Final report

jerry-can ltd

International Growth Centre

Assessing waste management services in Kigali

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jerry-can is a boutique urban planning research-and-action consultancy focusing on uncovering data insights and devising practical implementation strategies. We are based in Kigali, Rwanda.

Abbreviations

EDPRS	Economic Development and Poverty Reduction Strategy
EICV	Integrated Household Living Conditions Survey
FONERWA	National Fund for Environment in Rwanda
GWMO	Global Waste Management Outlook (2015)
KII	Key Informant Interviews
MININFRA	Ministry of Infrastructure
MoE	Ministry of the Environment
MoH	Ministry of Health
MINICOM	Ministry of Commerce
NST	National Strategy for Transformation
RURA	Rwanda Utilities Regulation Authority
REMA	Rwanda Environmental Management Authority
SWM	Solid Waste Management
WASAC	Water and Sanitation Corporation

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1 Executive Summary

Rwanda is a rapidly urbanizing country experiencing major economic transformations, and Kigali is a focal point for many of these changes. Rwanda's urban population more than doubled since 2002, while economically, the country has experienced a record of strong economic growth, with almost all additional GDP growth being generated in Kigali.

A major consequence of Kigali's population and economic growth is ever increasing volumes of Municipal Solid Waste. While there are no definitive estimates of the amount of waste generated across the city, various studies completed over the last 8 years have shown a steady increase in the amount of waste generated in the city, increasing from around 400 tons per day to 800 tons per day. Waste characterization studies indicate that the majority of waste has consistently remained organic.

Over the last decade, Rwanda has recognized poor solid waste management practices as a key impediment to sustainable development. This is reflected in SWM targets at the national and city level. However, keeping up with demand for waste collection services and preventing environmental pollution is becoming increasingly problematic.

This study takes a mixed-methods approach to understanding how the waste management system operates in Kigali. Waste system related information was collected from various sources including national household surveys (most notably EICV 2016-2017 and the Census 2012), internal reports and publicly available research, as well as interviews and data provided by stakeholders who form part of the City's SWM system. Broadly, our work consisted of (i) desk-research of existing legal frameworks, policies and research documents, (ii) waste flow modeling using national survey data, and (iii) primary research using key informant interviews with waste collection companies, recycling companies and government institutions including the City of Kigali, REMA, RURA and Sector officials.

1.1 Policy Motivation of Research

This study analyses the Kigali Waste Management System and offers critical insights into how the system currently operates while also providing insights into bottlenecks and how they might be addressed. The sustainable management of waste is a critical for the sustainable development of Kigali for a number of reasons.

Firstly, a well-managed solid waste management system is critical to a safe and clean urban habitat for residents. Solid waste management services form one of the four key urban services, in addition to provision of safe drinking water, electricity and improved sanitation. Secondly, effectively dealing with solid waste management is critical in preventing environmental degradation. Thirdly, moving from waste management to resource management (through beneficiation) will reduce waste and stimulate the green economy. And finally, if Kigali is to continue as an exemplar for well-managed urbanization on the continent, deficiencies in solid waste management ought to be a key priority.

The research study identifies key bottlenecks in the Kigali Waste Management System and the ways in which suboptimal institutional arrangements, a lack of coordination and data sharing and the absence of a long-term plan have contributed to deficiencies. We derive several key recommendations from these findings.

Key Research Questions	Summary of Key Findings
What is the institutional and legal structure of solid waste management in Kigali and how are national level initiatives implemented at the City level?	Overall, waste management in the city is fragmented with activities being regulated by organizations that deal with the environment, utilities regulation, water and sanitation, and local governance. In terms of implementation, the City of Kigali plays a central role in delivering waste management services. However, the central role of the City of Kigali is not reflective of its resources or coordination capacity to deliver new strategies and projects.
What estimates does the city have for the amount and type of waste that is generated, and how is this likely to change over time?	Few quantitative assessments of the total amount of waste generated exist but reputable sources put it at between 500-800 tons per day. The composition of the waste generated in Kigali shows that organics dominate (~70%). Accounting for population growth and changing economic profiles, it is possible that waste generation rates could increase by 63% over the next ten years, from approximately 800 tons being generated per day to approximately 1,300 tons per day by 2030
What proportion of households have access to solid waste management services and how has that changed over time?	Estimates of waste management services are generally low despite previous research highlighting the contrary. Estimates from EICV5 put the proportion of households that report access to waste management services in Kigali at approximately 49% (65% in urban areas). Estimates from the Census data indicates that the proportion of households that have access to waste collection services increased by 34 percentage points between 2002 and 2012.
What are the key shortcomings at the landfill site and how might they be addressed?	The Nduba landfill can be characterized as an open-air dumping site. The Nduba landfill faces a number of environmental problems including leachate, vermin and spontaneous combustions. The City ought to devise a phased landfill operations to closure plan.
How are waste management finances currently handled, and what is Kigali's estimated amount of cost-recovery?	The City has allocated 2.55% and 2.16% of its total operating budget in the 2018/19 and 2019/20 financial years, respectively, to solid waste management. Compared to international benchmarks, these allocations are likely smaller than necessary to manage a sustainable system. The budget for landfill management in 2018/2019 is RWF 316 million, translating to a unit cost of RWF 2,484 per ton. This is approximately $2.70 per ton, which when benchmarked against international costs, is insufficient to cover basic activities involved in the operation of a sanitary landfill. Finally, estimates indicate that the City recovers only 23.3% of budgeted landfill costs and 12.3% of actual costs incurred.

