typically stored in weathered surfaces between lava flows (Wright et al., 2013). The mean ground water level is at a depth of 6m (Wright et al., 2013), but the water table is higher in informal areas such as Usoma, Manyatta and Nyalenda (Agong et al.,

2014; Maoulidi, 2010) and can rise to a depth of 3 m Mnayatta and Nyalenda (Letema, 2012). There are three major low lying areas (Usoma, Manyatta and Nyalenda) which are prone to flooding (Agong et al., 2014; Maoulidi, 2010).

1.2 *Climate*

Kisumu city has a tropical climate, and is classified as Af (tropical rainforest climate) by the Köppen-Geiger system (Climate Data, 2015). The average annual temperature is 22.9 °C and the average annual rainfall is 1321 mm (Climate Data, 2015). Kisumu has two rainy seasons: the heaviest from March to June, and a lighter rainy season from November to December, although it should be noted that a significant amount of rain falls during the dry season (Climate Data, 2015; Kisumu City Council, 2015).

1.3 *Population*

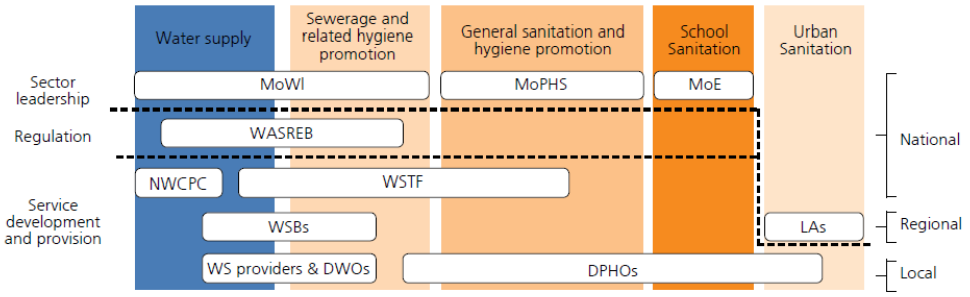
The current population is estimated to be 419,072 (Kisumu County, 2013). It is estimated that 60% of the population live in informal settlements or slums (Charles et al., 2013; Simiyu, 2015a; World Bank, 2013). The population growth is 2.8% per year (Maoulidi, 2010).

2 Service delivery context description

The right to sanitation is entrenched in the Constitution of Kenya (2010) (WASREB, 2014), and the new medium term plan under the Social Pillar in Vision 2030 , which states …'every Kenyan should have access to clean safe water and improved sanitation by the year 2030,' (Vision 2030, 2015).

Central government power in Kenya is administered through ministries, at a local level this power is delegated to local government. In the case of Kisumu City this is through the County Government of Kisumu and the City Council of Kisumu (CCK) (Adogo & Okotto, 2012). The law and institutions for the sanitation sector in Kisumu city are the same as at the national level. National institutions have regional offices in the city for administrating and implementing and enforcing relevant laws and policies (Adogo & Okotto, 2012).

The current policy, legislation and institutions in Kenya are going through a transition period as the pending National Water Bill (2014) will soon be implemented; this will supersede the Water Act (2002). The current Act dictates the institutional framework, including roles and responsibilities. Due to the devolution of power the District Public Health Officers are now known as Subcounty Public Health Officers, and school sanitation and hygiene promotion now falls within the remit of the Department of Health. The current institutional system under the Water Act (2002) is shown in Figure 2.



MoWI: Ministry of Water and Irrigation. Policy lead on water supply, oversight of WSBs and water services providers (including their sanitation activities); limited service provision through DWOs.
MoPHS: Ministry of Physical Health and Sanitation. Policy lead on Environmental Sanitation and Hygiene (ESH).
MoE: Ministry of Education. Supervision of ESH in schools.
LAs: Local authorities. Supervision of urban sanitation.
WASREB: Water Services Regulatory Board. Technical standards and tariffs, issues licenses and tariff guidelines.
NWCPC: National Water Conservation and Pipeline Corporation. Bulk supply development.
WSTF: Water Services Trust Fund. Provides grants for capital investment in underserved areas.

WSBs: Water Services Boards. Ownership of assets previously belonging to central government, MoWI or parastatals; may also 'acquire… use of assets' belonging to local authorities. Can operate as Water Service Providers (below) or bulk service providers. Provide hygiene promotion associated with sewerage.
WS providers: Water service providers. Operation and management. Can include local authority owned companies, NGOs and CBOs.
DWOs: District Water Officers, local MoWI officials.
DPHOs: District Public Health Officers, local MoPHS officials.
Additional bodies: Kenya Water Institute (capacity development); Water Appeal Board (dispute resolution).

Figure 2: Institutional roles and relationships in the water and sanitation sector in Kenya under the Water Act (2002) (WSP, 2011)

2.1 *National policy*

In Kenya the Ministry of Water and Irrigation (MoWI) is the policy forming institution in the water sector, and is the government agency responsible for implementing the current Water Act. Therefore the MoWI focuses on sewerage systems (offsite sanitation), which are only found in some urban areas (Pasteur & Prabhakaran, 2015). This ministry also has some mandate over the movement and treatment of faecal sludge (Adogo & Okotto, 2012). The MoWI manages the Water Services Trust Fund, which was formed under the current Water Act (Adogo & Okotto, 2012).

When the Ministry of Public Health and Sanitation (MoPHS) was established in 2008, it was given the remit for onsite sanitation in rural areas. This Ministry has Environmental Health and Sanitation Departments at national, regional, local government and community level (Adogo & Okotto, 2012). It partners with development agencies on sanitation projects, implements public health laws and, at a local level, formulates and enforces bylaws (Adogo & Okotto, 2012). These bylaws include those relating to sanitation technology, siting of sanitation facilities, handling of faecal sludge, and the maintenance of onsite sanitation systems (Adogo & Okotto, 2012).The duties of Public Health Officers include inspection of sanitation practices and conditions (Adogo & Okotto, 2012).

There is a policy gap due to this historical division of rural onsite vs urban offsite, as onsite urban sanitation and its associated service chain is not covered by either institution. It is regulated through policies from the National Environmental Management Authority (NEMA), which was formed under the Ministry of Environment and Natural Resources (Adogo & Okotto, 2012). NEMA's mandate is to monitor, evaluate and inspect activities of lead

agencies (Adogo & Okotto, 2012). NEMA's Waste Management Regulations 2006 provides guidelines on waste (including excreta) transport, treatment and disposal.

The Water Act 2002 emerged from water reforms in Kenya, and this Act spearheads the establishment of the current institutional regulatory framework for water resources management, which includes water and sanitation service provision (only offsite in urban areas) and initiated the devolution of these services from the central government.

