SFD Promotion Initiative

Kumasi

Ghana

Status Final Report

This SFD Report was created through field based research
by WEDC as part of the SFD Promotion Initiative.

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SFD Report Kumasi, Ghana , 2015

Produced by:

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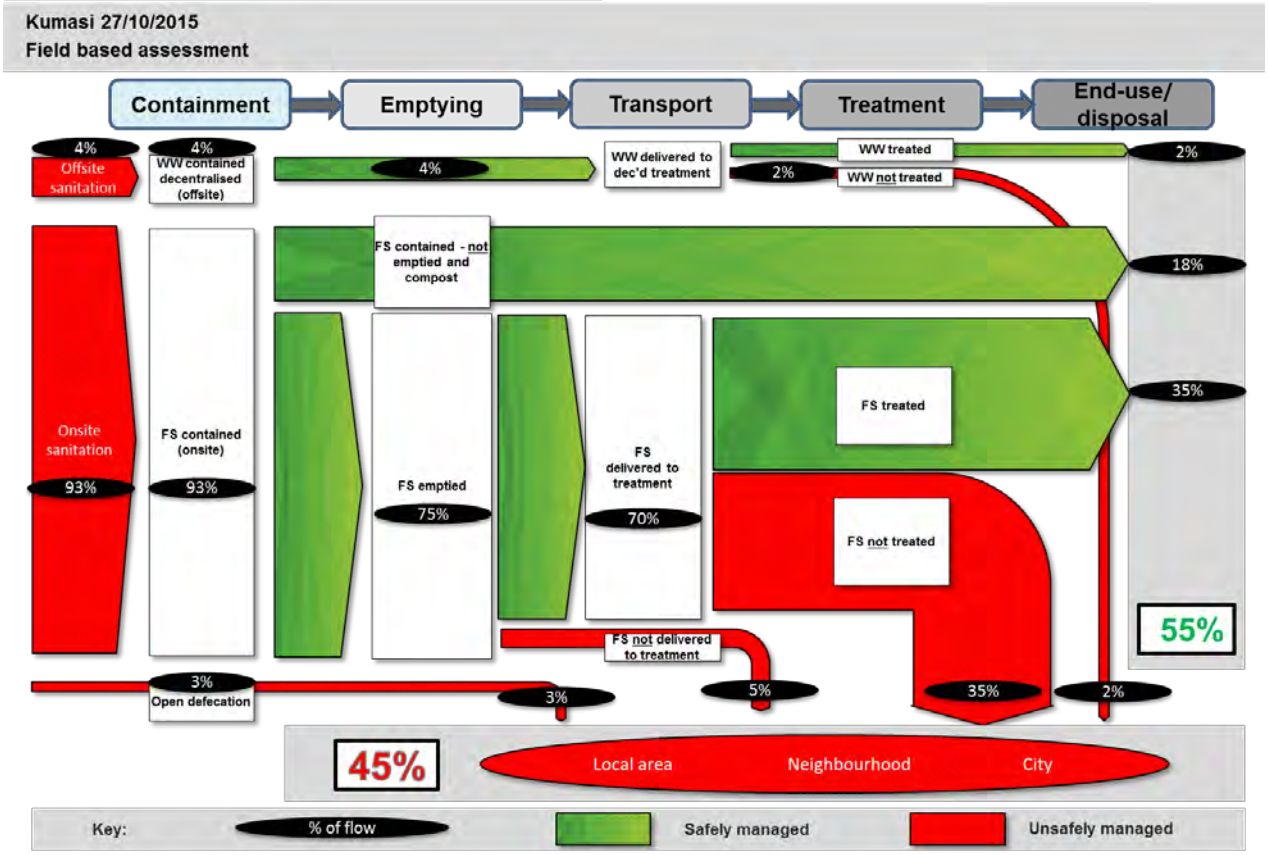
1. The Diagram



2. Diagram information

The excreta flow diagram (SFD) was created through field based research.

Collaborating partners:

Waste Management Department of Kumasi Metropolitan Assembly (KMA)

Status:

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3. General city information

Kumasi is the second largest city in Ghana and lies in the Ashanti Region in the south of the country (Adarkwa, 2011). Due to its location it is a national and international transport hub and a trading centre for several commodities (Adarkwa, 2011). The city covers approximately 254km^2.

The boundary used for the SFD was the old political border this includes Asawase sub-metropolitan area, which is no longer a part of the city. This was due to a lack of disaggregated data, as this separation occurred relatively recently.

The city has two rainy seasons; the main one from March to July and a shorter rainy season from September to November (Adarkwa, 2011), during which localised flooding occurs (Owusu-Ansah, 2015). There are three major natural drainage routes; the Sisa-Oda, Offin and Owabbi river systems (CEDAR 1999).

The current population of Kumasi is approximately 2.7 million and annual growth rate is 5.5% (City Population, 2015, World Bank, 2008). A high proportion of the population is acknowledged to have a low income (KMA, 2006), but the proportion is unknown.

4. Service delivery context

Sanitation in Ghana refers to a wider context than human excreta management. It covers solid waste management, storm water drainage, the cleaning of streets and public areas, food hygiene, and the disposal of dead animals and people (MLGRD, 2010). A major challenge for all stakeholders is that excreta management is only a small part of sanitation policy, legislation, regulations, plans and budgets, therefore is usually hidden in the wider sanitation agenda.

National policies for excreta management in Ghana are forward thinking and go beyond containment as

they consider all wastes as a resource (MLGRD, 2010). This is not currently translated into regulation and legislation. Regulations, legislations and targets focus on achieving access to containment, as they were developed in the MDG era. National laws are translated into local bylaws, but it is acknowledged locally and nationally that they are not enforced. Public toilet provision is overlooked in the targets and legislation as their focus is on compound or private toilets.

National **legislative powers** are devolved to local governments, which means KMA has legislative powers in all matters, including excreta management. KMA also has a role as both a service provider and regulator, so they are largely a self-regulating authority.

Ghana's sanitation sector has a well-established **institutional set-up** and clear lines of responsibility, but there is a lack of institutional ownership of monitoring, enforcement, registration and licensing of services. Although plans and policies in the sector do include monitoring and evaluation, there is little evidence that this occurs. When it does, the data is not made publically available, but held by local agencies, making it difficult to obtain both national and local data. KMA collects and collates data across the sanitation service chain in Kumasi including the number of vacuum tanker deliveries and details on the public toilets that are operated in the city. This data is only available from local agencies.

Excreta management **plans** in Ghana are currently being updated, as they were developed to run alongside the MDGs. National plans have been translated into local plans (KMA, 2008), but these focus predominately on provision of containment facilities.

Public sector involvement in sanitation is championed by national and local government. In Kumasi the private sector is involved in all aspects of the sanitation service chain, which has led to improvements in services e.g. the quality of public toilets.

Low income areas (LIAs) in Kumasi are not well defined not geographically. Measures are in place to ensure the urban poor have access to services, including the control of fees for the use of public toilets and special LIA programs focusing on the construction of compound toilets.

The population in Kumasi is growing at a faster pace than the budget allocated for waste management services (KMA, 2013; KMA 2014) or the expansion of services. It is predicted that this will cause slippages in the percentage of people served by sanitation facilities. If services did keep up with the increased demand, the capacity for septage treatment will need to be significantly increased.

5. Service outcomes

Kumasi has a diverse sanitation technology landscape and novel sanitation systems are currently being introduced, such as the Clean Team toilets, Biofil toilets and Duraplast septic tanks. Kumasi also has the only septage treatment plant in Ghana. The private sector has been involved in the sanitation sector in Kumasi for over 20 years.

A high percentage of the population in Kumasi is reliant on public toilets (39%, GSS, 2013). KMA regulate these facilities, which means they are designed appropriately, emptied by vacuum tankers and the septage is delivered to the septage treatment plant. A majority of the public toilet facilities are flushing toilets, with septic tanks connected to soakaways (23%). Other technologies used include aqua privies, Enviroloos and KVIPS. The quality of facilities is currently improving due to private sector involvement and the phasing out of dry technologies by KMA.

The number of open defecators is relatively small (3%, GSS 2013), with the remaining population having private toilets (57%, GSS 2013). Due to the high percentage of people living in compound housing (75%, Amoako & Korboe, 2011) this implies that most of these private systems are actually shared, although no official data is available to confirm this.

The technology definitions given in the national census focus on the user interface or external features i.e. the presence of a vent pipe or if the toilet is flushed by water. This gives little indication of how the containment or technology interfaces with the environment. Many terms are used interchangeably by stakeholders in Kumasi to describe the same technology. Therefore in-depth discussion was required with stakeholders to reach agreed definition of technologies that could be mapped onto the SFD.

A majority of the private systems are flushing systems (WCs, 36%). Of these, 24% are connected to septic tanks with soakaways, emptied by vacuum tankers and the septage taken to the septage treatment plant. The second most common containment is sealed tanks with no outlets (12%) i.e. septic tanks installed without a soakaway. The septage from these systems goes to the septage treatment plant via vacuum tankers. Basic pit latrines are only used by 11% of the population which are manually emptied, abandoned or emptied by vacuum tanker. The percentages which fell into each category were negotiated with the stakeholders.

The main kind of improved pit latrine used in Kumasi is the Kumasi VIP latrine (7%, GSS 2013). Discussion with owners indicates that they are predominately emptied by manual labourers. The material emptied is dry compost which is disposed of in the local environment, in a way that is considered to be safely managed.

A small proportion of the population are connected to decentralised sewer systems (4%). These localised sewer networks are connected to six sewage treatment plants, which are mainly pond systems.

Motorised emptying of facilitates has a long history of private sector involvement and there are currently 37 companies working in this field. They are highly organised through a trade association, but not overtly regulated by KMA. It is estimated that 95% of the waste they collect is taken to Dompoase septage treatment plant. Manual empting is very clandestine in Kumasi, although it is acknowledged that it occurs. Very little information is available about the practice of manual emptiers.

The septage and sewage treatment plants are deemed to be partially treating the waste. This acknowledges that there is a visual improvement in the effluent quality, although no effluent quality data is currently available. A lack of maintenance and monitoring at all sites results from insufficient capacity and budget. The maximum capacity of the septage treatment plant was exceeded up to 134 days during the first six months of 2015 (depending on average tanker volume and design capacity). Even when a more optimistic estimation is taken into account, the capacity of the septage treatment plant will be reached by 2020, which will significantly impact the treatment process.

A possible further contributor to excreta flow in Kumasi is school sanitation facilities. 35% of the population is estimated to be of school age (GSS, 2013) and there are 1,457 schools in Kumasi. The SFD does not include data from schools, as major assumptions are required to confirm the use of these facilities.

There is deemed to be a low risk to contamination of ground water from sanitation, due to the high usage of public toilets, and private septic and sealed tanks, which are well regulated. Plus a majority of the population gain their drinking water from piped supplies (66%, GSS 2013).

6. Overview of stakeholders

KMA's Waste Management Department is responsible for building and maintaining sanitation facilities at a public and school level, and service provision in Kumasi. KMA owns a majority of the public toilets and sewage treatment plants, the septage treatment and several vacuum tankers. The private sector is heavily involved through the management of these assets and in the provision of mechanical empting. Environmental health standards are enforced by sub-metropolitan Public Health Officers in collaboration with the regional Environmental Protection Agency with guidance from KMA's Environmental Health and Management Department. Compliance to sanitation regulations falls under the remit of KMA's Waste Management Department together with the regional Environmental Protection Agency. There are many associations active in the sanitation sector in Kumasi such as landlords association, tenants associations, Kumasi Sanitation Awareness Association and the Vacuum Tanker Operators Association. Water and Sanitation for the Urban Poor is the main NGO working in Kumasi.

At a national level the Environmental Health and Sanitation Directorate is responsible for coordinating all sanitation activities. This directorate is in the Ministry of Local Government and Rural Development who are responsible for sanitation promotion. The Ministry of Education and the Ministry of Health are responsible for school sanitation. Whereas the Ministry of Water Resources, Works and Housing is responsible for setting all water polices, through their Water Directorate.

7. Credibility of data

The SFD is based on the data from the 2010 census, triangulated through interviews and observations, and negotiated with key stakeholders. Data for other service outcomes came predominately from unpublished data held by local agencies, triangulated by field-based observation and key informant interviews.

The service delivery context has been developed through a literature review and reviewing nationally important policies and plans available in the public domain. KMA documentation has been obtained from local agencies, with results triangulated through key informant interview and observations.

8. Process of development

One limitation of developing this study is using census data from 2010 to generate the SFD. Another is that the study excludes the peri-urban settlements outside the boundary of KMA.

Little is documented on the sanitation realities in LIAs, due to these areas being poorly defined. There was a lack of primary data collected from service users and providers in LIAs. It is felt that school sanitation could be a significant contributor to the excreta landscape, but more research is required to include this component.

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 represents only the flows of wastewater and faecal sludge through the sanitation service chain.