1.2 Policy Recommendations

Our recommendations for improving Kigali's waste management system are divided into long-term and short-term initiatives.

Short Term:

- *Improvements in the collection and aggregation of data across the current waste management system*

  A number of short term interventions that could significantly improve data collection, while also allowing for analytics to better undertake long-term strategic planning, would include: (i) Collecting data from waste collection companies such as the current number of trucks and total tonnage of each truck, the number of trips to landfill, and the total number of households services per sector; (ii) developing standard reporting templates and a central data store that Sector officials report into; (iii) installing a weighbridge at the landfill to log all vehicles; and (iv) commissioning a topographical survey of the landfill, which could be done by aerial survey, to facilitate operations to closure planning.

- *More effectively structure SWM at the City of Kigali by increasing capacity and adding technical skills*

  Such a structure would effectively allocate responsibility along three functional lines: operations, (capital and engineering) projects and waste minimization. The three individuals accountable for these service lines should be led by a senior manager with skills in strategy development, technical leadership and operations.

- *Improving management of the Nduba Landfill*

  In the short term, it is critical that the City prepares a landfill management turnaround plan that address operational deficiencies, installs groundwater monitoring infrastructure, develops a monitoring plan and identifies new areas in which to developed sanitary landfill cells

Long Term:

- *Developing a waste strategy and implementation plan for improved waste management*

  A coherent plan is essential to ensure the waste management system is improved in the long-term. Usually referred to as an integrated waste management plan (IWMP), this type of approach evaluates the whole system and recommends strategies and interventions that balance competing demands to ensure an optimal solution for waste management.

- *Elevating the prominence of waste management by developing a clearer waste management policy and responsive institutional structure*

  Current waste management arrangements in Kigali are spread across a variety of different ministries and institutions, all of which follow waste management regulations that only form a small portion of their overall mandate. While the system is currently working, fragmented, unfocused and potentially incoherent waste management legislation can have serious consequences for the effective management of waste.

2 Introduction

Waste generation is an increasingly problematic issue as rates of urbanization increase and income levels rise around the world. The World Bank estimates the amount of municipal solid waste (MSW) is growing faster than the rate of urbanization: in 2002, 2.9 billion urban residents generated about 0.64 kg of MSW per person per day (0.68 billion tons per year), while in 2012 three billion residents generated about 1.2 kg per person per day (1.3 billion tons per year).[1] Although waste metrics and waste generation estimates are lacking for regions in sub-Saharan Africa, estimates put it at 62 million tons per year or 0.65 kg/capita/day, which is currently low but likely to grow over time as countries make the transition from low to middle income status.[2]

Kigali is a rapidly urbanizing city that is experiencing strong economic growth, a consequence of which is ever increasing volumes of Municipal Solid Waste. Various estimates on the amount of waste generated exist; the Rwanda Environment Management Agency (REMA) estimates that between 1,800 and 2,000 tons of solid municipal waste is generated in the city per day while other studies put it at a more realistic400-800 tons per day.[3] Regardless, evidence suggests that only between 300-400 tons of waste per day is actually collected and transported to a single dumping site.[4] Overall, official government policies and reports including the REMA *State of Environment and Outlook Report*, 2017, highlight the inevitability of waste production increases, as the city population continues to expand, as citizens continue to increase their incomes.