The National Environmental Sanitation and Hygiene Policy (NESHP) was produced in 2007 and the MoPHS is leading its implementation (Umande & Practical Action, 2012). The policy focuses on the coordination of stakeholders in the sanitation and hygiene sector in attaining the MDG target for sanitation (Umande & Practical Action, 2012). The aim of the policy is to increase household access to sustainable and functioning toilets to 90% by 2015 (Umande & Practical Action, 2012). It also targets schools, and reduction of preventable sanitation and hygiene related disease. A demand responsive approach has been championed in the NESHP, which led the MoPHS to formally recommend the use of this approach, including its use in urban areas (Umande & Practical Action, 2012). Under this policy the Environmental Sanitation and Hygiene Inter-agency Coordinating Committee was formed in 2010 (Adogo & Okotto, 2012). This agency is responsible for setting the sanitation and hygiene scope for the country with relevant government departments (Adogo & Okotto, 2012).

The Public Health Act Cap. 242 empowers Public Health Officers (employed by MoPHS) to inspect and assess hygiene standards in all sectors (Umande & Practical Action, 2012). Under this law, the public is able to sue a private entity or local government that provides a waste management service, when they are not fulfilling their responsibility, or are causing a public nuisance e.g. burst sewers (Umande & Practical Action, 2012).

2.2 *Local policy*

CCK was formed under the Local Government Act Cap. 265. Under this Act the local government manages the development and provides services in their area, including sanitation (Umande & Practical Action, 2012). Through this Act, the authorities are able to contract service provision to private entities through public private partnerships (PPPs), with the local authority ultimately ensuring standards of service and deliverables (Umande & Practical Action, 2012). With respect to sanitation this covers emptying services for onsite sanitation systems, and public sanitation service provision (Umande & Practical Action, 2012). Currently the sanitation sector is in a period of transition, no local bylaws could be found that apply to this sector. The current laws do not align with the Constitution of Kenya and the pending laws are currently being formulated at county level.

2.3 *Institutional roles*

As Kenya's water and sanitation sector is currently in a period of transition due to the pending introduction of the National Water Bill, the institutions which are currently in place

will soon become obsolete. Table 1 shows the current institutions alongside the pending new institutions. The current institutions were formed under the Water Act 2002, which included the formation of the independent regulator, the Water Services Regulatory Board (WASREB). Also under this Act, the ownership of assets was devolved to a regional level, with the creation of Water Service Boards (WSBs) which then contracted the assets to Water Service Providers (WSPs). The current key institutional roles and their interactions in this sector can be seen in Figure 2.

In urban and peri-urban areas water and sanitation services are provided by WSPs which are publicly owned water companies, and which levy tariffs to generate revenue to meet their operational and maintenance costs. Kisumu Water and Sewerage Company (KIWASCO) provides these water and sanitation services to urban residents in the city of Kisumu. WSBs delegate their legal responsibility to provide water and sanitation services to the WSPs, through service provision agreements. The WSBs' mandate is to develop water and sanitation assets as well as tariff regulation, and the Lake Victoria South Water Services Board (LVSWSB) serves Kisumu City. Both the WSPs and WSBs are regulated by the national Water Services Regulatory Board (WASREB). The regulator is mandated to ensure implementation of policies and strategies relating to water and sanitation nationally. It sets rules, enforces standards, and monitors the performance of WSPs and WSBs. In the urban sector the Water Services Trust Fund (WSTF) distributes funding for improving access to water and sanitation in low income areas (LIAs), and WSPs can access these funds (WSP, 2011). These funds are being used to develop the onsite sanitation service chain through the Upscaling Basic Sanitation for the Urban Poor programme, which aims to develop and improve collection, transport and treatment of faecal sludge (WASREB, 2014).

Under this system WASREB does not have total authority over regulation. There is duplication of responsibilities, as the WSBs and MoWI also inspect, monitor and report on the performance of WSPs (WSP, 2011). Although WASREB has prosecuting powers, these powers have never been fully exercised (WSP, 2011). The WSBs took administrative responsibility for water and sanitation assets formerly belonging to the MoWI, but have not yet received the deeds of ownership.

The pending National Water Bill 2014 states that the county government is responsible for water supply, and that the licence for WSPs will be granted through them. In this Bill sanitation services includes wastewater from centralised (offsite) and decentralised (onsite) systems, but excludes household sanitation facilities. Under the pending National Water Bill (2014) there will be significant institutional changes, which are highlighted in Table 1.

Table 1: Key changes in institutions from those formed in the Water Act 2002

Name of Institution		Roles and responsibilities' under the Water Bill 2014
Under the Water Act 2002	**Under the Water Bill 2014**	
Water Service Regulatory Board	Water Services Regulatory Authority	-To determine and prescribe national standards -To evaluate and set tariffs -To monitor and regulate the WSPs
Water Service Trust Fund	Water Sector Trust Fund	-Assist in financing water service in marginalized areas
Water Service Boards	Water Works Development Boards	-Technical assistant to WSPs and county governments -Hand over assets to the county WSPs
Water Appeals Board	Water Tribunal	-Dispute resolution

From Table 1 it can be seen that Kisumu County government will, under the pending National Water Bill, gain ownership of water and sanitation assets, but will license them to the WSPs. This means that the Kisumu County can be held accountable if the Water Bill is not enforced. The main responsibility of the WSBs (which is to ensure delivery of water and sanitation services) will be devolved to the county government under the pending National Bill. Therefore the future of the WSBs as the Water Works Development Boards is not clear. The two options currently being discussed are, (i) merging them into a single national body, or (ii) devolving them to county level. Devolving the licensing of WSPs to the county government creates a conflict of interest, as the county government will set-up, own and regulate them.

A peer review of the of the water services regulatory system was conducted by the Eastern and Southern African Water and Sanitation (ESAWAS) Regulators in 2014. In their view the National Government in Kenya has a duty to set standards, monitor and report on sector performance, which is not in current legislation (WASREB, 2014). ESAWAS also noted that the pending National Water Bill diminishes the effectiveness of water services regulation, as the WSBs are retained in the form of Water Works Development Boards (Table 1), but there is no provision to regulate them (WASREB, 2014). When the Water Bill is enacted, it will initially run alongside the Water Act. This will create a dual regulatory regime that could cause confusion and conflict between county and national government.

2.4 *Service provision*

Kenya is a signatory of the eThekwini Declaration and therefore should be spending 0.5% of its GDP on sanitation and hygiene (Washwatch, 2013). This is difficult to assess, as sector budgets are not easily disaggregated (Washwatch, 2013; WSP, 2011). The proposed public budget in the National Water Master Plan is under a third of what is required to meet the Vision 2030 goal for water and sanitation (WASREB, 2014). Additional funding will be sought

through private sector investment (WASREB, 2014; WSP, 2011). The funds available through the WSTF have dropped by 14% (from 2011/2012 to 2012/2013), partly due to the stabilisation of the Kenyan Shilling (WSTF, 2013).