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SFD Kumasi, Ghana, 2015

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Abbreviations

BOT	Build Operate Transfer
DEHO	District Environmental Health Officer
DESSAP	District Environment Sanitation Strategy and Action Plan
DIMES	District Monitoring and Evaluation System
EHO	Environmental Health Officer
EPA	Environmental Protection Agency
ESP	Environmental Sanitation Policy
FGS	Focus Group Discussion
GDP	Gross Domestic Product
GoG	Government of Ghana
GSGDA	Ghana Shared Growth and Development Agenda
GSS	Ghana Statistical Service
ISIO	Incremental Service Improvement Option
KATH	Komoto Anokye Teaching Hospital
KMA	Kumasi Municipal Assembly
KNUST	Kwame Nkrumah University of Science and Technology
KVIP	Kumasi Ventilated Improved Latrine
LIA	Low Income Area
M&E	Monitoring and Evaluation
MDG	Millennium Development Goal
MLGRD	Ministry of Local Government and Rural Development
M&E	Monitoring and Evaluation
MoE	Ministry of Education
MoH	Ministry of Health
MoFEP	Ministry of Finance and Economic Planning
MoWRWH	Ministry of Water Resources, Works and Housing
NDPC	National Development Planning Commission
NESSAP	National Environmental Sanitation Strategy and Action Plan
NGO	Non-Governmental Organisation
PPP	Public Private Partnership
SESIP	Strategic Environmental Sanitation Investment Plan
SFD	Excreta Flow Diagram
SNV	Netherlands Development Organisation
VIP	Ventilated Improved Latrine
VTO	Vacuum Tanker Operator
UNDP	United Nations Development Programme
US$	United States Dollars
WC	Water Closet
WMD	Waste Management Department
WSMP	Water and Sanitation Monitoring Platform
WSP	Water and Sanitation Program of the World Bank
WSUP	Water and Sanitation for the Urban Poor

1 City context

1.1 Location

Kumasi is a city in Ashanti Region, South Ghana and is the second largest city in Ghana covering an area of 254 km². It is located approximately 270 km north of the capital Accra (Adarkwa, 2011). The city encompasses nine sub-metropolitan areas: Manhyia, Tafo, Suame, Asokwa, Oforikrom, Bantama, Kwadaso, Nhyiaeso, Asawase and Subin, (Maoulidi, 2010) (Figure 1).

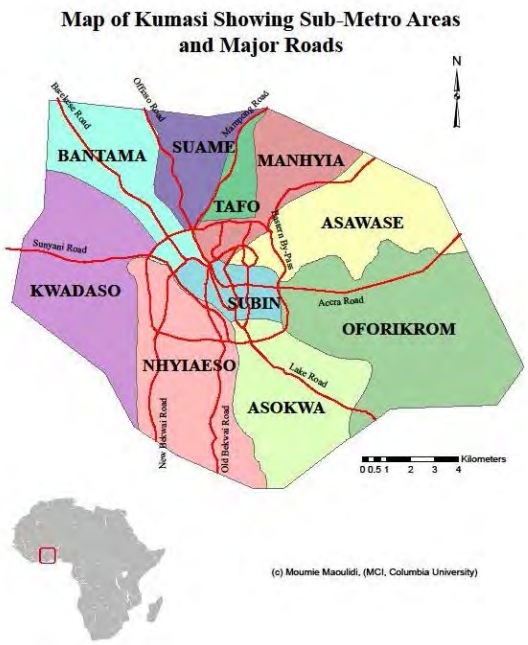


Figure 1: Kumasi sub-metropolitan areas (Maoulidi, 2010)

It should be noted that Asawase is now a separate area and no longer falls within the boundaries of KMA (KMA, 2015i). As this separation occurred in 2013 (KMA, 2015i), the data collected does not reflect this separation i.e. census data from 2010, hence for the scope of this study Asawase was included. Additionally Kumasi is a rapidly growing city with several peri-urban settlements outside the KMA boundary, but it was decided not to include these conurbations due to a lack of available data (KMA, 2015d).

1.2 Climate

The climate falls within the wet sub-equatorial type (defined as tropical wet and dry by the Köppen classification) with a relatively constant temperature (Adarkwa, 2011). Average minimum temperature being 21.5°C and a maximum average temperature of 30.7°C (Adarkwa, 2011). The city has a two rainy seasons, a longer rainy season from March to July and a shorter rainy season from September to November (Adarkwa, 2011).

1.3 Geography

The topography of Kumasi is undulating, ranging from 215.8m to 274.6 m above sea level (Owusu-Ansah, 2015). Much of the city drains south to the Sisa-Oda river system, but the northwestern part of the city drains west to the Offin and Owaabi river systems (from which the water supply is extracted Section 3.8) (CEDAR 1999). Flooding events within the city are common during the rainy seasons and flash flooding is common in November and January due to the hard baked soils (Owusu-Ansah, 2015).

The geology is made up of predominately two rock formations, Lower Birimian metasediments (mainly phyllites and metagreywackes) which cover 45% of Kumasi's land area and the associated granitic complex (granites, granodiorites, pegmatitic dykes and quartz veins), above these are superficial deposits of gravels, sands, silts and clays (UNDP/World Bank, 1990). The predominate soil types are gravelly and earthy, laterite and lateritic hardpans in the uplands, while in the valleys there are scattered deposits of sand and clay (UNDP/World Bank, 1990). Stabilised ground water levels vary widely from 1.5 m to > 12 meters depending on distance to floodplain and altitude (UNDP/World Bank, 1990). A few locations in Tafo, Asawase, Suame, Oforikrom and Nayhiaeso sub-metros (Figure 1) were identified as having high water tables of <2 m (UNDP/World Bank, 1990), while it is conservatively estimated that 60% of the population live in areas where the ground water table is <5m (22 housing settlements out of 32) (UNDP/World Bank, 1990) .

1.4 Economics

Due to Kumasi's location it is a principal transport hub for movements around Ghana and beyond. It is also a major trade route for landlocked countries in the region such as Niger, Burkina Faso, Togo and Mali (Adarkwa, 2011). Due to this there are a large number of people in transit in the city, but it was estimated that they amount to < 1% of the city's resident population. It has a role as a central trading centre for several commodities in the country (Adarkwa, 2011), and Kejetia Market (Kumasi Central Market) is the largest market in West Africa.

There are several manufacturing industries in the city including beverage and wood processing industries located in the Asorkwa-Ahinsan-Kaase industrial areas (Adarkwa, 2011). Several hundred small scale engineering industries are located in Suame (Figure 1) and there is significant agricultural activity within the city (Adarkwa, 2011). Many people are also employed by the surrounding mining industries which are located outside the city (WSUP, 2014b).

1.5 Population

The 2010 Census results show that the population of Kumasi was 2,035,064 (GSS, 2013). Using the annual population growth rate of 5.5% (City Population, 2015; World Bank, 2008), the calculated current population for Kumasi is 2,659,747. It is worth noting that internal and external migration is a contributing factor to the high population growth rate in Kumasi, presently over a third (34%) of the population are migrants (GSS, 2013).

Poverty levels are perceived to be high throughout the metropolis (KMA, 2006). Although many communities have mixed socioeconomic status, there are a few communities which are thought to be

predominately low income areas (LIAs). These are located in Manhyia, Asawase, Old Tafo, Oforikrom and Asokwa sub-metros (Figures 1 & 2) (Amoaka & Korboe, 2011). The proportion of the population living in LIAs is not known.

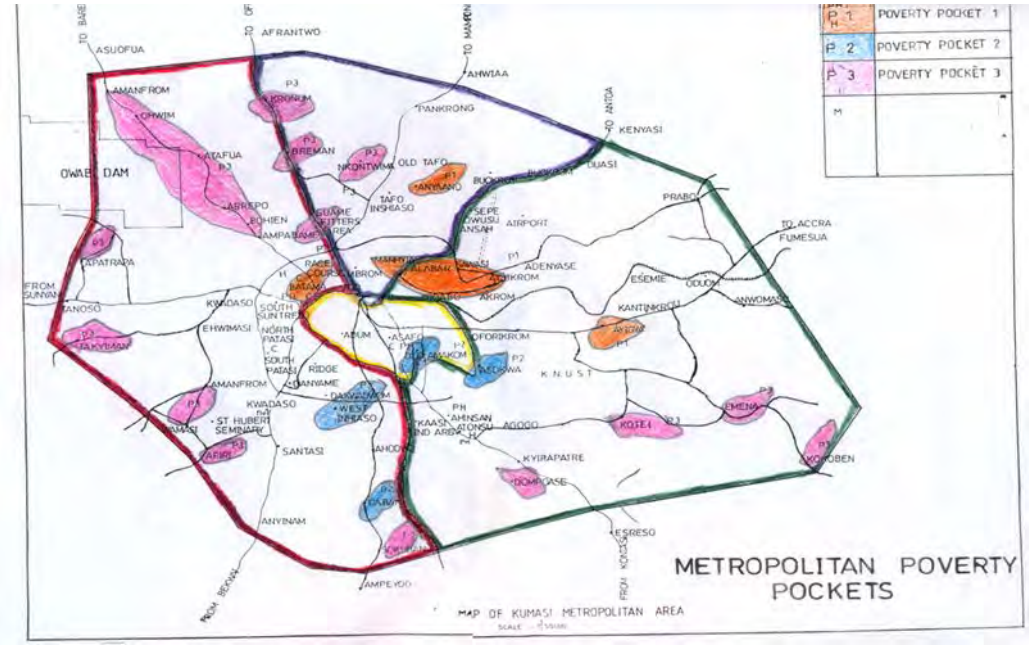


Figure 2: A sketch map showing pockets of poverty in Kumasi (KMA, 2015a)

2 Service delivery context description & analysis

It should be noted that the term "Sanitation" within a Ghanaian context refers to a wider sanitation context: It goes beyond human excreta management and covers solid waste management, storm water drainage, the cleaning of streets and public areas, food hygiene, and the disposal of dead animals and people (MLGRD, 2010a). Therefore excreta management is only a small part of sanitation policy, legislation or regulations. Human waste management is referred to as excreta or liquid waste management interchangeably and generally falls within the remit of Solid Waste Management Departments (Section 2.1.4).

2.1 Policy, legislation and regulations

There are three main policies which relate to excreta management in Ghana:

- The Environmental Sanitation Policy (revised in 2010) (MLGRD, 2010a)
- The National Environmental and Sanitation Strategy and Action Plan (MLGRD, 2010b)
- Public Private Partnership Policy (MoFEP, 2011)

2.1.1 National policy

The Environmental Sanitation Policy (ESP) contains the framework for environmental sanitation in broad terms. In the ESP, sanitation is the responsibility of all citizens (individuals, establishments or institutions) and states remedial action will be taken at the expense of those at fault (MLGRD, 2010a). Its aim is to develop a clear and nationally accepted vision for environmental sanitation. It contains seven policy focus areas;

1. Capacity development
2. Information, education and communication
3. Legislation and regulation
4. Levels of service
5. Sustainable management and corporate responsibility
6. Research and development
7. Monitoring and evaluation (WSUP, 2014b).

The ESP provides the framework for establishing a monitoring and evaluation system, but this has yet to be implemented (Section 2.2.1).

The goal of the National Environmental Sanitation Strategy and Action Plan (NESSAP) is to change the perception of both solid and liquid waste into a resource focused approach and is seen as a natural progression of the ESP (MLGRD, 2010b; WSUP, 2014). NESSAP reviews the current situation and defines national objectives and strategies which include:

- Banning defecation and urination in places other than toilets and urinals
- Banning the use of bucket latrines by 2010
- Promoting the use of domestic toilets
- Providing adequate and modern public toilets and urinals for transitory populations
- Monitoring all activities with the potential for pollution
- Enforcing bylaws (MLGRD, 2010b)

Public Private Partnership Policy has been produced by the Ministry of Finance and Economic Planning (MoFEP) and covers all aspects of public private partnerships (PPPs) in the public sector including sanitation (MoFEP, 2011), the details of this policy can be found in Section 2.1.5.

2.1.2 National Laws and regulations

Ghana has a number of regulations and bylaws to regulate excreta management. The 1992 Constitution devolved legislative powers to local governments, such as KMA (WSUP, 2014b). The Local Government Act (462) mandates that the sub-metros manage and operate public toilets, set public toilet fees, construct and maintain sewerage systems, and manage the removal and treatment of faecal sludge. Under the Environmental Protection Agency Act (1994), the EPA is responsible for the provision of solid waste management framework and guidelines in the sanitation sector, which includes the management of faecal sludge (WSUP, 2014b).