The City of Kigali has noted poor solid waste management practices as a key impediment to sustainable development. Rwanda's Vision 2020 document prioritizes SWM, highlighting the need for all towns to be serviced by solid-waste treatment plants for households to better manage their waste.[5] Similarly, EDPRS II, and its successor NST I, highlights adequate solid waste management as an integral part of the country's priority to pursue a "green economy" and provide services for the modern Rwandan household.[6] Additionally, various policy and legal documents stress important SWM principles such as the Waste Hierarchy, a cornerstone of waste minimization, and the polluter-pays-principal, which requires waste generators to pay for the disposal of waste to compensate for impacts to the environment.[7] Guidelines for sanitary landfills and landfill operation protocols have been articulated in order to manage leachate and unwanted

[1] World Bank, *What a Waste*, 2012, pp ix
[2] World Bank, *What a Waste*, 2012, pp 80
[3] See Republic of Rwanda, REMA, *State of Environment and Outlook Report,* 2017, pp 55
[4] Institution of Rwanda Engineers, Perspective of Solid Waste Collection in the City of Kigali, 2017; Internal reports, Report on Kigali Landfills, 2017
[5] See Republic of Rwanda, *Vision 2020*, 2012, pp 12
[6] See Republic of Rwanda, *Economic Development and Poverty Reduction Strategy II: 2013-2018*, 2013, pp 37 and *National Transformation Strategy I: 2017-2024 ,* 2017, pp 14-15
[7] Republic of Rwanda, REMA, *Practical Tools on Solid Waste Management in Imidigudu Towns and Cities,* 2010, pp 10

landfill gas buildup, while regulations are in place to manage waste disposal sites, waste recycling, e-waste and hazardous waste.[8]

In addition, the government has set several targets to be achieved at the national level and City level. These targets are aimed at improving aspects of the waste system including minimizing waste generation, increasing access to waste collection, better managing waste disposal and incentivizing waste beneficiation. As highlighted in the *National Sanitation Policy Implementation Strategy*, 2016, the government aims to properly dispose of 60% of domestic waste by 2019/2020 and 80% of waste by 2029/2030. Additionally, the government is targeting a recycling rate for non-organic solid waste of 30% by 2019/2020 and 40% by 2029/30.[9]

Despite commendable achievements and ambitions to better deal with SWM, the capacity of Kigali's waste management system to deal with current and future population growth is unclear. While the CoK has made steady improvements to the waste collection system through innovative public private partnerships, there remain gaps in understanding how the whole system currently operates and performs, in particular how waste administrators, waste collectors, waste disposal authorities and waste recyclers work together. Moreover, few studies highlight the current amount and the type of waste that is generated, as well as projected waste generation rates in the future. Finally, research on what could be done to mitigate negative impacts, including how waste management facilities and services can be improved to cope with current and future pressures based on global best practices, is lacking. Without a detailed assessment of the status quo, it is difficult to formulate plans to improve the waste management system such that it moves from a linear collect-and-dispose to one that prioritizes waste avoidance and allows for waste beneficiation.

In light of these trends and information gaps, jerry-can ltd – in collaboration with IGC – undertook a rapid assessment of Kigali's waste management system to better understand how it functions. Our study, which is aimed at understanding the current waste management in the CoK using a systems approach, addresses elements of the waste system including waste generation, waste collection, waste disposal and waste beneficiation. The importance of commercial and industrial waste notwithstanding, the City of Kigali is primarily responsible for ensuring adequate waste management services to households, which is why our study focuses on household waste generation, collection and disposal.

[8] See REMA, *Practical Tools on Solid Waste Management in Imidigudu Towns and Cities ,* 2010; RURA, *Regulations Governing the Management of Waste Disposal Sites*, 2018; RURA, *Regulations Governing Solid Waste Recycling in Rwanda,* 2015; REMA, *National Implementation Plan for the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 2014-2021,* 2014;
[9] Republic of Rwanda, Ministry of Infrastructure, *National Sanitation Policy Implementation Strategy*, 2016, pp 32

2.1 Structure of the Report

This report consists of the following sections:

- **Section two** will briefly outline the methodology that was used in this study;
- **Section three** will highlight the evolution of waste management in Kigali and also discuss the institutional and legal framework around SWM;
- **Section four** will provide an overview of current waste generation estimates and will also highlight future waste generation rates and composition of the waste;
- **Section five** will focus on waste collection services and improvements to household waste collection over time;
- **Section six** will focus on waste disposal and topics related to landfill management;
- **Section seven** will provide high level financial analysis of the current system;
- **Section eight** will conclude on policy relevant insights and case studies from each of the preceding sections

3 Methodology

This study takes a mixed-methods approach to understanding how the waste management system operates in Kigali. Waste system related information was collected from various sources including national household surveys and reports as well as interviews and data provided by stakeholders who form part of the City's SWM system. Broadly, our work consisted of (i) desk-research of existing legal frameworks, policies and research documents, (ii) waste flow modeling using national survey data, and (iii) primary research using key informant interviews with waste collection companies, recycling companies and government institutions including the City of Kigali, REMA, RURA and Sector officials.