The water sector in Kenya is mainly funded by the government, through levies and investment from development partners. It is assumed that householders will cover a certain proportion of the hardware costs (5% for onsite sanitation and 100% for sewerage), but there is no government policy on this contribution (WSP, 2011). As with hardware, the operation and maintenance costs are expected to be covered by the user. For onsite sanitation this is being applied by the service providers through tariffs, as they strive for full cost recovery (WASREB, 2014; WSP, 2011). Cost recovery of the WSPs is monitored and reported yearly in WASREB Impact Reports. KIWASCO almost reached full cost recovery in 2014 (WASREB, 2014).

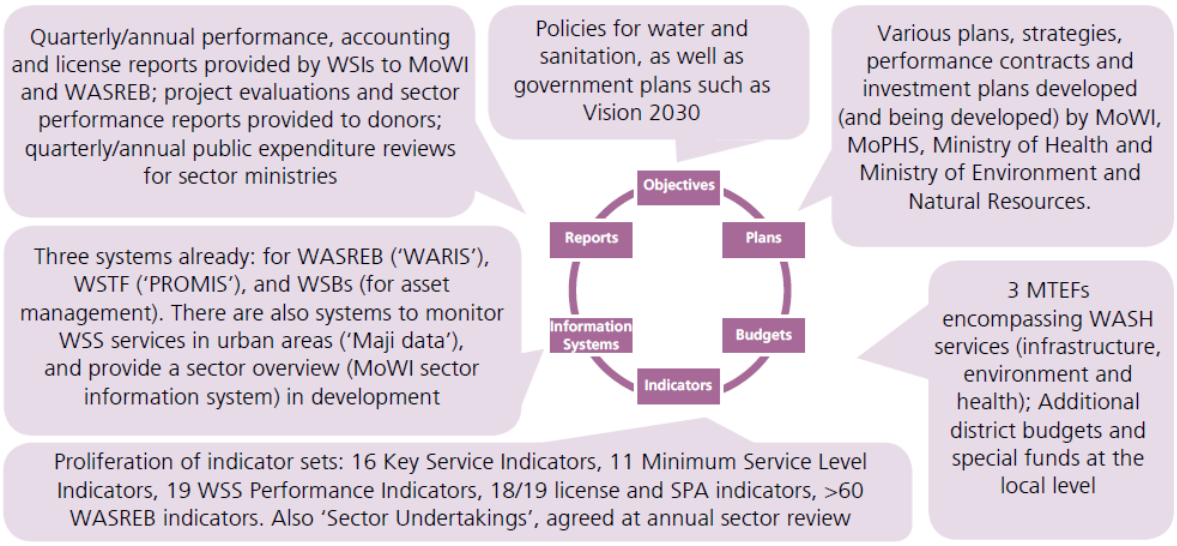
To safeguard public health the state has a responsibility to promote sanitation, but there is no policy, and it is unclear how this will be funded (WSP, 2011). A majority of the sanitation software budget pays the salaries of the environmental health workers employed by MoPHS. It is unclear what percentage of their time is dedicated to sanitation; additionally no specific budget is available for promotion materials (WSP, 2011).

Private sector investment in the water and sanitation sector dates back to 1996 (PPP Unit, 2013). To promote private sector participation, the Government of Kenya has adopted a Public Private Partner Framework (PPP Unit, 2013). Its aim is to improve the quality, quantity, cost-effectiveness and timely provision of much needed public infrastructure and services in Kenya. This has led to the strengthening of the legal and regulatory framework via the legislature below:

- PPP Policy statement (2011)
- Public Private Partnership Act, No. 15 (2013)
- The PPP Bill, No. 27 (2013)

2.5 *Service standards*

Most of the sanitation standards set in Kenya relate to offsite sanitation, but an integrated sector wide monitoring system has been evolving since the enactment of the Water Act. The monitoring and evaluation cycle in the Kenyan water sector emulates a project management cycle (Figure 3). Objectives are set through policies and plans, which are then translated into strategies for which budgets are set. Indicators are then developed to monitor progress, data are collated via information systems, and reports are then published.



MTEFs = medium term expenditure frameworks

Figure 3: Monitoring and evaluation cycle in the Kenyan water sector (WSP, 2011)

As discussed in Section 2.3 WASREB currently monitors and evaluates the performance of the WSBs and WSPs through gathering, collating and disseminating data in their annual Impact Report. The Water Regulation Information System (WARIS) is the data collection tool that is used by WSPs (WASREB, 2014). Table 3 shows a description of the data collected by WASREB that relates to sanitation. Most of the reporting criteria listed in the guidelines relate to water, rather than sanitation, as water is seen as the main business of the WSPs (WASREB, 2007). There are only five parameters which directly relate to sanitation (shown in bold text in Table 2). In the most recent Impact Report, offsite sanitation (sewerage) coverage is the only sanitation parameter that is specified. There is no obligation for WSPs to report on effluent quality for WARIS, although effluent quality data are reported to WASREB on a monthly and annual basis under the Environmental Management and Co-ordination (Water Quality) Regulations 2006. One of the major challenges with monitoring is caused by the differing quality of data submitted at various levels (WSP, 2011). Currently KIWASCO is considered to be non-compliant as it does not conform to WASREB's governance standards (WASREB, 2014). As mentioned in Section 2.3, the pending National Water Bill states that the county governments will set-up, own and regulate the WSPs. This means that future effluent quality standards will not be set independently.

Table 2: Information required for the Water Regulation Information System (WARIS) which relate to sanitation (WASREB, 2007)

Category	Parameter
General Information	• The number of board meetings during the reporting period • Objectives and achievements of the business and investment planning • Overview of service area including coverage
Financial Management	Legal obligation to provide financial statements which include: • Revenue • Expenditure • Balance sheet • Profit or Loss • Cash flow and debt management • Investments and Financial sources
Commercial management	• Customer services and complaints • **Sewerage and sanitation (domestic, tanks and latrines)** • Billing and customer categories • Connection and reconnection details • Collection efficiency • **Sewer tariffs**
Technical information	• **Sewage treatment capacity** • **Volume of sewage treated** • **Sewerage network length**
Personnel information	• Staff composition • Number of staff per 1000 connections • Type of employment contract • Staff qualifications • Training measures • Accidents

Although industrial effluent is not specifically included in this analysis, trade effluent discharged into the sewers systems requires a Sewer Use Ordinance (SUO) permit from the WSPs (under the Water Act 2002). This permit details the nature, composition and quantity of the waste discharged. Under this Act it is the industrialists' responsibility to implement a programme of self-monitoring guided by the SUO permit (WASREB, 2008). The industrialists must produce monthly and annual reports which are submitted to the WSPs and WSBs (WASREB, 2008). This means that industrial or trade waste entering the sewers and sewage treatment plant can be disaggregated from household sewage.