2.1.3 Local bylaws

Due to the devolution of legislative powers a number of KMA bylaws cover excreta management these include:

- Sanitation Bylaw 5 (1,2,3 and 4, 2015) provisions for faecal disposal at the compound level is required and refers to the banning of bucket toilets/latrines
- Nuisance Bylaw 4 (1) makes it an offence if sanitation facilities cause a nuisance via bad maintenance and accumulated excreta

- House Owner and Occupier Bylaw 7 (1, 2013) makes it an offence to construct a house without a toilet or latrine, it also prohibits households from emptying sanitation systems in an inappropriate way and disposing of their contents into drains (WSUP, 2014c)

It can be seen that most of the KMA bylaws concern the containment stage of the sanitation service chain. These bylaws are not strictly enforced as even with Bylaw 5 and 7 in place there is still a low number of household facilities and the population is highly reliant on public toilets (Section 3.3).

2.1.4 Institutional roles

It is widely acknowledged that Ghana's sanitation sector has a well-established institutional set up and clear lines of responsibility. At a national level the Ministry of Water Resources, Works and Housing (MoWRWH) is responsible for setting the water polices in the country and water resource management. Within the MoWRWH the Water Directorate oversees sector policy formation and review, monitoring and evaluation of activities of agencies and coordination of activates of donors (WSP, 2011). The Ministry of Local Government and Rural Development (MLGRD) is responsible for policies and programs for the efficient administration of local government structures such as KMA. Within MLGRD the Environmental Health and Sanitation Directorate is responsible for coordinating activities of all sector institutions involved in the sanitation sector (WSP, 2011). The Ministry of Education (MoE) is responsible for school sanitation and jointly responsible with the Ministry of Health (MoH) for sanitation and hygiene education. The Ministry of Environment, Science and Technology ensures that sector activities are consistent with environmental policies and objectives (WSP, 2011).

At a regional level the Metropolitan Assembly (i.e. KMA) is responsible for delivering sanitation using the private sector for infrastructure delivery or management, and for developing the District Water and Sanitation Plan (WSP, 2011). The District Water and Sanitation Team, comprising of members from the Works, Health and Planning Departments are responsible for implementing the Districts Water and Sanitation Plan (WSP, 2011). District Environmental Health Officers (DEHOs) educate communities on sanitation and hygiene, and enforce regulations regarding the construction, use and management of public, institutional and household facilities (WSP, 2011). More details of the institutions and their roles can be found in Table 1.

Table 1: Roles and responsibilities in the water and sanitation sector in Ghana
(Adapted from WSUP, 2014b)

Institution	Role	Responsibility
MLGRD	Oversight responsibility	-Coordination and formulation of policy including M&E -Development of technical guidelines -Promulgation of national legislation -Mobilisation of funds
MoFEP	Financial relations	-Fund mobilisation -Direction on PPP
Regional Coordination Council	Coordination, monitoring, evaluation and advisory services	-Compliance to standards and guidelines
Waste Management Dept. KMA	Ensure the provision of services	-Provision of sanitation services -Compliance with regulations
Environmental Health & Management Dept. KMA	Ensure environmental health standards	-Public health monitoring -Sanitation education -Implemented through EHOs in collaboration with the EPA
Metropolitan & Works Dept. KMA	Provision of infrastructure	-Provision of infrastructure
Sub Metropolitan Assemblies	Public health monitoring and facility development	-Sanitation education -Inspection and monitoring of facilities -Implemented through local agents such as EHOs
EPA – Regional office in Kumasi	Enforcement of environmental regulations	- Ensure the environmental regulations are met

The Environmental Monitoring Section of the Environmental Protection and Standards Enforcement Unit (located in the Environmental Health and Management Department in KMA) in collaboration with the EPA is responsible for monitoring and enforcing environmental standards and regulations set by the EPA and other regulatory agencies. This includes the monitoring of the environmental impact of the Assembly's own sanitation services such as septage treatment and public toilets; hence they are a semi self-regulating authority.

Additionally a directory of Ghana's water and sanitation sector is available, which identifies all key stakeholders and their roles and responsibilities including bilateral organisations and NGOs. This has not been updated since 2010 (WSMP, 2010). Even with the above in place there is no well-defined institutional responsibility for monitoring, enforcement, registration and licensing of operators (KMA, 2015i, WSP, 2011).

2.1.5 Service provision

The NESSAP sets the national sanitation agenda, including the agenda for excreta management (MLGRD, 2010b). This includes a framework for funding the strategies proposed. These financial plans for improving service provision were further developed in the Strategic Environmental

Sanitation Investment Plan (SESIP) which intends to provide a sustainable financing plan for implementing the NESSAP (MLGRD, 2010b).

The Government of Ghana (GoG) states that the majority of excreta management services should be provided by the private sector, with Assemblies maintaining an in-house capacity to provide at least 20% of the services directly (MLGRD, 2010a). Through the ESP, provision is made for private sector involvement in desludging of all facilities, construction and management of public toilets (MLGRD, 2010a). This is reiterated in the subsequent national and local plans and policies. The Ghana Shared Growth and Development Agenda (GSGDA) 2010-2014 contains sections on private investment in Ghana, which is pursued through the Private Sector Development Strategy in GSGDA (NDPC, 2010), NESSAP (MLGRD, 2010b) and SESIP (MLGRD, 2011). Private sector involvement is mainly through PPPs and in Kumasi sections on PPPs have been included in the District Environmental Sanitation Action Plan (KMA, 2008) and Medium Term Development Plan (KMA, 2015a).

The Public Private Partnership Policy creates a structure to encourage the development of PPPs for infrastructure and services, including those required for excreta management. It harmonizes the policy guidelines and creates a PPP framework which can be followed. It states that all PPPs are to be governed in accordance with clear objectives and output requirements, accountability and transparency. It establishes six guiding principles for PPPs within Ghana which are: value for money, transfer of risk to the private party, ensuring end users ability to pay, promotion of local companies and technologies, safeguarding the public and conforming to national laws (MoFEP, 2011).

In Ghana there is a framework to enable and guide investment from the public and private sector. Although many of these frameworks include provision for M&E, reports are either not readily available or do not exist, so it is unclear if these frameworks or M&E activities are being implemented.

2.1.6 Service standards

Nationally, monitoring is poorer in urban sanitation than in other sectors (WSP, 2011). This was meant to be addressed by the Water and Sanitation Monitoring Platform (WSMP), which was set-up to assemble, analyse, repackage and disseminate all relevant water and sanitation data (WSP, 2011). This platform seems to be obsolete as the latest data on the website is from 2010. Even after WSMP was established there was no agreement on sector indicators or harmonisation of definitions (WSMP, 2009; WSP, 2011). Information on urban sanitation at a city level is difficult to access; this includes basic data on coverage, functionality and investment. Although sector wide annual reports are supposed to be available, these could not be found. Therefore consolidated reporting of outputs are missing and data can only be obtained at agency level. A framework for M&E in the sector is highlighted in NESSAP (MLGRD, 2010b), but there is no evidence that this has been implemented.

Presently there is no credible provider-based data for access and coverage in the sanitation sector, so Ghana Statistical Service (GSS) data has to be used. There is no systematic monitoring of the number and quality of facilities at households or equity within this sector (WSP, 2011). As noted in Section

2.1.4 there is a lack of institutional ownership of monitoring and evaluation in Ghana, which means these data is lacking from reports (KMA, 2015i).

Records are kept by KMA from different parts of the sanitation service chain i.e. fees are collected from those connected to sewers and the number of tankers entering the septage treatment plant are recorded etc. (KMA, 2015c,f). These records are not in the public domain and there is limited analysis of the data collected (e.g. KMA, 2014c, m-n).

As noted in 2011 by WSP there is a lack of M&E in the sanitation sector, which Ghana has tried to address by multiple action plans, but this has not been resolved, possibly due to a the noted lack of budget and capacity (MLGRD, 2011; NDPC, 2010). When monitoring occurs there is a lack of evaluation and transparency as data can only be accessed via local agencies.

2.2 Planning

Nationally the main plans relating to excreta management are the: GSGDA 2010-2013 (NDPC, 2010) and NESSAP (MLGRD, 2010b). These are then translated into local plans, such as the Medium Term Development Plan for Kumasi (KMA, 2015a) and District Environmental Sanitation Strategic Action Plan 2008 to 2015 (DESSAP) (KMA 2008). It should be noted that 2015 is a transition period as the plans were designed to be implemented with the MDGs, so new local plans are currently being formulated.

2.2.1 Service targets

The goal of the ESP is for 90% of Ghanaians to have access to acceptable domestic sanitation and for 10% to have access to hygienic public latrines by 2020. (MLGRD, 2010a). An incremental approach is being applied and NESSAP calls for 75% household coverage by 2015 (MLGRD, 2010b). Furthermore this approach has been applied to improvements in the sanitation technologies as nationally they are using Incremental Service Improvement Options (ISIOs). Within this there is a push for implementing simplified sewerage (MLGRD, 2010b). A National Annual Progress Report for GSGDA produced in 2013 noted that those with access to improved sanitation increased from 13% to 14% from 2012-2013, which fell short of the 28% target for 2013 (NDCP, 2014).

In Table 2 strategies and targets in these plan and how have been adopted into the local context by KMA can be seen. Most of the local targets focus on containment. This is a reflection of the development agenda when they were authored, which was dominated by the MDGs. Local targets therefore do not reflect the evolved sanitation service chain in Kumasi i.e. the number of vacuum tankers and the presence of a septage treatment site.

Table 2: National and local sanitation strategies and targets

Authority	GoG		KMA
Year	2010-2013	N/A	2008-2015
Plan	GSGDA	NESSAP	DESSAP
Strategies and Targets	Promotion of low cost domestic latrines	Household toilet coverage of 75% by 2015 2,910 facilities for basic schools in rural, small and large towns and low income urban areas	Build 2,000 household latrines Construct 20 public toilets Rehabilitate 30 public toilets
	Improve treatment of wastewater	ISIOs Disposal sites to be operational by 2012	
	Promote the use of simplified sewerage	ISIOs promoting simplified sewerage	
	Improve the state and management of urban sewage systems	Rehabilitation of sewage systems	KMA to purchase 2 vacuum tankers
	Enforce bylaws	Enforcement of current laws	Enforcement of sanitation bylaws
	Strengthen PPP	Private sector involvement in public latrines and treatment processes, all desludging provided by private sector, training of private artisans	
	Promote cost effective and innovative technologies	ISIOs	
	Develop and M&E system for sanitation		
	Implement the Sanitation and Water for all Ghana Compact		

2.2.2 Investments

Ghana's eThekwini commitment was to spend at least 0.5% of its GDP on sanitation and hygiene, but in 2012 only 0.0002% of GDP was spent on urban sanitation (WaterAid, 2012). National spending on urban sanitation averaged US$ 7 million per year from 2008 to 2010, but this decreased in 2011, due to delays in projects and budget cuts (WaterAid, 2012).

The GSGDA calls for sustainable, predictable and adequate financing for sanitation (NDPC, 2010). The total cost of implementing NESSAP from 2011 to 2015 is estimated to be US$ 941,186,491. Approximately 18% of this budget is allocated to excreta management, while a majority of the budget is dedicated to solid waste management (MLGRD, 2011). This budget is provided by local government (58%), the users (21%), the private sector (13%) and the GoG (8%) (MLGRD, 2011). It is acknowledged that there is a finance gap of 65%, which is the responsibility of the GoG to fill. This is expected to be

financed via the Consolidated Fund, development partners, international direct funding, increasing the District Assemblies Common Fund, ring fencing funds for sanitation, and sourcing funds from sectors which benefit from sanitation (MLGRD, 2011).

The budget is to be spent in the following ways: ensuring private sector involvement under the management of the public sector (7%), implementing pro-poor improvements (31%), ensuring wastewater treatment facilities meet standards (5%), ensuring adequate systems for wastewater treatment and reuse (3%), ensuring accessible facilities are available (<1%), and seed funds for revolving loan home sanitation promotion (targeting the urban poor) (53%) (MLGRD, 2011).

Additionally through NESSAP the GoG are committed to establish Special Sanitation Funds for the five biggest cities which includes Kumasi, and a National Sanitation Investment Fund (MLGRD, 2010b). These funds are only now just being set up, so have not been available for use (SNV, 2015). Historically the GoG has been reluctant to release the funds promised to this sector (WaterAid, 2012, WSP, 2011). It is believed that this is the first sanitation investment plan that disaggregates excreta management, so previous budgets cannot be explored.

2.3 Reducing inequity

In Kumasi the urban poor are ill-defined and not readily identified by institutions; this is possibly due to the extent of mixed housing in most areas, although pockets of poverty have been identified (Section 1.5).

2.3.1 Current choice of services for the urban poor

In Kumasi the urban poor are heavily reliant on public toilets (Section 3.3) and different types of sanitation technology are being used (Section 3.4.3). A majority of the public toilets (54%) are now operated by the public sector under either build operate transfer (BOT), rehabilitate operate transfer or build operate own agreements (KMA, 2015n). The charge for using a public latrine ranges from 0.2 to 0.5 Cedes depending on technology type, the requirement for paper and if the user is a child (KMA, 2015e).The charges are set by KMA on a yearly basis and KMA collects a 15% surcharge on all public toilets (WSUP, 2014b). Public toilets are opened from 5 am to 10 pm (KMA, 2015e), but there are queues at peak periods (5.30-6.30 am) (WSUP, 2014b). Many of the private operators are also vacuum tanker operators (VTOs) (KMA, 2015e) and cost of emptying can be seen in Table 7. Once emptied the waste is taken to Dompoase septage treatment plant (Section 3.7).