Existing data collected by the Government of Rwanda's National Institute for Statistics as well as existing data on waste produced by multilateral institutions provided the basis of our quantitative analysis. Government data that is used extensively in this report include the country's household survey (EICV 4 and EICV 5), the Census (2002 and 2012), and population projections which were generated by IGC. One of the outputs of this study is a Waste Flow model to estimate waste generation, composition and current management pathways in the City. Given the dearth of waste related data for CoK, the waste flow model is primarily founded on a data provided by the government and a comprehensive literature review of waste studies undertaken by multilateral institutions in Sub-Saharan Africa.

Primary data collection was largely undertaken through Key Informant Interviews. Interviews were pursued with key decision makers at institutions responsible for policymaking, implementation and regulation of waste management. A list of key informant interviews and the date of the interview are highlighted in

Table *1* below:

Table 1: List of Interviewees at Government Institutions

Institution	Title	Date
City of Kigali	Public Health and Environmental regulation	March 18, 2019
City of Kigali/ WASAC	Nduba Landfill managers	May 23, 2019
University of Rwanda	Dr. Sylvie Mucyo	May 27, 2019
REMA	Beatrice Cyiza	May 30, 2019
RURA	Jacques Nzitonda	May 29, 2019
Niboye sector	Executive Secretary	May 23, 2019
Muhima sector	Sector administrator and Hygiene officer	May 23, 2019
Remera sector	Sector administrator and Hygiene officer	May 28, 2019

In addition, a number of waste collection and recycling companies. These are listed below:

Table 2: List of interviewees at Waste collection & Waste recycling companies

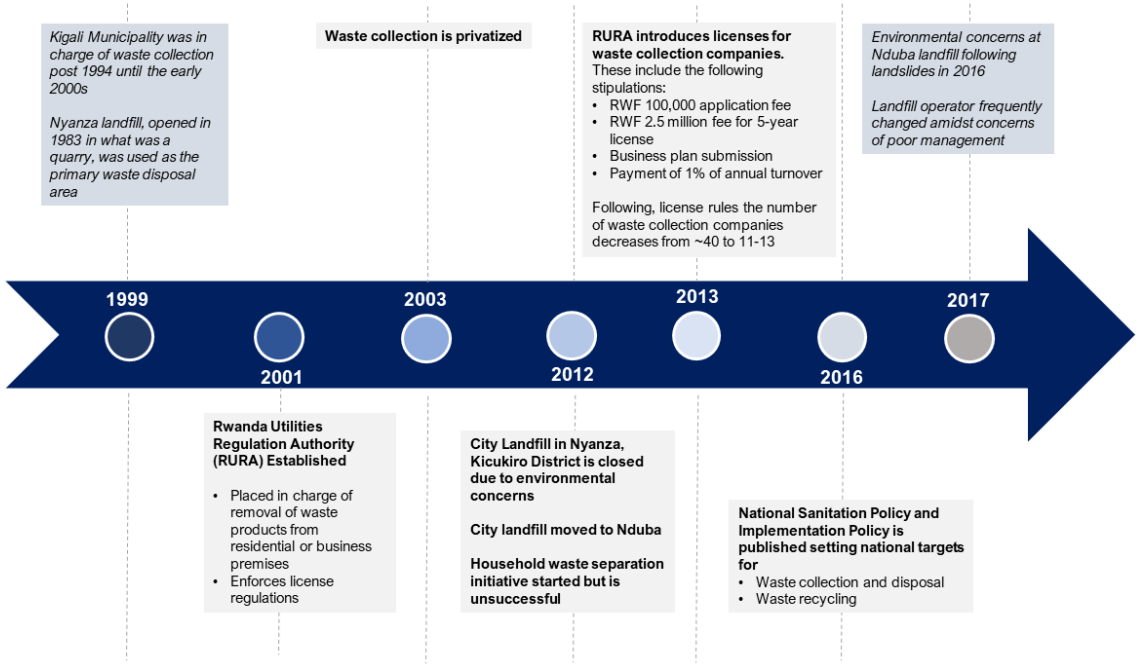
Institution	Title	Date
Ubumwe Cleaning Company	CEO; General Manager	May 9, 2019
COPED	General Manager	May 15, 2019
Jardin Muebles	General Manager	May 13, 2019
AgroPlast	General Manager	May 13, 2019
EcoPlast	CEO	May 16, 2019
Agruni	General Manager	May 20,2019
Baheza	General Manager	May 21, 2019
COOCEN	General manager	May 21,2019