Within the sewage treatment plant (STP) samples are taken at several points: influent, effluent from the different treatment stages, and the final effluent (WASREB, 2008). Each WSP must analyse the results of its influent and effluent samples to ensure compliance with the Kenyan Standards. WSPs must submit monthly and annual reports for each treatment works to the WSB and WASREB, and highlight any problems and corrective action taken (WASREB, 2008). WASREB are meant to publish the results annually in their Impact Report. This does not occur, and effluent quality is not included in the WARIS (Table 2).

The standards for effluent discharged to the environment, and what parameters are monitored, are set in the Environmental Management and Co-ordination (Water Quality) Regulations 2006. A total of 49 parameters are listed in these regulations. Hotels, restaurants and lodges have to monitor 11 of these parameters, domestic sewage treatment systems have to monitor 12, and combined STPs have to monitor 42 (WASREB, 2008). In the latest Impact Report no data were published on the compliance of the WSPs to these regulations. In this report it was noted that most WSPs did have the necessary laboratory resources to monitor drinking water quality (WASREB, 2014). In the absence of effluent quality data and the lack of laboratory resources, it is assumed that the effluent quality monitoring is not implemented at most STPs.

There is currently no systematic monitoring of the number or quality of household onsite sanitation systems in the urban sector (WSP, 2011). Monitoring and reporting on urban underserved areas remains poor (WSP, 2011), although it is improving. There is a clear lack of mandate on onsite sanitation, and WASREB currently relies on data from external sources such as the Department of Public Health, although data on LIAs are now available via Maji Data.

Motorised empting and transport services (i.e. *exhausters*) are licensed through WSPs, County Government and NEMA. WSPs monitor the discharges of faecal sludge at the sewage or sludge treatment plant (Section 3.5.2). This is due to the removal of sludge being governed by multiple acts (Water Act, Local Government Act and then Environmental Management Coordination Act) (Okotto, 2014). Presently manual pit emptying is illegal under Kenyan law, due to their legal status manual emptiers are not licensed or monitored (Section 3.5.1).

3 Service outcomes

There is a diverse technology landscape in Kisumu City which includes two STPs (Section 3.1) and a number of onsite technologies (Section 3.2).

3.1 *Offsite systems*

The sewers in Kisumu cover 10% of the land area of the city (World Bank, 2013) and serve 20% of the population (WASREB, 2014). The principal components of the sewerage networks in Kisumu are gravity sewers, inverted siphons and pumping stations (Letema, 2012). The sewers were designed as a separate sewerage system, as all storm water is diverted away from the sewers (Letema, 2012). Large sections of the sewerage network pass through areas where the water table is high and the ground is saturated throughout the year, meaning infiltration is common (Letema, 2012). The ground levels in the low lying areas of Manyatta and Nyalenda are lower than the sewer network, therefore cannot be connected (Maoulidi, 2010). The sewers are considered to be combined sewers for the

purposes of the SFD, with 80% of the sewerage being delivered to the sewage treatment plants.

There are two sewage treatment plants (STPs) in the city. Kisat STP serves the central district and the north-western part of the city; and Nyalenda STP serves part of the central business district and the east of the city (Letema, 2012; World Bank, 2013). Currently the west of the city is unsewered, although there are plans to sewer this area and build another STP (World Bank 2013).

Kisat STP is a conventional tricking filter plant, and was originally built in 1958 (Maoulidi, 2010). It consists of initial screening, six primary settlement tanks (clarifiers), six trickling filters, four sludge digesters, six secondary sedimentation tanks (clarifiers), and 38 sludge drying beds, (Letema, 2012; World Bank 2013). Effluent is discharged into the Kisat River and then to Lake Victoria (World Bank, 2013). Kisat STP was rehabilitated in 2014 (LVSWSB, 2014) and now has a treatment capacity of 8,900 m^3 per day (Obunde, 2015a). In 2015 Kisat was receiving approximately 5,600 m^3 per day (KIWASCO, 2015), so it is operating within its design capacity.

Nyalenda STP is a pond system which includes screens and grit chambers, with the flow then being divided into three parallel systems, each consisting of a series of an anaerobic lagoon, a facultative lagoon, and an aerobic (maturation) lagoon, as shown in Figure 4. Nyalenda STP was recently rehabilitated (LVSWSB, 2014) and has a treatment capacity of 11,000 m^3 per day (Obunde, 2015b). Currently Nyalenda is receiving approximately 6,000 m^3 per day (KIWASCO, 2015), so it is operating within its design capacity. It also receives faecal sludge from motorised emptiers (Jura, 2015; Letema, 2012; Obunde, 2015a). The plant receives between 20 and 50 motorised emptying trucks per day, although the number is not monitored (Obunde, 2015a). It is estimated that, in total, the trucks discharge between 160 and 400 m^3 of faecal sludge per day (Obunde, 2015a).

The total effluent received and treated at the two sewage treatment plants is 11,600 m3 per day (KIWASCO, 2015). In 2010 the volumes treated at both plants was 11,000 m3 per day Letema, 2012; World Bank 2013). Over this time period (from 2010 to 2015) the percentage of the population connected to the sewer system increased from 10% to 20% (KNBS, 2009; WARSEB, 2014), and the population of Kisumu increased from 259,258 to 419,072 (Kisumu Country, 2013). Therefore in 2010 420 litres of sewage per person per day reached the STPs, whereas in 2015 140 litres of sewage per person per day reached the STPs. The volume per person in 2010 is very high, as is the volume in 2015. The high volumes could be due to a number of factors such as infiltration of water into the sewers, discharge of large volumes of faecal sludge or industrial effluent into the sewers, or unaccounted for connections. As the strength of the influent at both STPs is currently medium to strong in terms of organic load (COD >500 mg/l BOD>220 mg/l (Metcalf & Eddy,2003)) this would suggest that the high volumes are not due to infiltration, as the organic load would be diluted.

There are four industries connected to the STPs (KIWASCO, 2015). One of the industries has a high organic load (COD values within the range 840 to 4,960 mg/l (KIWASCO, 2015)), it is likely that the industrial discharges are increasing the volume and organic strength of the wastewater treated at the STPs.