The Clean Team (www.cleanteamtoilets.com) also serve the urban poor in Kumasi using a modernised version of bucket toilets/latrines. Although now outlawed, bucket latrines have been historically used since the colonial period in Kumasi (Amoako & Korboe, 2011). A description of the Clean Team technology can be found in Section 3.2.7. The household cost of this system and service is 35 Cedes per month and there are approximately 1,000 households using the system although user numbers fluctuate as the hardware is removed if payment is not made (Clean Team 2015a-b).

Presently KMA and the GoG are promoting the building and use of compound toilets. This has developed into KMAs "Toilets in Every Compound Scheme" which is being supported by WSUP. This scheme is targeting the urban poor and introducing two relatively novel technologies; prefabricated plastic septic tanks produced by Duraplast Ghana (Section 3.2.8) and the Biofil (Section 3.2.9). These technologies are listed with seven traditional technologies that households can choose to purchase using a financing scheme (KMA, 2014b).

As a majority of the urban poor are renting they have little influence on the sanitation facilities in their compound. The GoG and KMA's push for compound sanitation through the Toilets in Every Compound Program may increase household sanitation, but tenants' access to the facilities may be limited. This situation has been seen in a recent study of compound sanitation in Kumasi (Mazeau et al., 2014). Presently a majority use public toilets, which seem affordable and the quality of the facilities are improving due to private sector involvement. Restricted opening hours do however limit access. The Clean Team toilet seems to be affordable and acceptable to many, but it is yet to be seen if their business model is scalable and can standalone without its current subsidy. What is of interest is that a majority of the Clean Team users have switched from using public toilets (Clean Team, 2015b).

It could be concluded that the urban poor's present needs are partially met by a combination of public toilets and the Clean Team's toilets, which both seem to be affordable, appropriate and safe, but capacity needs to be increased due to the rapidly growing population.

2.3.2 Plans and measures to reduce inequity

There are measures in place in the legislature to ensure services reach the urban poor i.e. the control of the public toilet pricing by local government. There is also legislation in place to ensure the affordability of private sector services and to safeguard vulnerable groups (MoFEP, 2011).

Within NESSAP, excreta management sections state that LAs need to ensure services meet the needs of specific target groups including the poor. This developed into an initiative to improve 2,9100 school sanitation facilities in LIAs across the country (MLGRD, 2010b) and led to 31% of the excreta management budget in SESIP being used for a pro-poor school sanitation programme (MLGRD, 2011).

KMA has a five year program to increase the access to compound toilets for 100,000 residents in LIAs (under the Toilet in Every Compound Program) has its origins in NESSAP and DESSAP and has just started to be implemented. This five year strategy is being supported by WSUP and the Department for International Development (United Kingdom) (Mazeau et al, 2014). KMA, supported by WSUP also has a program to improve school sanitation in LIAs. Under an ongoing program they have built three and rehabilitated four toilet blocks, providing sanitation facilities to > 7, 500 pupils in LIAs (WSUP, 2015c).

2.4 Outputs

2.4.1 Capacity to meet service needs, demands and targets

As mentioned in Section 1.5 Kumasi has an annual population growth rate of 5.5% (City Population, 2015; World Bank, 2008). KMA's waste management budget increased by 3% from 2013 to 2014 (KMA, 2013, 2014a). Furthermore there were 347 public toilets in Kumasi in 2010 (Maoulidi, 2010) which increased to 359 in 2015 (KMA, 2015n). It seems unlikely that KMA will be able to meet the demands of its growing population. A decrease in coverage has already been seen in certain areas, due to the rapidly increasing population i.e. the percentage of the population with access to sanitation via sewers has decreased from 8% (GSS, 2013) to 4% (Section 3.1). In reality this increase in population will increase the reliance on public toilets, which will require more frequent emptying. From interviews with VTOs (motorised emptiers) they had on average two to three customers per day, while their maximum capacity is between five to eight customers per day (KMA, 2015g). An increase in emptying frequency has already been recorded as it was found that public toilets are presently desludged once or twice a month by vacuum tanker (KMA, 2015e), compared to once every six weeks in 2010 (Maoulidi, 2010). This increases the volume of faecal sludge going to the septage treatment plant. If the capacity of the septage treatment plant is assumed to be 450m^3 (Section 3.7) depending on mean volume of tankers discharging at the site (6.5m^3 or 7.5 m^3) the capacity of the present system will be reached by either 2017 and 2020. It is also probable that this growing population will lead to an increase in open defecation due to a lack sanitation facilities, unless more public toilet are built and bylaws are enforced on the provision of compound sanitation.

2.4.2 Monitoring and reporting access to services

As stated before there is limited monitoring of programs and facilities in Kumasi. Where data is collected (such as the septage treatment plant Section 3.7) the information is held by local agencies and is not publically available. Currently the only monitoring and reporting on access to service is via the census, the most recent one being undertaken in 2010.

2.5 Expansion

2.5.1 Stimulating demand for services

Software aspects are built into local programs. In the compound sanitation strategy uses marketing approaches to stimulate demand (KMA 2014b). In the national budget for sanitation, the public sector budget is predominately for capacity building (WSP, 2011).

2.5.2 Strengthening service provider roles

The GoG is providing a legislature to strengthen the role of service providers and to encourage private investment in the sector. Additionally NESSAP and SESIP provide a framework and budget for strengthening service providers which is then translated locally into the DESSAP and city level programs. The current programs in Kumasi includes the Toilet in Every Compound program (WSUP, 2014c; KMA, 2014b) which strengthens the sanitation markets This also applies to the Clean Team and School Sanitation programs. WSUP are working with VTOs (motorised emptiers) building capacity and aiding them to form and strengthen their professional association (WSUP, 2014a). KMA are

strengthening capacity in the public toilet sector by the development of an award program for the best public toilets at sub-metro and city level (KMA, 2015e).

3 Service Outcomes

Kumasi has a diverse sanitation technology landscape which includes onsite and offsite sanitation, with a well-developed collection system and the only septage treatment plant in the country.

3.1 Offsite technologies

The GSS shows that 8% of Kumasi's population is connected to sewers (GSS, 2013) which are decentralised separate sewerage systems. Approximately 102,000 people are served by these systems (Table 3). As the population has rapidly grown and these sewer networks have not been expanded, the percentage of the current population served by these systems has decreased to 4%. Only 80% of the sewage by this population goes to sewage treatment plants that are functioning (Table 3). No data was available on the volume of sewage going to each plant, as a majority of them are gravity fed. Therefore an assessment of whether they are functioning within their design capacity could not be made. It is known that the network and connections have not increased since they were built (KMA, 2015f), but the number of users per connection could have potentially increased. No current records of the effluent quality could be obtained, as they are not currently being monitored due to a lack of capacity and budget. Four of the sewage treatment plants were visited and observations were made of their functionality (Figure 3). It was concluded that these systems were partially treating the waste, as the effluent and influent were visibly different.

Maturation pond at Asafo Sewage Treatment Plant
Photo credit: Claire Furlong

Sludge drying bed at KNUST Sewage Treatment
Photo credit: Claire Furlong

Figure 3: Two sewage treatments plants visited

Table 3: Details of the sewage treatment plants in Kumasi

Sewage Treatment Plant	Sub Metro Served	Types of connections	Population served	Ownership and management	Technology	Functioning
Asafo	Subin	Households, 4 schools, public toilets, Polytechnic, Golden Tulip hotel[1]	50,000[3]	Owned by KMA operated by Environmental Engineering Ltd[1]	Pond system[1]	Yes[1]
Ahinsan Housing Estate	Asokwa	Households only[1]	6,500[3]	Owned by KMA operated by Environmental Engineering Ltd[1]	Pond system[1]	Partially[3]
Chirapatre Housing Estate	Asokwa	Households only[1]	6,000[3]	Owned by KMA operated by Environmental Engineering Ltd[1]	Pond system[1]	Yes[1]
4BN army barracks	Subin	The barracks only including living quarters.	About 2,500[3]	Owned and operated by the Army[3]	Pond system	No[3]
Komoto Anokye teaching hospital (KATH)	Subin	The hospital only including living quarters.	About 12,000[3]	Owned and operated by KATH[3]	Pond system	No[2]
KNUST (University)	Oforikrom	The older part of the campus including housing for students and staff	25,000[3]	Owned and operated by KNUST	Trickling filter	Yes[3]

[1] visits and interviews (KMA, 2015f, KNUST, 2015b), [2] Maoulidi, 2010, [3]data supplied by KMA

3.2 Onsite technologies

There is a highly diverse onsite sanitation technology landscape in Kumasi. It should be noted that there are differences in how different institutions define specific technologies, but the following definitions were finalised after discussion with stakeholders (KMA, 2015e, k-l). The technologies are also discussed in relation to how they are related to the categories used to generate the SFD.

3.2.1 Water closet (WC)

Within the context of the census a WC is used to mean a flushing (pour-flush or automatic flush) toilet with a waterseal, but no reference is made to the sanitation technology that it discharges to. In the

Kumasi context the waste is transported via a pipe to a tank outside of the facility, if it is not connected to a sewer (KMA, 2015e; WSUP 2015a). This tank is referred to as a septic tank in Kumasi an example can be seen in Figure 4. Most tanks have vents and it is thought that these tanks have varying number of chambers (normally >2). It was noted that the chamber numbers directly correlate to the number of lids on the tank (KMA, 2015e). This technology is used for both private (Table 4), public (Table 5) and institutional toilets (i.e. schools, Figure 9). The design of private septic tanks is left to the household or artisans who construct them. The design of public and institutional septic tanks is controlled by KMA and generally incorporates a soakaway, which is under the final chamber of the tank (Figure 4).

In terms of the SFD it is assume that all public toilet septic tanks are septic tanks with soakaways. For private septic tanks it is estimated that two thirds are septic tanks (containing chambers) with soakaways while one third are sealed tanks without soakaways. The latter is considered to be a sealed tank with no outlet in the SFD. It is estimated that a majority of these systems are emptied by VTOs and the faecal sludge is delivered to the septage treatment plant.

Photo credit: Claire Furlong

Photo credit: Claire Furlong

Figure 4: Public septic tank facility, Ayeduase Market, Oforikrom

3.2.2 Pit latrines

Pit (or basic) latrines are used at an institutional (i.e. schools, Figure 9) and private level (Table 4). In Kumasi they are normally unlined pits with a well-engineered superstructure at household level, due to mainly being found in middle class households (KMA, 2015j-k). If there is high usage and emptying is required in less than two years they can be emptied by VTOs (motorised emptying) as the faecal sludge is relatively fluid (KMA, 2015j). If they require emptying beyond every two years, then they are manually emptied, using labourers to dig out the drier thicker sludge (KMA, 2015j). In terms of the SFD this technology is classified as unlined and abandoned pits. This, together with the fate of the faecal sludge generated, was agreed upon with stakeholders (Table 9).

3.2.3 Improved latrines

The GSS classifies an improved latrine as one with only a vent pipe (GSS, 2015), including the Kumasi ventilated improved pit (KVIP) latrine (Figure 5). The KVIP is the only type of improved latrine installed as public or institutional toilets and it is the most common improved latrine installed in homes (due to

KMA programs). The designs and how it functions in private and institutional contexts differs (KMA, 2015i-l) and therefore it is considered to be two different technologies in terms of the SFD.

- At the household level a KVIP is a twin semi-lined pit system. One pit is used, while the other is resting. When the second pit becomes full the first pit is emptied. It takes over two years for the pit to fill (KMA, 2015j). Once emptying is required the material in the pit is like dry compost, this is then dug out manually and disposed of in the local environment or used in gardens (KMA, 2015j). Under the SFD this is considered to be an abandoned pit which is adequately covered in soil, as the contents are disposed of in the local environment, but deemed as being safe (Tables 8 and 9).
- KVIPs used in public and institutional toilets are sealed tanks with an air pipe. They are emptied by VTOs (motorised emptiers) and the faecal sludge is then taken to the septage treatment plant. In terms of the SFD they are classified as sealed tanks with no outlets that are emptied.