4 Waste Management Status Quo in Kigali

4.1 Overview

Kigali city's management of waste has mostly evolved over the last 10 years. Prior to 2010, there was no national policy or harmonized regulatory framework addressing solid waste management, with households, communities, NGOs, the private sector, community associations and district authorities undertaking SWM activities, often with limited financial and technical resources.[10] Rather than emerging as part of a comprehensive initiative, however, the SWM sector has mostly been shaped by gradual changes. Rapid urbanization, changing city boundaries, the emergence of new institutions over time and environmental emergencies have shifted how waste collection is undertaken and regulated. Figure 1 highlights the evolution of the City of Kigali's waste management since 1994.

Figure 1: Evolution of the Kigali SWM system



At present, SWM for households in the City of Kigali is managed linearly. Overall, waste generated by household and commercial entities, is collected and disposed to landfill with little formal recycling of in-organic waste, and with little waste reprocessing of organic waste. The market for recyclables and reprocessed waste is also nascent, with little waste being reprocessed and returned to the material cycle. Waste collection is entirely privatized and managed by a

[10] Republic of Rwanda, REMA, *State of Environment and Outlook Report 2015,* 2015, pp 121

number of waste collection companies. The city's waste is exclusively disposed of at Nduba landfill, located in Gasabo district.

4.2 Legal and institutional framework

Waste management in Kigali – and Rwanda as a whole – are guided by principles that center around environmental protection, sustainability, and sanitation. The backbone of all waste management activities in the country is the Organic Law Determining the Modalities of Protection, Conservation, and Promotion of the Environment in Rwanda (2005). While outlining the general principles that guide the whole environment sector such as the protection principle and the polluter-pays principle, the Organic Law on the Environment also establishes a legal footing and delegates responsibilities to different "competent authorities," in addition to establishing both the Rwanda Environment Management Authority (REMA) and National Fund for Environment in Rwanda (FONERWA).[11]

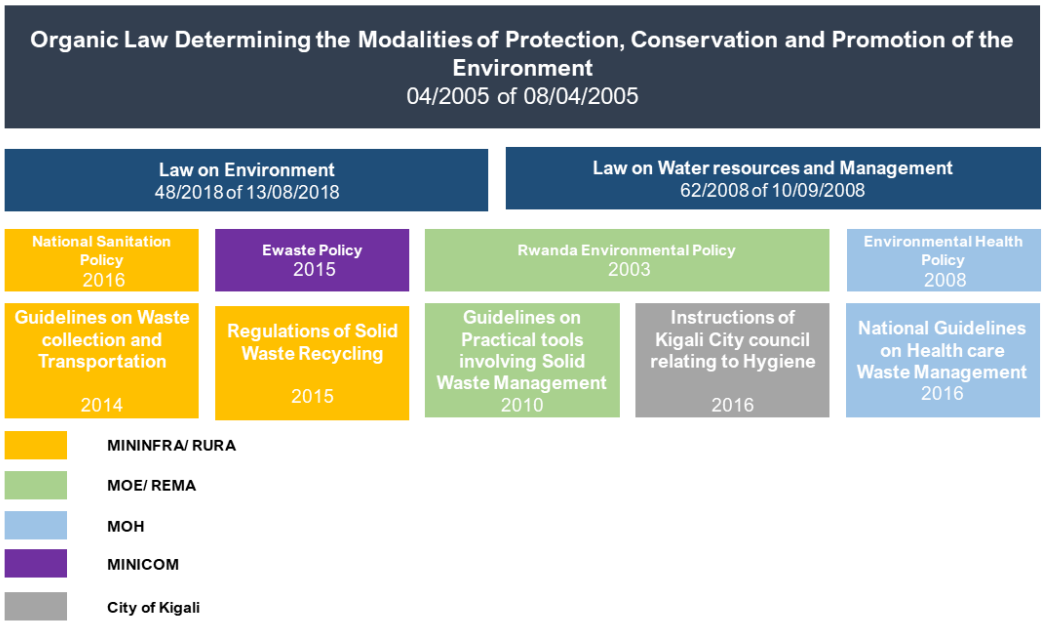
The three additional tiers of the legal hierarchy governing waste management draw most of their authority from the overarching Organic Law.