Figure 4: Nyalenda STP pre- rehabilitation (World Bank, 2013)

Ten months of effluent quality data were obtained from KIWASCO for both STPs, summarised in Table 3. It can be seen from Table 3 that the effluent quality at Nyalenda STP meets the NEMA standards, whereas the COD in the effluent from Kisat STP is above the NEMA standard. As the data are from the STPs in Kisumu, and the average effluent quality almost meets the NEMA standard, the effluents are considered to be 95% treated in the SFDs.

Table 3: NEMA effluent quality standards and average effluent quality at Kisat and Nyalenda sewage treatment plants

Parameter	NEMA standard	Average effluent quality	
		Kisat STP [1]	Nyalenda STP [1]
COD (mg/l)	50	65	34
BOD_5 (mg/l)	30	25	24
SS (mg/l)	30	0.1	0.1

[1] averaged monthly data for January 2015 to Oct 2015 (KIWASCO, 2015)

Kisumu Molasses sewage treatment plant is the only satellite wastewater treatment plant in Kisumu (Jura, 2015). It treats 800 m^3/day of industrial wastewater (Letema, 2012), and does not treat any domestic wastewater or faecal sludge, so it is outside the scope of this study.

3.2 *Onsite systems*

The dominant onsite sanitation systems in Kisumu are traditional latrines, followed by septic tanks then VIP latrines (Letema, 2012).

Traditional or basic pit latrines are the most common technology type used by people, and their usage is more predominant amongst the poor (World Bank, 2007; Tsinda et al., 2015a). These latrines are generally poorly constructed and the pits are unlined (Letema, 2012). Due to their location these latrines are often affected by flooding (Okotto, 2014).Traditional pit latrines in peri-urban areas have a depth of approximately 4 m (Wright et al., 2013). Due to this shallow depth they fill quickly (Okotto, 2014), as a majority of latrines in LIAs are shared (Section 3.4.2). As they are found in densely populated areas, there little room for digging a replacement pit once a pit is full. Motorised emptiers (*exhausters*) are limited in number in Kisumu (see section 3.5.2), have limited access to these areas and generally refuse to empty unlined pits, because of the risk of pit walls collapsing. Therefore the most common form of emptying for this technology type is manual emptying (see section 3.5.1) (Simiyu, 2015a,b; Tsinda et al., 2015a,b). In terms of the SFD this technology is classified as unlined pits, which are mainly emptied by manual means, although some are abandoned once full.

The second most common form of onsite sanitation in Kisumu is septic tanks, which are commonly used in middle and high income areas. In general they either do not meet the requirements for septic tanks (e.g. having one compartment instead of two), or do not function as septic tanks due to over-use (Halcrow Foundation, 2015; Letema, 2012). This is reflected in the data used to generate the SFD (Table 6). The proportions operating as sealed tanks and septic tanks were negotiated with stakeholders. These systems are emptied by motorised means (see section 3.5.2).

Improved latrines are classified as VIP latrines in Table 4. They are semi-lined and have a vent pipe with superstructures made from a variety of materials. In terms of the SFD improved latrines are classified as lined pits with semi-permeable wall and open bottom with no outlet or overflow. They are generally located in middle class areas. As they are lined and easy to access due to location, it is assumed that they are emptied by motorised means (Section 3.5.2).

Ecosan toilets are being used in schools and high water table areas such as Manyatta, Nyalenda and Kogony (Adongo, 2015; Letema, 2012; Maoulidi, 2010), but there are relatively few examples of these systems in the city. Studies have noted that only a few of the Ecosan toilets installed were functioning or used (Letema, 2012; Simiyu, 2015b), but now it is believed that between 60-70% of household Ecosan systems are functioning (Adongo, 2015). Due to the low coverage of this technology in Kisumu Ecosan toilets are not included in the SFD.

There are seven communal bio-latrines (latrines generating bio-gas) in peri-urban parts of Kisumu. The biolatrine in Nyalanda serves Pand Pieri Primary School and the surrounding community, and was designed for 600 people per day (Letema, 2012). Another, at Obunga, serves 150 people per day, and two more at Manyatta possibly serve similar populations to the one in Obunga, based on their size (Halcrow Foundation, 2015; Letema, 2012). Others have also been built in Bandani, Kibuye Market and Wandiege (IPSOS, 2015), but little information could be found on the populations served by these systems. It is conservatively estimated that these systems serve a total population of 1,500 people. The effluent from the bio-latrines is discharged into the environment without further treatment. (Ebrahim, 2015; Letema, 2012). As this technology serves <1% of the population it is not included in the SFD.

3.3 *Usage*

A summary of studies which have reported the usage of different sanitation technologies across Kisumu City can be seen in Table 4. Four of the eight data sets focus on LIAs, so they are not representative of the city as a whole (Table 4). The only data sets which include data for the whole city are from KNBS (Table 4). Hence data obtained by KNBS, together with the most recent data on sewerage coverage (WASREB, 2014), were used to generate the SFD.

Table 4: Summary of studies on sanitation types in Kisumu

Data source	World Bank	KNBS	Letema et al.	Maoulidi et al.	Majidata.	World Bank	WASREB	Charles et al.	Data used for the SFD- from KNBS 2009 and WASREB 2014
Year	2007	2009	2010	2012	2011	2013	2014	2015	
Study area	LIAs	Kisumu Town East & West urban	Unknown	Nyalenda A &B, Obunga (LIAs)	LIAs	City	City	NyalendaB, Manyatta B & Obunga (LIAs)	
Sample size households	719	Population	Unknown	626	155,542	Population	Population	1,927	
Sewered	-	10	28.9	N/A	11	26	20	-	20
Septic tank	-	5	10.4	N/A	1	-	-	-	5
VIP latrine	-	4	9.3	N/A	24[c]	-	-	11	4
Traditional/basic latrine	37	75	26.9	87.06	55	-	-	69[d]	66
Flushing[b]	24	-	-	4.47	1	-	-	4	
Shared	32	-	-	-	-	-	-	-	
Flying toilet	-	-	-	-	1	-	-	-	
Open defecation	5	6	24.4[a]	5.57	<1	-	-	17	5
Composting toilet	-		-	1.28	N/A	-	-	-	
Public latrine	-		-	-	-	-	-	<1	
Other	-	<1	-	1.44	6	-	-	-	

[a]24.4% is the sum of shared facilities and open defecation, [b] no technology specified, [c] VIP latrine is a combination of improved latrines 20% and VIP 4%, [d]69% is the sum of pit latrines with slabs and other latrines

3.4 *Categories of origin*

3.4.1 Households

The average household size in Kisumu is 4 (Majidata. 2011). As there is an estimated population of 419,072 (Kisumu County, 2013) this means there are an estimated 104,764 households in Kisumu.