It should be noted that in Kumasi some basic pit latrines have vent pipes (KMA, 2015j), so may have been misclassified in the census

Inside a private KVIP in Asokwa
Photo credit: Claire Furlong

Outside a private KVIP in Bantama
Photo credit: Claire Furlong

Figure 5: Kumasi VIP Latrines

3.2.4 Aqua privy

The terms aqua privy, septic tank and *bomba latrines* are used interchangeably in Kumasi (Figure 6). The waste enters a sealed tank directly below the user interface via a chute or pipe which extends below the level of the effluent, which produces a seal (KMA, 2015e). They are not flushing toilets. Presently most of the chutes are missing, so no seal is present. These systems are emptied by VTOs and the sludge is taken to the septage treatment plant. This technology is only used at a public (Table 5) and institutional level in Kumasi (KMA, 2015e). In terms of the SFD these systems are considered to be sealed tanks that are emptied (Tables 8 and 9).

Photo credit: Claire Furlong

Photo credit: Claire Furlong

Figure 6: A public aqua privy facility, Bomoso, Oforikrom

3.2.5 *Enviroloos*

These technologies have been installed in schools (Figure 7) and public toilets (Table 5) only. Enviroloos are dry toilets with a sealed tank and an aeration system via a fan and vent pipe designed to aid the drying of the faecal material (Figure 8, KMA, 2015e). Due to high levels of usage the material in these sealed tanks is usually fluid (KMA, 2015e). They are emptied by VTOs (motorised emptiers) and the waste is taken to the septage treatment plant (KMA, 2015e,h). For the SFD these systems are classified as sealed tanks with no outlets that are emptied.

Photo credit: Claire Furlong

Photo credit: Claire Furlong

Figure 7: Public Enviroloo facilities Angola, Oforikrom

3.2.6 *Bucket latrines*

Buckets latrines/toilets are basically vessels that are emptied daily. These were introduced in Kumasi in the colonial period when collection was organised via the local government (Amoako & Korboe,

2011). This practice has been outlawed in Ghana since 2010. From the census data it would appear that this system is being used by < 1% of the population, hence this technology is not included in the SFD.

3.2.7 The Clean Team Toilets

These are moulded plastic toilet units which contain a barrel, which people use inside their house or rooms, as seen in Figure 8. The used barrels are hygienically exchanged three times a week at a cost of 35 Cedes per month (Clean Team, 2015a,b). There are two types of technologies (dry and wet), but both have urine diversion and the users need to dispose of the urine (Clean Team, 2015b). In the wet system the barrels contain 5 litres of a "blue chemical" and in the dry toilet the barrel contains 2 kg of saw dust. A majority of the households served (90%) are using the wet systems (Clean Team, 2015b). The full barrels are transported via motorised tricycle or truck to the septage treatment plant, where the barrels are emptied, cleaned and prepared for reuse (Clean Team, 2015b). The waste from the wet systems goes into a twelve chamber septic tank and then into the septage treatment system (KMA, 2015c). The dry waste is composted, but currently there is no demand for the product (Clean Team, 2015b).These systems have probably gained wide acceptance as logistically it is very similar to the bucket latrine system which until recently was widely used in Kumasi. There are currently 1,008 households using this system and with an average household size of four people (Section 3.4.1) this equates to 4,032 users (Clean Team, 2015b). As the percentage of the population using this technology is < 1% it is not included in the SFD.

Clean Team Toilet
Photo credit: Claire Furlong

Clean Team collection service
Photo credit: Claire Furlong

Figure 8: Clean Team service chain, Sawaba

3.2.8 Duraplast septic tanks

This is a plastic moulded septic tank produced by Duraplast in Ghana (www.duraplastghana.com). These have been introduced as a technology option under KMA's compound and school sanitation programs (KMA, 2014b), but currently are not commonly used in Kumasi. Therefore they are not included in the SFD.

3.2.9 Biofil

Biofil is a Ghanaian technology which uses macro-organisms such as worms and insects to break down faecal waste. It can be used dry or wet and is linked to a leach field or infiltration trench (www.biofilcom.org). Again this option has been introduced under the compound and school sanitation program (KMA, 2014b) and is not commonly used in Kumasi, so it is not included in the SFD.

3.3 Usage

The usage levels for the technologies explained in the previous sections can be seen in Table 4, together with the definition of the technologies from the census. With respect to WCs it can be assumed that 4% are connected to sewerage systems (Section 3.1) therefore 36% are connected to sealed and septic tanks (Section 3.2.1). No technologies are specified for public toilets in the census, but this is discussed in Section 3.4.3. The data used to generate the SFD is the census data from 2010 as it is the most recent, so was deemed to reflect the current situation more accurately.

Table 4: Usage levels for different sanitation types in Kumasi

Type of sanitation system	KMA, 2008 (%)	Census, 2010 (%)	Definition for Census
Private WC	33	40	WC is a system flushed by water
Private pit latrine	10	11	
Private improved latrine	Not included	7	A latrine which includes a vent pipe
Bucket latrine	12	<1	Pan or bucket which is removed for the disposal of waste
Public toilet	38	39	A public toilet is where members of the household use a communal or public facility
Other	Not included	<1	Any other technology which is not covered in the above criteria
No facilities	6	3	People are practicing open defecation
Sources of data	*Mazeau et al., 2014*	*GSS, 2013*	*GSS, 2015*

3.4 Categories of origin

3.4.1 Households

According to the census the average household size in Kumasi was four people (GSS, 2013), using the current estimated population of the city (Section 1.5) this would mean that there approximately 665,000 households in Kumasi.

3.4.2 Shared or communal toilets

Since 75% of Kumasi's population live in compound houses (multi-occupancy houses) (Amoako & Korboe, 2011), it can be assumed that a majority of the population that use private sanitation (58%, Table 4) are using a shared or communal facilities. No data is available on the number users sharing each private facility.

3.4.3 Public toilets

Kumasi has a long history of using public toilets, they have been implemented since the 1930s (WSUP, 2014b). The high usage in current times (39%, GSS, 2013) is thought to be due to: their historical use, the banning of bucket latrines, the high proportion of the population that rent (53%, GSS, 2013), lack of incentives or enforcement for landlords to provide compound toilets, and the reliance on local government on the revenue generated (WSUP, 2014b).

There are 359 functioning public toilet facilities, housing 5,792 toilet cubicles in the ten sub-metros (WSUP, 2015a). This data is supported by a more recent survey which found 359 functioning public toilets in the nine current sub-metros (excluding Asawase) (KMA, 2015n). This is a slight increase from the 347 that Maoulidi reported in 2010. The breakdown of the type of technologies is given in Table 5. It can be seen that overtime there has been an increase in the number of facilities have WCs and a decrease the number of facilities using non flushing technologies. This is due to KMA phasing out the

use of dry technologies in public toilets (KMA, 2015i; WSUP, 2014). The data that was used to generate the SFD can also be seen in Table 5. In this estimate it is assumed that the population is spread proportionally across the sanitation technologies listed.

Table 5: The breakdown of different sanitation technologies used in public toilets

Technology / Study	Aqua Privy (%)	WC[1] (%)	Basic latrine (%)	KVIP latrines (%)	EnviroLoo (%)	Unknown/ Other (%)
KMA, 2008	48	34	N/A	9	8	1
Maoulidi, 2010	51	25	1	16	7	N/A
WSUP, 2015a	48	39	1	6	6	N/A
KMA, 2015n[2]	20	49	<1	14	3	12
Data used for SFD[3]	23	57	<1	16	3	N/A

[1]WC is defined in Section3.2.1, [2]Excludign data from Asawase, [3]Scaled proportionally to include 12% of unknown

3.4.4 Institutional toilets

There were 1,075 institutional toilets in Kumasi in 2008 (KMA, 2008), which include toilets that are in educational institutions, prisons etc. A majority of institutional toilets are WC (63%), followed by KVIP (17%) and ventilated latrines (10%). Further details are discussed in the sections below.

Prisons

Kumasi central prison holds approximately 2,000 inmates (Omgghana.com, 2013). From the WSUP survey of public toilets it is known that there are 46 WCs, 14 aqua privies and 7 KVIPs in the prison run under a BOT agreement (WSUP, 2015a). They also have their own vacuum tankers which are emptied at the septage treatment site (KMA, 2014c, 2015m). As prisoners are counted in the census as being in Kumasi the data from these systems is incorporated into the SFD.

Military bases

Kumasi is the headquarters of the Northern Command of the Ghana Armed Forces the 4th Infantry Battalion that are housed in Complex and Uaddara Barracks (Adarkwa, 2011). These are served by the 4BN sewage treatment plant (Section 3.1). People living in the barracks are included in the census therefore included in the data used to generate the SFD.

Educational Institutions

Kumasi is an educational hub, the Millennium Cities Initiative reported that there was 649 public pre-primary, primary and junior high schools, two public universities, one medical school and a polytechnic in the city (Millennium Cities Initiative, 2015). There were also about 1,500 private educational institutions (Millennium Cities Initiative, 2015).

Kwame Nkrumah University of Science and Technology (KNUST) has an enrolment of 23,591 students (KNUST, 2015a) and its own sewage treatment plant, as does Komoto Anokye teaching hospital (KATH) (Section 3.1). Kumasi Polytechnic is connected to the Asafo simplified sewerage system (KMA,

2015f). It is thought the other tertiary institutions have WCs. These tertiary institutions are partially accounted for in the SFD due to staff and students living onsite. Students and staff living in Kumasi would be included, due to their inclusion in the census data.

As data on the number of schools in Kumasi is outdated and little was known about the sanitation situation a phone survey was commissioned (KMA, 2015o). It was found that there are 1,457 private and public schools in Kumasi (Table 6). A total of 645 schools were contacted by phone, 200 public and 445 private schools (KMA, 2015o). It was found that 84% of private schools have WCs and 6% have no facilities. Only 64% of public schools have toilets facilities, the breakdown of the technologies used can be seen in Figure 9.

Table 6: Number of public and private schools in Kumasi (KMA, 2015o)

	Public	Private
Preschool	157	
Primary	203	670[1]
Junior high school	186	187
Senior high school	21	33
Total	567	890

[1]in the public school system all primary and preschools are combined.

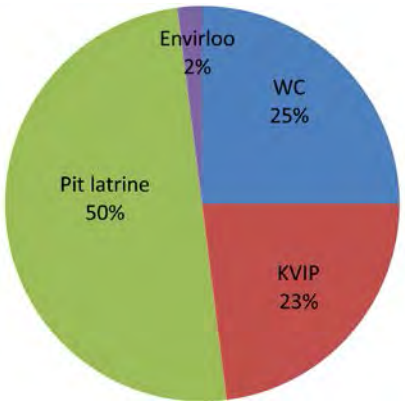


Figure 9:The types of sanitation systems used in public schools in 2015 (KMA, 2015o)

There is a huge school aged population in Kumasi (which is taken to be 3 to 18 years) accounting for 35% of the population (GSS, 2013). 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. To include the flow of excreta from schools 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.

Hospitals

There are eight hospitals in Kumasi (Millennium Cities Initiative, 2015), the largest being Komoto Anokye teaching hospital (KATH) which has over 1,000 beds (Adarkwa, 2011) and its own sewage treatment plant (Section 3.1). The others are reliant on tank based systems such as aqua privies and septic tanks which are emptied by VTOs. The faecal sludge is then taken to the septage treatment plant. Although those seeking treatment in hospitals may come from outside the city boundary, they would represent < 1% of the current population, hence no adjustment in the SFD was made.

Restaurants and hotels

The number of hotels in Kumasi is estimated to range from 30 (KMA, 2006) to over 100 (Briggs, 2014). It is thought that half of the tourists who visit Ghana visit Kumasi (KMA, 2006) and most current data for external tourist is 931,000 (World Bank, 2010). It is estimated that on average these tourists spend 3 days in Kumasi, which equates to <1% to the population annually. So no adjustment was made to the SFD. It should be noted that a majority of hotels and restaurants have septic tanks, which are emptied by VTOs

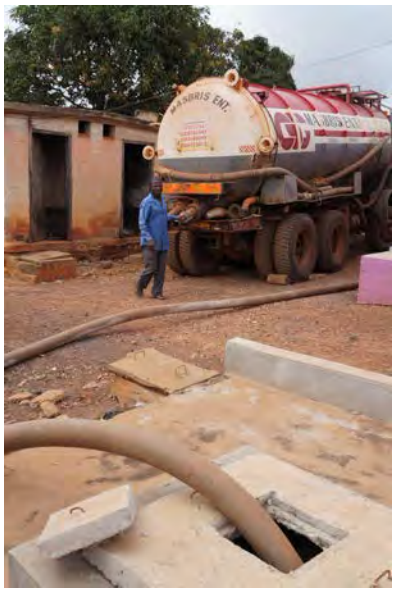
3.5 Motorised Emptying

It has been estimated that close to 90% of the residents of Kumasi have utilized the services of vacuum tankers (motorized emptying) either indirectly thorough public toilets or directly by households having their homes or compounds toilets emptied (WSUP, 2014a). Examples of motorised emptying in Kumasi can be seen in Figure 10. VTOs are registered with KMA and 42 companies and institutions have vacuum tankers (KMA 2014c, m). The vacuum tankers have a standard customer fee depending on their volume, which is set by KMA (Table 7). They are then charged a standard tipping fee at the septage treatment plant depending on tanker volume (Table 7). As there is a good system and management of the VTOs it is estimated that 95% of the waste collected is delivered to the septage treatment plant.