- The second tier of the waste management legal hierarchy primarily consists of the Law on the Environment of 2018. The Law on Environment of 2018 defines terms in the waste management sector, as well as sanctions and fines for unauthorized activities; it also creates environmental protection committees at district, sector and cell levels in the City of Kigali.[12]
- The third tier of legal activities concerning household waste is largely encompassed by the National sanitation policy. This sets the vision for the whole sector and carves out specific interventions needed to achieve a sustainable and equitable access to solid waste management and sanitation. It aims at improving the efficiency of the SWM at the national level, while highlighting principles such as full cost recovery, and the financial stability of waste operators. The policy also calls for the principles of the waste hierarchy to be implemented.
- Regulations and guidelines on solid waste collection and transportation and recycling – largely determined by RURA, REMA and the City of Kigali (CoK) – constitute the last tier of legal directives around waste management. These include: (i) Guidelines on Solid Waste Collection and Transportation (2014), drafted by RURA, which categorizes waste collection companies, sets out requirements and types of licenses, regulates the mode and frequency of waste collection and specifies the amount and deadlines of fees payable to RURA, and determines household tariffs; (ii) the Regulations of Solid Waste Recycling in Rwanda (2015) also drafted by RURA, which provides standards for a recycling site and recycling facility permitting process and requirements, recycling operational and working

[11] See Organic law no 04/2005 of 08/04/2005 Determining the Modalities of Protection, Conservation and Promotion of the Environment in Rwanda
[12] See Law n°48/2018 of 13/08/2018 on Environment

environment standards and recycling company license application process and requirements; and (iii) Guidelines on practical tools involving Solid Waste Management (2010) by REMA, which provides detailed technical guidelines on the landfill and compost operations including: site slope requirements, soil and clay liners thickness standard, landfill gas management techniques, landfill closure plan and compost chemical composition.

Figure 2: Overview of Legal and regulatory framework



Kigali's waste management structure, in accordance with international best practices, consists of national level policy making institutions, and a mix of national and local level implementation agencies and regulatory bodies. Ministries including MININFRA (the Ministry of Infrastructure), MoE (Ministry of the Environment), MoH (Ministry of Health) and MINICOM (Ministry of Commerce), are largely involved in drafting policies to be implemented by local administrative entities including the City of Kigali and Sector level local government bodies. RURA (Utilities Regulation Authority) and REMA (The Environmental Management Authorities) are responsible for setting out the guidelines that guide the way in which all implementation activities are carried out; WASAC – the water and sanitation authority – additionally implements SWM through their involvement in landfill management. Finally, Districts and Sector officials, with support from the City of Kigali, are involved in both managing contracts with waste management companies as well as ensuring environmental protection.[13]

Figure *3* highlights the institutional bodies involved in waste collection in Kigali and their respective roles.

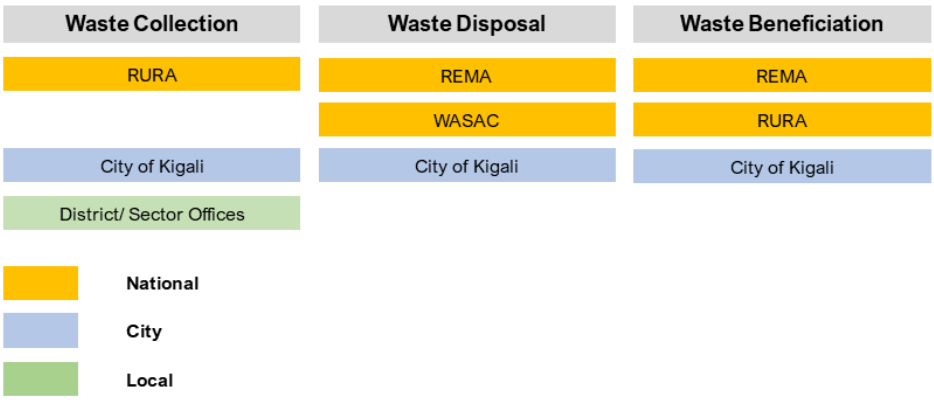
[13] Republic of Rwanda, EU Commission, *Environmental Profile of Rwanda*, 2006, pp 34

Figure 3: Institutional Framework

Examination of institutions in terms of their involvement in the waste collection system highlights the central role of the City of Kigali throughout the process. On one end of the waste system, the City of Kigali – through various Sector offices – and RURA – are responsible for managing private waste collectors, and coordinating and keeping a list of licensing waste recyclers; on the other end, WASAC and the City are responsible for managing the Nduba landfill site. In addition, the City of Kigali is responsible for a number of ancillary functions involving waste management including: strategic planning and the development of an integrated approach to solid waste management, building capacity for waste management and recycling, outreach campaigns to separate waste (carried out through Sector officials), beneficiation at the landfill (including vetting plans to implement projects such as waste-to-energy), and zoning of industries involved in waste management.[14] Figure 4 highlights the role of the City in the waste management system, along with the involvement of other national and local level administrations.