3.4.2 Shared or communal toilets

Shared sanitation is defined by UNICEF as sanitation shared by two or more households (UNICEF, 2015). As the average number of households per compound is five (Majidata, 2011) it can be assumed that a high proportion of the population used shared or communal toilets. The Citizens Report Card (CRC), published in 2007, found that 31% of households were sharing their sanitation, predominantly in poorer households (World Bank 2007). Letema also stated that 31% of the population of Kisumu used shared sanitation (Letema, 2012), although in LIAs the percentage is known to be higher. Charles et al. (2015) found that 98% of households were sharing latrines in the LIAs surveyed (Table 4), and the average number of households sharing was 6.8.

3.4.3 Public toilets

Simiyu (2015a) found that there was at least one public toilet in each slum settlement. The users were mainly found to be passers-by and local traders, rather than residents (Simiyu, 2015a). This is supported by the earlier findings reported in the CRC, which found that people generally used public toilets when out, rather than on a daily basis, and they were not used as a main sanitation option (World Bank, 2007). Therefore they are not thought to contribute significantly to the excreta flow across the city.

3.4.4 Prison

Kodiaga prison, in the city of Kisumu, holds approximately 5,000 prisoners (Standard Media, 2015). As prisoners will be counted in the census, these population data will already be included in the SFD.

3.4.5 Universities

Although there are many universities in this area, most of the large universities are located outside the administrative city boundary (identified via Google Maps). Kisumu Polytechnic is the only large institution found within the city. The other universities in Kisumu have small campuses i.e. buildings or parts of buildings in the town centre (identified from Google maps). They are located in areas which are connected to the sewers, and it is therefore assumed that waste generated from these buildings goes into the sewerage system. University students living in Kisumu will have been counted in the national census, hence no specific amendment was made to the SFD. Consideration of student numbers would have resulted in counting them twice; at their places of residence and at their places of study.

3.4.6 Schools

There were 172 primary (Opendata, 2015a) and 52 secondary schools (Opendata, 2015b) classified as being in Kisumu City[1] in 2007. Of the primary schools, 59 were private (Opendata, 2015a). There were 68,904 students attending primary schools in the city, but as no data were returned for 25 schools, therefore this is considered to be a conservative figure. Within these schools there were 1,695 toilets (326 for staff and 1,369 for students) (Opendata, 2015a). Of the secondary schools in the town the majority were public (32) (Opendata, 2015b). In 2007 there were 7,649 secondary pupils, but no data were returned for 21 schools, so this is a conservative figure (Opendata, 2015b). The number of toilets was not recorded in the secondary school data set (Opendata, 2015b). Therefore, there were more than 70,599 pupils attending schools in the city in 2007, which was approximately 27% of the population in 2007. If it is assumed that 27% of the current population is currently attending school, this would mean that there are approximately 113,000 pupils in the city.

It is assumed that pupils defecate either before or after school, therefore the SFD is not adjusted to account for this flow. If this assumption is correct, but if the school excreta flow was included, each pupil would be counted twice in the SFD, once at home and once at school. For the flow of excreta from schools to be included as a separate category, a better knowledge of the use of school and home sanitation facilities is required, so usage could be split between locations. It is noted that this is potentially a huge excreta flow, if the facilities are used for defecation by a high percentage of pupils. If the flow were to be included, then adjustments would be needed for the domestic excreta flows.

3.4.7 Hospitals

There were 14 hospitals or residential medical centres Kisumu City[1] in 2007 (Opendata, 2015c). Together the hospitals had 1,104 beds and 40 cots. This represented <1% of the population (Opendata, 2015c). It is assumed that the proportion of beds to population has remained the same; hence these data are not included in the SFD analysis.

3.4.8 Commercial areas

The Central Business District (CBD) is a distinct zone in the town, and is in the historical heart of the town, which is sewered. Therefore it is assumed that sewage generated from this area will be accounted for in the amount received and treated at the STPs (Section 3.2).

3.5 Emptying technologies for onsite sanitation

There is a combination of manual and two types of motorised emptying in Kisumu City. A summary of the methods used, their status, cost, providers and clients can be found in Table 5.

[1] Defined as being in the past constituencies of Kisumu Town East and West

Table 5: Details of pit emptying methods used in the informal settlement of Kisumu (data from Simiyu, 2015a & Tsinda et al., 2015a)

Method used	Legal status	Cost (US$)		Service provider	Client
		Tsinda	Simiyu		
Motorcycle (MAPET) (motorised emptying)	Legal	50		Private emptier	Landlords/owners
Vacuum truck (motorised emptying)	Legal	60-80		Municipal/ Private emptier	Landlords/owner/ caretakers
Emptying manually into another pit or storm water drain	Illegal	17-35	≥72	Private casual labour	Landlords/ owners

3.5.1 Manual emptying

In Kisumu manual emptiers are known as '*scoopers*' (Letema, 2012). They operate at night in groups of two or three (Letema, 2012). They normally come from the community where they work and are from a specific tribe. As they are working outside the law the services are promoted by word of mouth (Tsinda et al., 2015a). As there is a limited number of motorised emptiers (see section 3.5.2) to empty pit latrines, most are emptied manually (Charles et al., 2013). Additionally pit latrines sites are difficult to access by motorised emptiers (Simiyu, 2015b). Four types of emptying processes have been identified in the city (Charles et al., 2013; Letema, 2012; Simiyu, 2015b; Tsinda, 2015b)

- Scooping faecal sludge into buckets and pouring the faecal sludge into drainage channels
- Digging a pit beside the latrine and emptying the faecal sludge into the new pit
- Empting the sludge into a nearby sewer manhole
- Discharging sludge into the local area during the rainy season.

It has been estimated that a majority of pit latrines are emptied by manual emptiers (Simiyu, 2015b; Tsinda, 2015b). The most common method for disposal of the faecal sludge is to discharge it into drainage channels (Simiyu, 2015b; Tsinda, 2015b), this method is popular as it does not require any land. This is followed by burying the faecal sludge on the plot (Simiyu, 2015b; Tsinda, 2015b).

It was assumed that all the basic (traditional) pit latrines were manually emptied (66% of the population use this type of sanitation). In terms of the SFD the following assumptions were made concerning the disposal of faecal sludge:

- 50% of those with basic pit latrines the faecal sludge is discharged into the environment (via drainage channels).
- 10% of those with basic pit latrines the faecal sludge is buried on their plot and covered with soil.

- 6% of those with basic pit latrines the faecal sludge is buried, but not adequately covered with soil.