Table 7: Vacuum tanker criteria and fees charged (KMA, 2015c)

Criteria	Volume (m^3)	Customer fee (Cedes)	Tipping fee (Cedes)
Small	<5	200	10
Medium	5-6	225	15
Large	>6	250	20

Empting a private septic tank in Nhyiaeso
Photo credit: Claire Furlong



Empting a public septic tank in Bantama
Photo credit: Claire Furlong

Figure 10: Motorised emptying in Kumasi

3.6 Manual Emptying

Manual emptying in Kumasi is very clandestine, although it is acknowledged that it exists (KMA, 2015d). As only a limited number of the population rely on basic latrines (Table 4), it is therefore possible that there are only a few manual emptiers in Kumasi. Additionally latrine owners can use vacuum tankers for emptying their systems, which as the advantage of not damaging the superstructure (this is known to occur during manual emptying) (KMA, 2015j). From discussion with KVIP users it is known that they use general labourers rather than specialised manual emptiers to empty their latrines, but the waste emptied is then either disposed of or reused in the local environment (KMA, 2015j).

3.7 Treatment, end-use and disposal

All of Kumasi's septage should be received at Dompoase septage treatment plant (Figure 11), which was built in 2004 (Mensah, 2006; KMA, 2015l). It also receives leachate from the neighbouring landfill and industrial liquid waste (KMA, 2015c). Documentation on the design of the system shows the design capacity to be 300 m^3 for sludge and 308 m^3 for leachate (KMA, 2015l), although it is thought that this was increased to 450m^3 for sludge in the final construction (KMA, 2015l).

Photo credit: Claire Furlong
Figure 11: Dompoase Septage Treatment Plant

The system comprises of six anaerobic ponds in two parallel streams of three each that connect to one facultative pond, which is followed by two maturation (aerobic) ponds. The first pond of each stream receives septage alternatively to facilitate desludging (KMA, 2015c).The system is currently short circuiting as the containment of one of the anaerobic ponds is breached. The effluent from this pond is discharging into the storm water system and then enters an adjacent stream without treatment (KMA, 2015c). The reason for this is the lack of budget for operation and management of the facility (KMA, 2015c). Desludging has only occurred once since the septage treatment was built (KMA, 2015c). The final destination of the effluent is the Ofin River (KMA, 2015c). The effluent quality from the ponds is not currently monitored due a lack of technical staff (KMA, 2015c). The effluent does not conform to local or national standards, but it was acknowledged that the waste is being partially treated and receives more treatment than septage in other cities in Ghana (KMA, 2015c).

The plant opens from 6 am to 6 pm, 7 days a week including public holidays (KMA, 2015c). The weighbridge at the site has not been functioning for two years, so there are only estimates for the amount of septage and liquid waste entering the site. From the records at the septage site it could be seen vacuum tankers made 18,609 trips in 2014 (KMA, 2014c). This equates to 51 tankers per day delivering approximately 331 m^3 of septage (assuming tankers are full of septage) to Dompoase septage treatment plant, which is above the documented capacity of the plant, but below the capacity which the plant is believed to have.

From questioning vacuum tanker drivers when leaving the septage treatment plant over a two and a half day period, it was found that nearly all of the waste being deposited was septage (only one tanker out of 152 trucks was depositing industrial liquid waste). As the VTOs mentioned during the stakeholders meeting, they also collect liquid waste from beyond KMA's boundary, but it was found that 80% of waste deposited is from within KMA's boundary (KMA, 2015h). From the breakdown of the origins of the septage generated (in KMA's boundary) it was found that 5% comes from institutional toilets, 38% from public toilets and 57% from household toilets (*n=120*) (KMA, 2015h). Interestingly all of the liquid waste collected from household toilets comes from flushing (wet) systems (i.e. septic tanks) and none comes from dry systems, bit approximately 40% of the faecal sludge from public toilets comes from dry systems. This suggests that a majority of the dry household toilets (used by 18% of the population) are emptied manually, which is supported by interviews with the users of KVIPs in Kumasi (KMA, 2015j). It is assumed that 9% of household dry systems are emptied manually in the SFD (Tables 8 and 9).

During two full days of monitoring, a total of 59 and 71 vacuum tankers entered each day. It was acknowledged by the vacuum tanker drivers that this was a quiet time of the year, but this is above the 2014 daily mean of 51 tankers and above the current daily mean for 2015 of 48 tankers (KMA, 2014c, 2015h,m). When the size of the tankers was assessed, using the sizing categories of $6m^3$, $9m^3$, or $11m^3$, just over half of the tankers were $6m^3$ or below, whereas 31% were classified as $9m^3$ and 14% as 11 m^3. Using these estimations the mean size of the tanker is above 7.5 m^3, higher than the official mean tanker size of 6.5 m^3. This has significant impact on the potential loading of the treatment system. This is modelled in Figure 12, which uses data from the first six months of 2015. It can be seen that the maximum capacity of the system is exceeded on three days when the official mean tanker volume ($6.5m^3$) is used (Scenario 1), but when a higher mean tanker volume is used the maximum capacity is exceeded 30 days out of 180 days (Scenario 2). When the lower septage treatment capacity is considered ($300m^3$/day) and the official tanker volume used ($6.5m^3$) the capacity of the septage treatment system is exceeded over half of the time (Scenario 3).

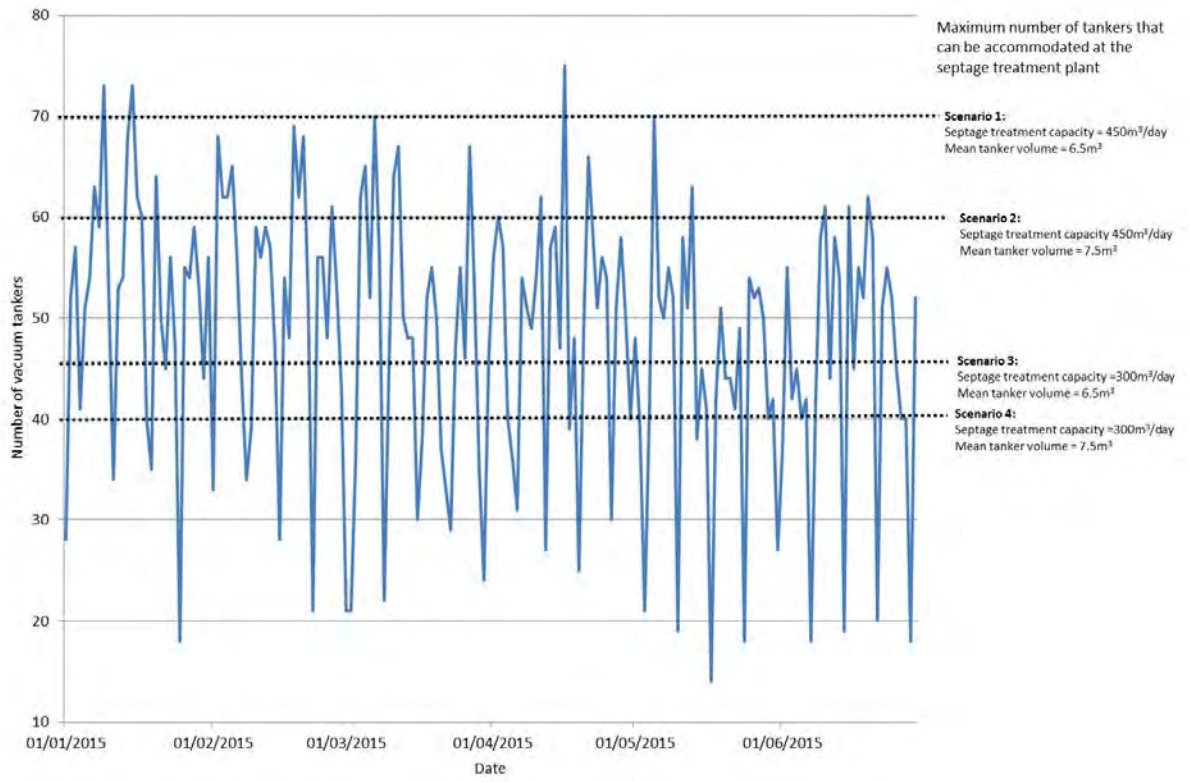


Figure 12: The number of vacuum tankers discharging at Dompoase Septage treatment plant over six months in 2015, compared to the maximum number of tankers that can be accommodated under four different scenarios

It can be seen that the septage treatment plant is operating at close to, or above its current capacity. While there is no effluent monitoring and the system is short circuiting, but as some treatment occurs, it is assumed septage treatment plant was partially treating waste for the purpose of the SFD (Table 8).

It should also be noted that the Clean Team have explored the use of product derived from human excreta and found that currently there is no local market for these products (Clean Team, 2015b). Additionally the wastewater and sludge from the septage and sewage treatment plants visited (KMA, 2015c,f; KNUST, 2015b) were not being utilised by local farmers. The septage treatment plant has a plan to introduce fish to their aerobic ponds and start fish farming (KMA, 2015c), this is unofficially happening at one of the sewage treatment plants (KMA, 2015f).

3.8 Drinking water supplies in the city

The piped water supply for the city is obtained from surface water such as the Offin and Owabi Rivers (Maoulidi, 2010). There are two water intake points one at Owabi (10 km from the city) and the other at Barekese (19 km from the city) (KMA, 2006; Maoulidi, 2010). The abstracted water is treated at the Owabi and Barekese Water Treatment Plants (KMA, 2006; Maoulidi, 2010). Over two thirds of the city's population use piped water for their main drinking water source (GSS, 2013).

3.8.1 Ground water pollution assumptions

From the data presented in Section 1.3, a conservative estimate is that the stabilized water table is <5 meters. Less than 25% of sanitation is either <10 meters from, or uphill of ground water sources. This is due to the high usage of public toilets (Section 3.4.3), whose construction is well regulated by KMA. Furthermore few ground water sources are used for drinking water in Kumasi (Section 3.8). It is estimated that up to 1-25% of drinking water is produced from ground water, as 66% of the population gain their drinking water from a piped supply, which originates from surface water (Section 3.8). Using these data a low ground water pollution risk was generated by the SFD matrix.

4 SFD Matrix

The data from Section 3 has been collated in Table 8. Assumption made were negotiated and agreed upon with stakeholders (KMA, 2015k). The data from Table 8 was then transposed into Table 9, which was used to generate the SFD found in the Executive Summary and Appendix 4. The SFD includes only technologies that are used by >1% of the population and flows that are >1% of the total. The flows at all stages of the sanitation service chain are rounded so the total at each stage is 100%.

The assumption which is not explained in Tables 8 and 9 is the use of 95% throughout for emptying rates. This is used to acknowledge that in real life nothing is 100%, as discussed and agreed by stakeholders (KMA, 2015k). This figure was also used for the delivery to treatment. As the effluent from the sewage (Section 3.1) and septage treatment plants were both deemed to be partially treated, the percentage of treatment (Table 8) was negotiated with the primary stakeholders in this process (KMA, 2015k).

Additionally the tool 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 it has been disregarded. This was done to more accurately reflect the sanitation service chain in terms of faecal sludge movement. It was felt that the inclusion of the infiltrate would detract from this.

4.1 Levels of uncertainty

The main uncertainty in the data is the reliance on census data for technology types used to generate the SFD. This is because the city is rapidly developing and the census data was from 2010 (GSS, 2013). Little is documented on the sanitation realities in LIAs, due to these areas being poorly defined. There was a lack of primary data collected from service users and providers in these areas.