[14] See Republic of Rwanda, Office of the Auditor General of State Finances, *Performance Audit Report on Management of Solid and Liquid (Sewage) Waste in the City of Kigali,* 2016, pp 14; See Republic of Rwanda, MININFRA, *National Sanitation Policy Implementation Strategy*, 2016, pp 31-32

Figure 4: Institutional roles along SWM system



The central role of the City of Kigali in the management of waste, however, is not reflective of its resources or coordination capacity to deliver new strategies and projects that will improve the system in Kigali. At the city level, the responsibility for both the City's solid and liquid waste services vests in a single waste management officer. Responsibility for day to day operations leaves little capacity available for the waste officer to conceptualize new strategies and projects and appoint specialists to carry out the necessary work. Additionally, responsibility for waste collection is managed at sector level by Hygiene Officers, and it is unclear whether there is any direct accountability or communication between the city and local officials. Moreover, with regards to data sharing it is unclear how much is done in terms of reporting contractor performance and collection data (households serviced and trips to landfill), all of which is vital for policy and strategy development at City level.

Overall, waste management in the city is fragmented with activities being regulated by organizations that deal with the environment, utilities regulation, water and sanitation, and local governance. As highlighted above, waste collection, disposal and management form a small part of laws, policies and institutions that broadly deal with a range of environmental issues. Added to this, the fragmented nature of waste management regulation and enforcement means that policy goals, regulatory oversight and implementation are not always coherent. On the policy side, it is likely that goals around waste collection and waste recycling might not align with what is

actually achievable; on the regulatory side, it is often the case that *ad hoc* inspections take place by agencies that do not directly communicate with implementing institutions; and on the implementation side, it is often the case that the collection contractors have incentives from local officials (maximizing service coverage) that are at cross-purposes to guidelines set out by regulators (modernized service and costly collection vehicles). Each of these issues will be discussed in more detail below.

5 Waste Generation

Few quantitative assessments of the total amount of waste generated exist but reputable sources put it at between 500-800 tons per day. REMA's *State of the Environment and Outlook Report 2013* has the highest estimates of overall waste generation of between 1,800 and 2,000 tons per day with a per capita generation rate of between 1.8-2 kg per day.[15] These estimates, however, are vastly higher than any other estimates produced by researchers and are unlikely to reflective on the situation on the growth. A recent study conducted by the research consortium Rapid Planning put the city-wide generation rate at 808 and per capita generation at 0.5. Similar studies by Kabera, et al, records the amount of household waste at 638 tons per day, which translates to a per capita generation of 0.57kg/ day or 205 kg/ year.[16] Studies going further back, including the Kigali Master Plan of 2013, estimates the amount waste generation at a similar level of 640 tons per day, with 0.6kg/day being generated on a per capita basis.[17] A similar waste generation rate was noted by Dr. Sylvie Mucyo in 2013.[18] As a point of comparison, all estimates of waste generation put Kigali below the average waste generation rate of 0.74 kg/day per capita in urban sub-Saharan Africa.[19]

Table 3: Estimates of Waste generation rates (per capita and city wide) across various sources

Waste generation per day	UNEP GWMO/ EICV5 (2018)	Rapid Planning[20] (2018)	Wilson, Kabera (2017)	Auditor General (2015)	Kigali Master Plan (2013)	Mucyo (2013)	SWM strategic Plan for Kigali[21] (2012)
Per capita *(kg)*	0.49	0.5	0.57	0.6	0.6	0.6	0.47
Province wide *(tons)*	800	808	638	-	640	450	408