3.5.2 Motorised emptying

In Kisumu motorised emptiers are known as *'exhausters'* (Jura, 2015). They are required to obtain three licences to operate and discharge at Nyalenda STP from (i) NEMA, (ii) the County Government and (iii) KIWASCO (Jura, 2015). The KIWASCO annual fee allows them to discharge as many times as they are able throughout the year (Obunde, 2015a). Currently it is estimated that there are only six *exhausters* licensed in the city (Jura, 2015). *Exhausters* empty most commonly empty septic tanks, followed by VIP latrines, then public toilets (Letema, 2012). They rarely empty basic latrines due to the risk of collapse and the need for water to fluidise the sludge (Letema, 2012; Simiyu, 2015b). The average volume of *exhausters* in Kisumu is 8 m^3, and together they make between 20-50 trips to Nyalenda per day (Obunde, 2015a). It acknowledged that informal *exhausters* also operate within the city (Jura, 2015).

3.6 *End-use or disposal*

Currently the biosolids from the Kisat STP are sold for horticulture use (Obunde, 2015b). KIWASCO are currently exploring the market for this product (Obunde, 2015b). The aerobic (maturation) ponds at Nyalenda STP are stocked with fish, but this is an informal arrangement (Letema, 2015a; Obunde, 2015b).

3.7 *Drinking water supplies in the city*

Lake Victoria is the main source of drinking water for the city (Maoulidi, 2010; World Bank, 2013). The intake and treatment works are located at Ndunga beach in the south of the city (Maoulidi, 2010; World Bank, 2013). A second water treatment plant, Kajulu water treatment plant, takes and treats water from the Kibos River, which is north east of the city (World Bank, 2013). Piped water coverage in the city was reported by WASREB (2014) to be 67%, although Maoulidi (2012) found that 84% of people living in LIAs obtained their water from public taps and standpipes. Although ground water from shallow hand dug wells is used to supplement the intermittent piped water supply in LIAs, it is rarely used for drinking (Okotto et al., 2015; Simiyu, 2015b).

In terms of generating the risk of ground water pollution from sanitation sources for the SFD fractured rock was assumed to be the rock type in the unsaturated zone (Section 1.3), and a conservative estimate of the depth to the stabilised water table is thought to be less than 5 meters (Section 1.3). It is estimated that less than 25% of sanitation facilities are less than 10 metres from ground water sources, and more than 25% of sanitation facilities are uphill of groundwater sources. This is due to the gradient of the city (Section 1.3). Few ground water sources are used for providing drinking water in Kisumu (see above) so it is estimated that between 1 and 25% of drinking water is obtained from ground water sources. Using these data a low ground water pollution risk was generated by the SFD matrix.

4 SFD

The data from Section 3 have been collated in Table 6. The assumptions made were negotiated and agreed upon with stakeholders. These data were used to generate the SFD found in the Executive Summary and in Appendix 3.

Table 6: Data used to generate the SFD

Sanitation type	%	Sub division	How defined in SFD	How emptied	Emptied (%)	Going to treatment (%)	Treated (%)	Notes
Open defecation	5		Open defecation	-	-	-	-	
Sewered	20		Centralised foul sewer – combined sewer	-	-	80	95	Combined due to leakages 80% delivered due to leakages
Basic pit latrines	66	50	Unlined pit with no outlet no overflow	Manual	100	0	0	50% emptied manually and discharged into drainage channels
		10	Pit never emptied , abandoned when full and covered in soil	-	-	-	-	10% emptied manually and buried on site safely
		6	Pit never emptied abandoned when full not adequately covered in soil	-	-	-	-	6% emptied manually and buried by not properly covered
Improved pit latrines (i.e. VIP latrine	4		Lined pit with semi permeable walls open bottom with no outlet no overflow	Motorised	90	90	95	90% emptied via tanker and discharged at the STP
Septic tanks	5	4	Sealed tank with no outlet no overflow	Motorised	90	90	95	5% are not septic tanks, but sealed tanks which are emptied by tanker 90% of waste gets taken to STP
		1	Septic Tank outlet to soakway	Motorised	90	90	95	1% septic tanks and 90% goes to STP

NOTE: Exhausters only used to empty septic tanks and VIP latrines, most basic latrines are emptied manually and discharged into drainage channels

The percentage of waste delivered by the sewer network and the partial treatment of sewage at the STPs is explained in Section 3.1 The use of 90% for the emptying percentage for improved pit latrines, septic and sealed tanks, is due to no options reaching 100%. Once emptied, it was assumed that 90% of this faecal sludge is delivered to Nyalenda STP. The choice of 100% for the percentage of basic pit latrines manually emptied is explained in Section 3.2. All of the assumptions made were discussed and agreed by the stakeholders listed in Table 7.

The SFD calculation tool that was used has the ability to take into account the flow of infiltrate from soakaways and pit latrines, but as this stream was deemed to be safely managed (Section 3.7), it was felt it could be disregarded in Kisumu. This was done to reflect the sanitation service chain more accurately in terms of faecal sludge movement.

5 Stakeholder engagement

Permission to undertake this research was gained from Ms Doris Ombara, the Kisumu City Manager. The City Manager was not available to validate this report as she had left the post prior to the report being finalised and we have been unable to contact her replacement to validate this report. The primary stakeholder in this process was the Jaramogi Oginga Odinga University of Science and Technology (JOOUST), represented by Dr Lorna Grace Okotto, and JOOUST are the local collaborative partners in this project. Additionally the author has worked closely with KIWASCO. Stakeholders were identified via a snowball approach i.e. one stakeholder putting the author in contact with another stakeholder etc. This approach was successful, but time consuming.

5.1 *Key informant interviews*

Table 7 lists the key informants with whom unstructured interviews were held. The table also shows the topics covered in the interviews. Interviews were undertaken after initial electronic contact and engagement; and further details and additional clarifications were gained through continuing these dialogues after the interviews.