Table 8: Data from Section 3 used to generate the SFD

GSS data	%	Further breakdown	%	How defined SFD	% Emptied	% Going to treatment	% Treated	Notes
No facilities	3		3	Open defecation	-	-	-	
Private WC	40	Sewered	4	Decentralised foul sewer – separate sewer	-	95	50	Explained in Section 3.1
		Septic tank	24	Septic Tank outlet to soakaway	95	95	50	Household septic tanks with soakways
			12	Sealed tank with no outlet no overflow	95	95	50	Household septic tanks without soakaways
Private pit latrine	11	Basic latrine	5	Unlined pit with no outlet no overflow	95	60	50	3% emptied and going to treatment 2% released into the environment
			6	Abandoned and covered in soil	-	-	-	1% abandoned safely 5% emptied by manual labourers and disposed of safely
Improved pit latrine	7	Improved pit latrine	2	Lined pit with semi permeable walls open bottom with no outlet no overflow	95	50	50	1% are emptied by vacuum trucks and taken to treatment 1% released into the environment
			5	Abandoned and covered in soil		-	-	1% abandoned safely 4% emptied by manual labourers and disposed of safely
Public toilets	39	Aqua privy	9	Sealed tank with no outlet no overflow	95	95	50	
		Septic tanks	23	Septic tank outlet to soakaway	95	95	50	
		Basic latrine	<1	N/A to low	-	-	-	
		KVIP	6	Sealed tank with no outlet no overflow	95	95	50	
		Enviroloo	1	Sealed tank with no outlet no overflow	95	95	50	

Table 9: Data used to generate the SFD

SFD category	%	% Emptied	% Going to Treatment	% Treated	Notes
Open defecation	3	-	-	-	
Decentralised foul sewer – separate sewer	4	-	95	50	
Septic Tank outlet to ground	47	95	95	50	24% private 23% public
Sealed tank with no outlet no overflow	28	95	95	50	12% private septic tanks 9% public aqua privies 6% KVIP 1% Enviroloos
Lined pit with semi permeable walls open bottom with no outlet no overflow	5	95	50	50	Household basic pit latrines: 3% emptied and going to treatment 2% released into the environment
Unlined pit with no outlet no overflow	2	50	50	50	1% emptied and going to treatment 1% released into the environment
Abandoned and covered in soil	11	-	-	-	1% abandoned safely 5% emptied by manual labourers and disposed of safely 1% abandoned safely 4% emptied by manual labourers and disposed of safely

5 Stakeholder Engagement

Permission to undertake this research was gained from the Mayor of Kumasi. On arrival an initial meeting was held with the Waste Management Department of KMA who are the primary stakeholders and collaborative partners in this project (KMA, 2015b). This meeting was attended by the Head of the Waste Management Department, their deputy, the Head of Sanitation and the Research & Development Manager (KMA, 2015b). This led to the planning of a stakeholder engagement meeting; held in the second week of the field trip (KMA, 2015d). This was arranged through KMA and the participant list and a photo of the group can be found in Appendix 3. During this meeting the concept of SFDs was explained as was the type of data required. The stakeholders then plotted the activities they and others in Kumasi were involved in, onto the sanitation service chain (Figure 13). This was then used to agree collectively on a plan to collect the data. At the end of the field work phase an exit meeting was held with two main stakeholders the Waste Management Department at KMA and WSUP (KMA, 2015k). In this meeting the research gaps were highlighted, the research findings were discussed, and the draft SFD was explained and negotiated (KMA, 2015k). This was highly valuable initiated the process of finalising the SFD.

Stakeholder	Details	Containment	Emptying	Transport	Treatment	Reuse & Disposa
Kumasi Municipal Assembly	Local Government					
KNUST	University					
KNUST STP	University sewage treatment plant					
JSO	Septage treatment plant operators					
Environmental Engineers Ltd	Sewage treatment plant operator					
Vacuum Truck Operators	Trade Association					
JSE/GAPO						
Water and Sanitation for the Urban Poor	NGO					
SUB METROS	Local Government					
Public Health Office	Local Government					
Clean Team	Private Operator					
The Community	Users					
Environmental Protection Agency	Government					
Schools	Users					
Institutions	Users					
KATH - hospital with STP	Users to technology management					

Figure 13: Stakeholder involvement in the the sanitation service chain in Kumasi (KMA, 2015d)

5.1 Key informant interviews

Unstructured key informant interviews held are listed in Table 10, showing the topics covered. Most were undertaken in conjunction with unstructured observations. The value of using unstructured interviews meant that secondary data and changes in the current situation could be checked and observations triangulated. The interviews also opened up dialogue with stakeholders for further secondary data collection, such as the release of internal data and reports. An example of the value of interviews was in understanding how dry technologies are emptied, this was done through interviews with high level stakeholders (KMA, 2015b), then cross-checked with user interviews (KMA, 2015j), unstructured observations (KMA, 2015g) and informal discussions with vacuum tanker drivers (KMA, 2015h).

Table 10: Details of unstructured interviews

Key informants	Role	Topics covered
Mr Antony Mensah	Head of Waste Management at KMA	General information on KMA, the planning and design parameters of the septage treatment plant, sanitation policy, programs etc.
Mr John Donkor	Head of Sanitation at KMA	General information on KMA, sanitation legislation, school sanitation, public toilets, technology types and definitions.
Ps Michael Morrison Nyarko	Manager of the septage treatment plant	Details on the operation and processes at the septage treatment plant and VTO
Ms Asantewa Gyamfi Other Clean Team staff	Technical Manager of the Clean Team	Clean Team technology and business model
Mr Samwel Adjei	Program Manager WSUP	Current situation in Kumasi and present programs they are involved in (WSUP,, 2015b)
Mr Abu Suleyman	Plant manager for Environmental Engineering Ltd	Working of Asafo, Ahinsan and Chirapane sewage treatment plants
Clean Team customers (*n=11*)	Users of Clean Team technology	Household size, type of technology and what they swapped from
Vacuum truck drivers (*n=3*)	Emptiers	Technology type normally emptied, type of customers i.e, number of trips made today, max number of trips, busy periods of the year, typical customer base etc.
Vacuum truck customers (*n=3*)	Users and vacuum truck customers	Number of toilets, types of technology, frequency of emptying, if they use the same company, etc.
Public toilet managers (*n=11*) and local public health workers (*n=3*)	Operators	Discussion and clarification on the definition on technology types, how emptied and frequency of emptying
Dry toilet users (*n=5*)	Users	Number of toilets, number of users, when built, when emptied, how emptied etc.

5.2 Focus group discussions

Focus group discussions (FGDs) were not undertaken due to the difficulty in organising them. The major constraint was time as the researcher was only in the city for four weeks. Most user groups and associations meet once a month and at the weekend. Additional observations with unstructured interviews were undertaken.

5.3 Observation of service providers

Observations of service providers were undertaken at several points along the sanitation service chain, these are described in Table 11. The observational data was used to cross-check primary data collected through interviews and secondary data. An example of this was defining the technologies used in public toilets. Data from KMA (KMA, 2015n) and WSUP (WSUP, 2015a) were cross-checked through observations and interviews (KMA, 2015e), these data were then used to classify the technologies in the SFD (KMA, 2015k).

Table 11: Observation of service providers

Activity	Details
Clean Team Shadowing in Sawaba	Shadowed a payment collector with staff from the Clean Team – Interviewed users and made observations of the community, which included a school
Visits to septage treatment plant in Dompoase	Visited the septage treatment plant at the landfill in Dompoase and the Clean Team facility. Combined with an interview with staff.
Visits to Asafo, Ahinsan and Chiraptre decentralised sewage treatment plant	Visited sewage treatment plant at the landfill in Dompoase. Observed the treatment plants. Combined with interviews on site and visit to the management kiosk at Asafo
Public toilet visits in Oforikorm sub-metro	Visited 10 public toilets in Oforikorm with local public health officers. Observation of technology types, cost and states of facilities. Combined with interviews with sub-metro public health workers and public toilet managers.
Shadowing of vacuum tankers drivers.	Shadowing of three vacuum trucks from Dompoase to their customer, observations made on the types of systems emptied and how they were emptied. Combined with interviews with vacuum truck and interviews with customers.
Visits to users in Atonsu Old Town and S-line	Observations on the technology type and state the facilities, combined with interview with users.
Vacuum tanker survey at Dompoase septage treatment plant	Over two and a half days every vacuum truck driver a survey was undertaken to find out the following information: company, sub-metro where they collected the waste, volume of tanker, type of effluent, type of location they collected the waste at, whether the toilets were wet or dry and the type of sanitation technology.

The main advantage of collecting primary data was in getting a better understanding of how technology terms are used in Kumasi and what is meant by different stakeholder by the terms used. This enabled the systems to be classified more accurately in the SFD, it is doubtful that this would have occurred without interviews with public health workers (KMA, 2015e), direct observations (KMA, 2015e, j) and on-going dialogue with staff at KMA (KMA, 2015i-k).

6 Prospects for uptake and use of this study

Kumasi Metropolitan Assembly's Waste Management Department believe this is a useful document and process which will be used in the following ways:

- Provides a current baseline of sanitation situation in Kumasi
- Inform specific and city wide strategic sanitation intervention planning
- Inspiring academic research at undergraduate and post-graduate levels
- Source of information for research institutions and consultants
- Aid with the development of lectures

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KMA. 2015d. Stakeholders meeting organised by the Waste Management Department. 12/8/2015

KMA. 2015e. Public toilet visits and interviews. 18/8/15

KMA. 2015f. Visit to sewage treatment plants and interview with Mr Abu Suleyman (Environmental Engineering Ltd) 19/8/15

KMA. 2015g. VTO shadowing, interviews with VTO drivers and customers with Mr Charles Mensah. 20/8/15 & 25/8/15

KMA. 2015h. VTO survey at Dompoase. 21-22/8/15 & 24/8/15

KMA. 2015i. Interview with Mr Donker. 24/8/15

KMA. 2015j. Visits and interviews with dry sanitation users with Mr Charles Mensah. 24/8/15

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Appendix 1: Stakeholder identification

Name of organisation	Name of contact person	Position	Source of contact	Influence (high/medium/low)	Interest (high/medium/low)
Bantama Sub Metro	Mr Erie Abogogle Mansah		Mr Anthony Mensah	High	Medium
Clean Team	Ms Yankieke Stomp	Intern	Asantewa Gyamfi	Low	Medium
Clean Team	Ms Asantewa Gyamfi	Head of Clean Team	KNUST	Low	High
Clean Team	Mr Kofi		Asantewa Gyamfi	Low	Medium
Clean Team	Abigail Aruna		Mr Anthony Mensah	Medium	High
Clean Team	Ian Parks		Mr Anthony Mensah	Medium	High
Enviromental Engineering Ltd	Mr Abu Suleyman	Sewage Treatment Plant Operator	Mr Anthony Mensah	Medium	Medium
Enviromental Engineering Ltd	Mr Kofi Thompson	Sewage Treatment Plant Operator	Mr Anthony Mensah	Medium	Medium
J. Stanley Osusu & Co	Mr Antony Adukpo	Landfill Operator	Mr Anthony Mensah	Medium	Low
KMA	Mr Charles Mensah	Community Officer	Mr Anthony Mensah	High	Medium
KMA EHO	H.O. Amabnwe		Mr Anthony Mensah	High	Medium
KMA EHO	E. D. Sanche		Mr Anthony Mensah	High	Medium
KNUST	Dr Kwabena B Nyarko	KNUST	Sam WEDC	Medium	Medium
KNUST	Mr Ofoshuene Joshu	RA KNUST	Dr Kwabena B Nyarko	Low	Medium
KNUST	Dr S Oduro Kwarteng	Lecturer/Researcher Wastewater	Mr Anthony Mensah	Medium	Medium
Kumasi Sanitation Assoicaiton	Kofi budn		Mr Anthony Mensah	High	Medium
Kumasi Sanitation Awareness Assoication	Mrs Rosemary Ninkaabs	N/A	Mr Anthony Mensah	Medium	High
Kumasi Sanitation Awareness Assoication	Mr Orwsu Takyi	N/A	Mr Anthony Mensah	Medium	High
Mayor of KMA	Hon. Kojo Bonsu	Mayor of Kumasi	Mr Anthony Mensah	High	Unknown
Oforikorm sub-metro	Mrs Unis Crunchie	Head of Town Council Oforikrom	Mr John Donkor	High	Medium
Oforikorm sub-metro	Did not get their name	Public Health Officers	Mr John Donkor	High	Medium
Oforikorm sub-metro	Did not get their name	Public Health Officers	Mr John Donkor	High	Medium
Oforikorm sub-metro	Did not get their name	Sanitation Officer	Mr John Donkor	High	Medium
Subin Sub Metro	Mr Opolen Abdin		Mr Anthony Mensah	High	Medium
Vacuum Truck Operators Assoication	Mr Michael Asamoah	VTOA and owner OP'SKI	Mr Anthony Mensah	High	Medium
Vacuum Truck Operators Assoication	Mr Kojo Asarne	VTOA and owner of Europal San	Mr Anthony Mensah	High	Medium
Vacuum Truck Operators Assoication	Mr Akwasi Afrane	VTOA and owner of Afrane Sanitation	Mr Anthony Mensah	High	Medium
WMD/KMA	Mr Anthony Mensah	Head of WMD in KMA	Rebecca WEDC	High	High
WMD/KMA	Augustina	Head of Research		Med	Medium
WMD/KMA	Prosper Kotoko	Depty Director		Med	Medium
WMD/KMA	Ossei Asibbey	Unsure	Mr Anthony Mensah	Medium	Medium
WMD/KMA	Ms Doris Eyamfi		Mr Anthony Mensah	Medium	Medium
WMD/KMA	Mr Joeseph Charles Mensal		Mr Anthony Mensah	Medium	Medium
WMD/KMA	Mr John Donkor	Head of Sanitation		High	High
WMD/KMA	Ps Michael Morrison Nyarko	Landfill Manger	Mr Anthony Mensah	High	High
WSUP	Mr Georges Mikhael		Rebecca WEDC	High	Medium
WSUP- Kumasi	Mr Ebenizer Astugah		Mr Georges Mikhael	Medium	High
WSUP- Kumasi	Mr Frank Romeo Kettey		Mr Georges Mikhael	Medium	High
WSUP- Kumasi	Mr Samwel Adjei	Project Facilitator - Public Toilets	Mr Georges Mikhael	Medium	High
Zoomlian VTO + public toilets	Arthur Reagah	Zoom	Mr Anthony Mensah	High	Medium
Zoomlian VTO + public toilets	Kofi Selgyer	Zoom	Mr Anthony Mensah	High	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 assessmet through the corresponding data collection method	Date of Engagement	Purpose of Engagement	Maximum 100 word summary of outcomes
Mr Georges Mikhael (GM)	04/05/2015	Introduction of Claire	Introductory email
Mr Anthony Mensah (AM)	04/05/2015	Introduction of Claire	Introductory email
GM and AM	13/03/2015	Intro to method	Claire sent introduction email about method and data collection, asking for a date and time for an initial phone call
Anthony Mensah	13/05/2015	Replied to email	Set a date for first call first week in June
Anthony Mensah	03/06/2015	For introductory call	Date set 5th June
Anthony Mensah	05/06/2015	Introductory call	Introduced project and types of activates, asked about gaining permission and by-in suggested sending a letter to Mayor of Kumasi
Sam WEDC	05/06/2015	Meeting with Sam WEDC about KNUST	Met Sam to discuss his trip last week to Kumasi and to ask for introductions to KNUST, Clean Team and WSUP in Kumasi
Anthony Mensah	09/06/2015	Email confirm letter details	Confirmed what needed to be in the letter
Dr Nyarko KNUST	09/06/2015	Emailed introduction about project	Replied on 10/6/15 with introduction to Clean Team and saying I could stay at KNUST when I do my field work
Ms Gyamfi	10/06/2015	Emailed to introduction and asked about field work interview	Replied on 12/6/15 saying happy to be interviewed and happy for me to shadow a team member, sent info on user numbers
Hon. Kojo Bonsu	11/06/2015	Gain permission for field work	Email sent to KMA with letter and calling card for the Mayor
Dr Nyarko KNUST	10/07/2015	Accommodation KNUST	Emailed about Accommodation
Anthony Mensah	16/07/2015	Visa letter	Have visa letter from the Mayor
Anthony Menah	24/07/2015	Draft outline of work	Sent rought outline of work
Georges Mikhael	24/07/2015	Rebecca emails about Kuamasi	
Georges Mikhael	24/07/2015	Introducion to WSUP Kumasi	Introduction to Ebenezer Astugah, Frank Romeo, Samwel Adjei
Ebenzer et al	28/07/2015	Introduction of project	Sent the one pager and ask for phone number so could have a meeting
Anthony Mesah Meeting at KMA	04/08/2015	Introduction of project	Two hour meeting at KMA to discuss project and how they can help
Ms Asantewa Gyamfi	06/08/2015	Shadowing clean team	Half day shadowing money collectors in Sawaba - Interviews users and clean team
Mr Samwel Adjei	07/08/2015	Introductory visit	Discussed public toilet, compound toilet and school sanitation programs sending data
Ps Michael Morrison Nyarko	10/08/2015	Visit dompoase STP	KII - STP, visit and provided me with data for truck movements
Stakeholder meeting	12/08/2015	Stakeholders meeting	Discusssed scope of project, activities, identified people to help etc…
Ms Unis Crunchi (Leader Sub-Metro)	18/08/2015	Visit public toilets in Oforikrom	Visited 10 public toilets with sub metro PHO - observations and interviews
Mr Abu Suleyman	19/08/2015	Visited STP	Visited 2 STP and KII with Mr Abu Suleyman
John Donkor	20/08/2015	Shadowing VTO cancelled	Informal interview and fact checking
Ps Michael Morrison Nyarko	20/08/2015	Visit dompoase STP	To organise shadowing VTO and truck counting
Ps Michael Morrison Nyarko	21/08/2015	Truck counting started	-
John Donkor + Anthony Mensah	22/08/2015	Planning work and final meeting	Visit KMA to discuss and plan final work
Charles Mensah	23/08/2015	VTO shadowing	Shadowed two VTOs
Charles Mensah	24/08/2015	Interview households	
Anthony Mensah	09/09/2015	Negotiating drafts	Negotiating drafts and fact checking until the report was completed

Appendix 3: Stakeholders meeting

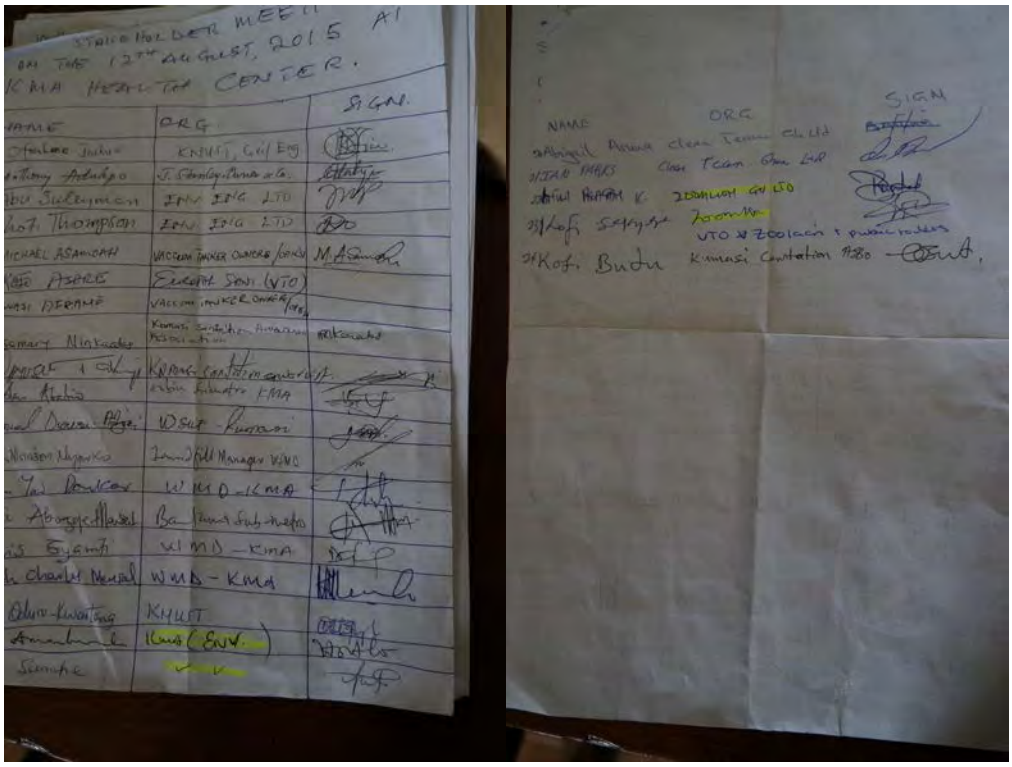

Photo of participant list (Photo credit: Claire Furlong)

Photo of stakeholder meeting participants (Photo credit: Claire Furlong)

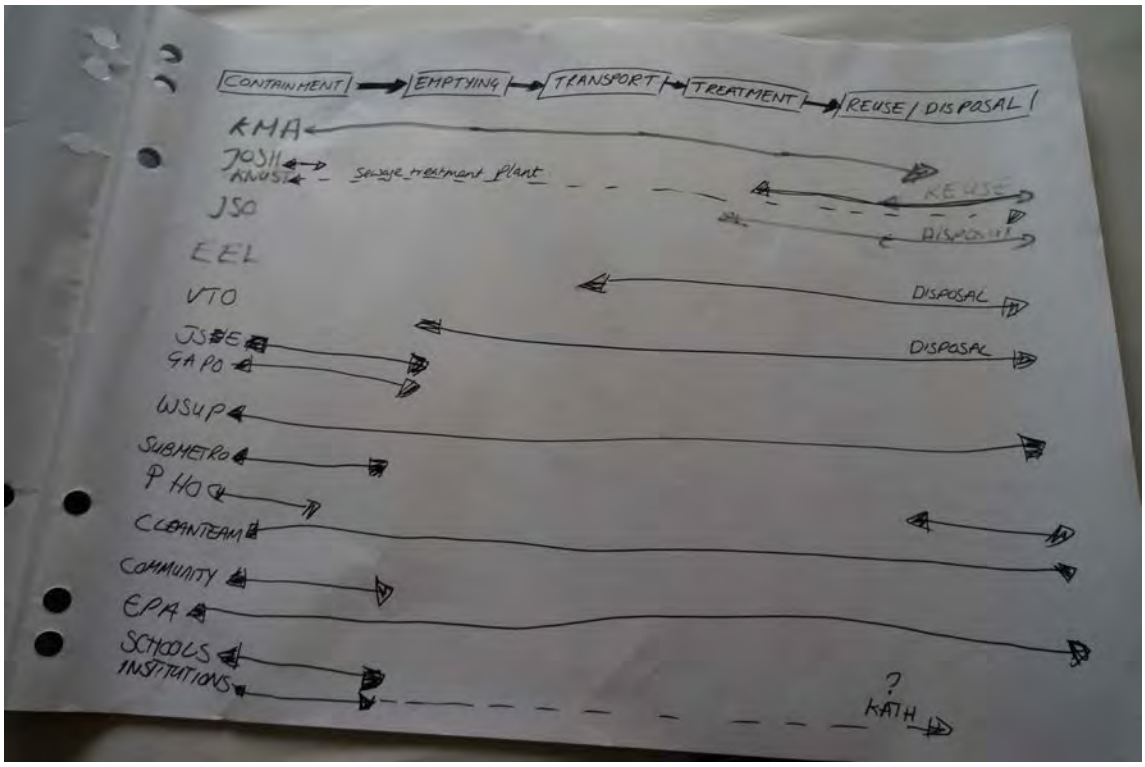

Photo of the mapping of stakeholders on the sanitation service chain (Photo credit: Claire Furlong)

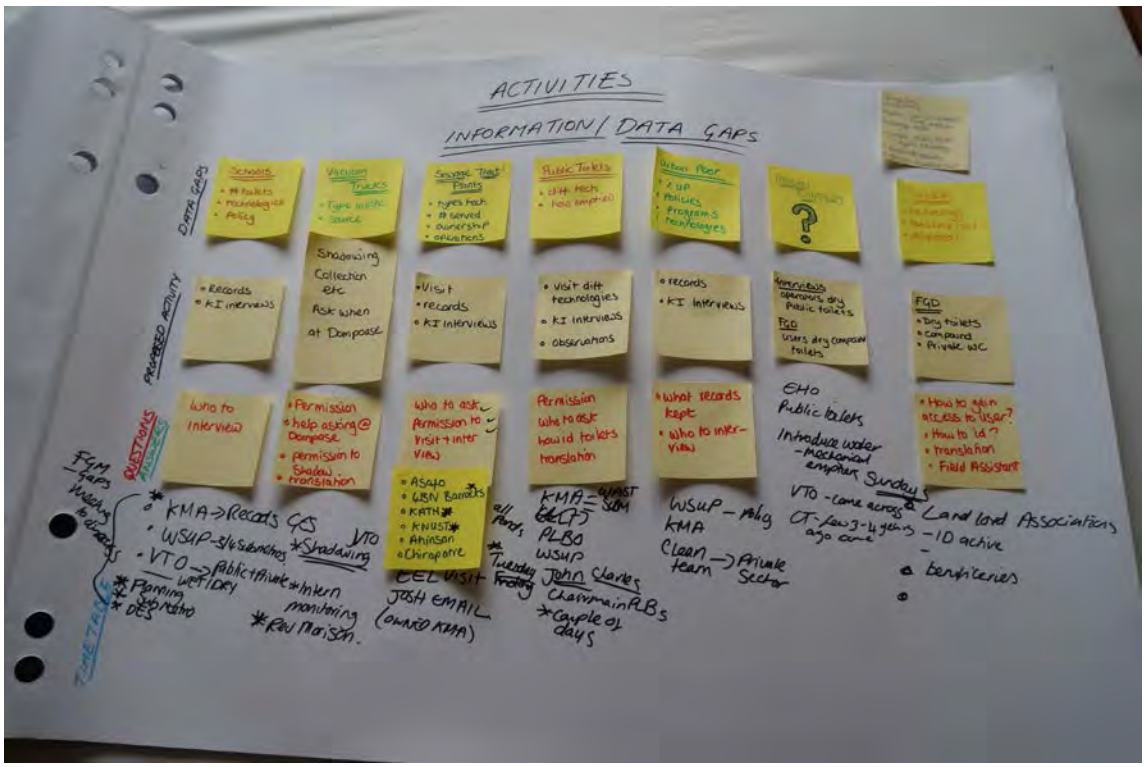

Photo of the work plan produced during the stakeholder workshop (Photo credit: Claire Furlong)

Appendix 4: Final SFD for Kumasi