Table 7: Details of unstructured interviews with stakeholders

Key informants	Role	Topics covered
Dr Lorna Grace Okotto	Lecturer and sanitation researcher at JOOUST	Introduction to the sector, answering specific questions to fill knowledge gaps, negotiating assumptions
Dr Michael Oloko	Lecturer and water researcher at JOOUST	Questions to fill knowledge gaps, negating assumptions
Eng. Moses Jura	Head of Technical Services - KIWASCO	Answering specific questions to relating to sewage treatment plants , negating assumptions
Mr Joseph Obunde	Wastewater Operations Engineer - KIWASCO	Answering specific questions to relating to sewage treatment plants, negating assumptions
Mr Alfred Adongo	CEO- SANA International	Information on SANA's project in Kisumu
Ms Sheillah Simiyu	Lecturer - Kenyatta University	Answering questions relating to onsite sanitation and emptying, negating assumptions
Dr Aime Tsinda	Senior Research Fellow Institute of Policy Analysis and Research - IPAR-Rwanda	Answering questions relating to onsite sanitation and emptying. negating assumptions
Ms Aidah Ebrahim	Director of Umande Trust	Umande Trust's programmes in Kisumu

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Appendix 1: Stakeholder identification

Name of organisation	Name of contact person	Position	Influence (high to low)	Interest (high to low)
Kisumu City Council	Ms Doris Ombara	City Manager	High	High
JOOUST	Dr Lorna Grace Okotto	Lecturer	High	High
KIWASCO	Eng. Moses Jura	Head of Technical Services	High	High
KIWASCO	Mr Joseph Obunde	Wastewater Operations Engineer	Medium	High
JOOUST	Dr Michael Oloko	Lecturer	Medium	High
SANA International (NGO)	Mr Alfred Adongo	CEO	Medium	Medium
Kenyatta University	Ms Sheillah Simiyu	Lecturer	Medium	High
Institute of Policy Analysis and Research	Dr Aime Tsinda	Senior Researcher	Medium	High
Umande Trust	Ms Aidah Ebrahim	Director	Medium	Medium
University of Oxford	Dr Katrina Charles	Lecturer	Medium	Medium

Appendix 2: Tracking of engagement

Comment: List stakeholder that was directly engaged in the study. For desk-based assessment through Email or Phone. For field-based assessment through the corresponding data collection method	Date of Engagement	Purpose of Engagement	Maximum 100 word summary of outcomes
Ms Doris Ombara	04/05/2015	Introduction of Claire	Introductory email
Ms Lorna Grace Okotto	04/05/2015	Introduction of Claire	Introductory email
Dr Sammy Letema	06/05/2015	Emailed: Info on PhD Thesis	Sent email to ask for more information on his PhD
Dr Sammy Letema	09/05/2015	Replied: PhD these	Said he would send it next week as he is out of his office
Ms Doris Ombara & Ms Lorna Grace Okotto	13/05/2015	Claire sent intro of data email	Email sent introducing methodology
Mr Peter Murigi	15/05/2015	Emailed: About PA report	Sent email introducing myself and project - Replied the same day
Ms Doris Ombara & Ms Lorna Grace Okotto	27/05/2015	Sent another email	Trying to establish contact. Lorna replied the same day as spoke of gaining permission from KIWASCO
Mr Peter Murigi	29/5/015	Details of the study	Sent calling card about the project
Mr Peter Murigi	31/05/2015	Reply	Sent the baseline report for the previous PA study (Nakuru only)
Mr Peter Murigi	03/06/2015	Skype interview: About reports	Review of reports - Mainly Nakuru
Ms Lorna Grace Okotto	11/06/2015	Sent email about a call	Have date for a call on 17/6/15
Ms Lorna Grace Okotto	17/06/2015	Skype interview: Data gaps	Explained type of data I require and what is missing
Ms Aidah Ebrahim	16/07/2015	Skype interview Umande Trust Activities	Gained an overview of Umande Trusts activities in LIAs and Schools in Kisumu and Nakuru
Ms Lorna Grace Okotto	24/09/2015	Email update	Updated Lorna on progress
Ms Lorna Grace Okotto	07/10/2015	Skype interview: Data gaps	Discussed data gaps and how to fill them
Ms Lorna Grace Okotto	13/10/2015	Email update	Follow up from call the previous week
Ms Lorna Grace Okotto	15/10/2015	Email identification of contacts	Series of emails identifying organisations and contacts including an introductory email to Eng. Moses Jura
Ms Lorna Grace Okotto	19/10/2015	Email introduction to Mr Albert Adongo	Email introduction to CEO of SANA International. Sent an email he replied on the same day.
Mr Alfred Adongo	20/10/2015	Email arranging interview	Emails to arrange interview
Eng. Moses Jura	22/10/2015	Email introduction to Eng Moses Jura	Emailed to introduce the project
Ms Lorna Grace Okotto	30/10/2015	Email from Lorna about KIWASCO	Lorna had followed up on my email to Eng. Jura and he was out of the country hence no reply
Eng. Moses Jura	03/11/2015	Email to arrange skype interview	Emails and replies from Eng. Jura on arranging a skype interview
Eng. Moses Jura	04/11/2015	Skype interview: STP	General data on KIWASCO, Information on emptying and licensing of exhausters, requested further data
Ms Sheillah Simiyu	05/11/2015	Emailed about paper on Kisumu	Introduction to the study and trying to get more info on onsite sanitation and emptying. Replied the next day about setting up a call
Dr Katrina Charles	06/11/2015	Skype and email messages about paper	Sent data from paper about onsite sanitation systems and their coverage
Eng. Moses Jura	10/11/2015	Email from Eng. Jura to Mr Obunde	About sending me data from the previous call
Ms Sheillah Simiyu	10/11/2015	Skype interview: about paper	Further information on her paper including information on onsite sanitation and emptying
Ms Lorna Grace Okotto	10/11/2015	Email introduction to Dr Oloko	Email introduction to Dr Oloko
Dr Amie Tsinda	10/11/2015	Email about paper	Email about his paper asking for further information and a skype interview
Dr Amie Tsinda	11/11/2015	Response	Setting time for interview
Mr Joseph Obunde	11/11/2015	Emailed data on STP	Sent further questions on STP and he replied the following day
Dr Amie Tsinda	14/11/2015	Skype interview: about paper	Further information on her paper including information on onsite sanitation and emptying. Followed up by sending further papers.
Mr Joseph Obunde	19/11/2015	Email data request	Ask for more data on STPs
Ms Lorna Grace Okotto	20/11/2015	Skype interview: boundaries and bylaws	Discussed boundaries with Lorna and current bylaws
Mr Alfred Adongo	20/11/2015	Skype interview: SANA projects	Information on SANA programs in LIAs and Schools and emptying
Dr Michael Oloko	20/11/2015	Introductory email	Introducing the project etc.
Dr Michael Oloko	23/11/2015	Replied	Set a date for a skype call
Mr Joseph Obunde	25/11/2015	Skype interview: STP	Information on the number of exhausters and faecal sludge, STPs current capacity
Stakeholders	29/11/2015	Email: Draft SFD and assumption	Sent out draft SFD and assumptions for comment
Ms Lorna Grace Okotto	03/12/2015	Email	SFD paints a better picture than what happens. Report on the law and comment on data sets
Dr Michael Oloko	03/12/2015	Skype call: SFD and assumptions	Discussed assumptions
Mr Joseph Obunde	07/12/2015	Email: Data on reuse	Sent details on the reuse of feacal sludge at the STPs

Appendix 3: SFD