[15] REMA, *State of the Environment and Outlook Report 2013,* 2013, pp 95; this is likely to be an overestimate as it would put Kigali in the same waste generation profile as developed countries like the United States.
[16] Wilson et al, *Benchmarking performance of solid waste management and recycling systems in East Africa: Comparing Kigali Rwanda and other major cities*, Waste Management and Research, Vol 37, 2019 Pp 62
[17] See City of Kigali, *Detailed District Development Plans for Kicukiro & Gasabo, Kigali, Rwanda., Kigali 2013 Analysis, Benchmarking and Vision report*, 2013 pp 56
[18] See Sylvie Mucyo, *Analysis of Key Requirements for Effective Implementation of Biogas Technology for Municipal Solid Waste Management in Sub-Saharan Africa: A Case Study of Kigali City, Rwanda.,* Unpublished Dissertation in partial fulfillment of Doctor of Philosophy at Abertay University, Scotland, 2013
[19] See World Bank., *What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050*, 2018, https://openknowledge.worldbank.org/handle/10986/30317 License: CC BY 3.0 IG, pp 77
[20] See Presentation by Dr. Undine Giseke, TU Berlin, October 25, 2019. *Introduction to the Trans-sectoral Scenario Workshop Nyarugenge District, Kigali*
[21] Cited in Nishimwe pp 55

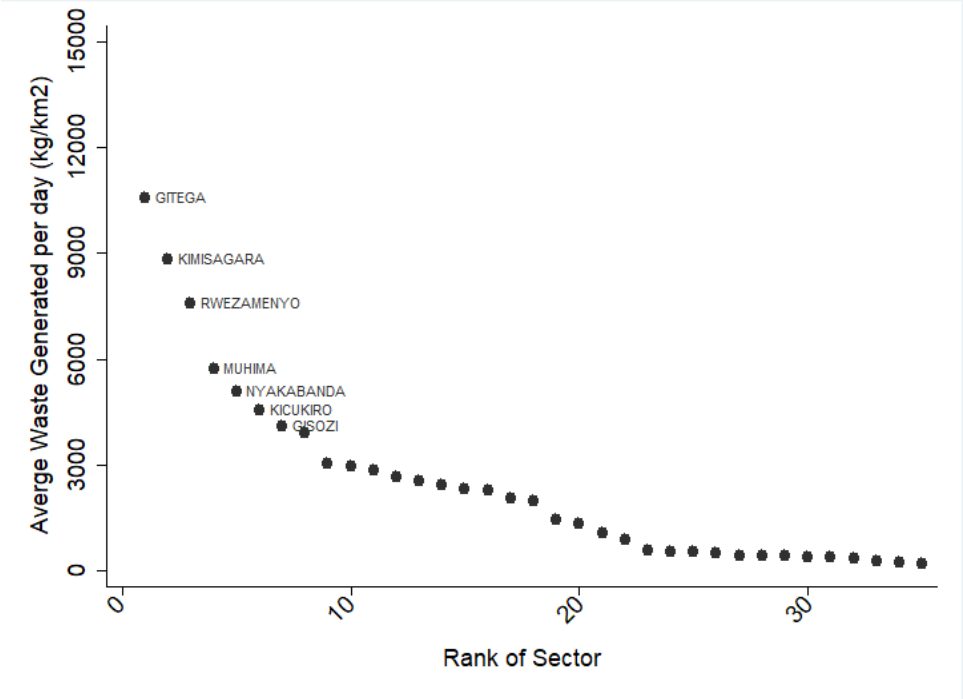
Most of these studies produce estimates that are similar to waste generation rates that would be predicted based on the current literature.[22] The Global Waste Management Outlook produced by UNEP presents a study that correlated waste generation rates in 82 countries with their GDP per capita, using regression analysis to estimate the per capita waste generation rate across countries and cities. Based on an estimate of Kigali's GDP from studies of nightlights – estimated at approximately USD 1,958 per capita in 2017 after inflating estimates from 2014 - and population data from EICV5, we produce a generation rate of 0.49 kg/capita/day.[23] Applying this generation rate to the 2017 population estimate for Kigali equates to approximately 800 tons/day (see above).

Spatially, we find that waste generation is likely highest in concentrated in areas around the city centre. Using population estimates from the Census 2012, and average waste generation rates per capita of 0.49 kg/capita/day, we find that the sectors with the highest waste generation per sq km in Kigali province are located in Gitega, Rwazamenyo and Kimisagara all of which are estimated to produce waste magnitudes higher than other parts of the city. Nevertheless, our analysis suggests that the areas where waste is generated in highest quantities coincides with areas where waste collection operations take place, which is in areas closer to the CBD (see below). At the district level, we find that waste generation is likely highest in Gasabo district compared to Kicukiro or Nyarugenge. This is a product of both the per capita generation rates – approximately 0.51 kg per capita per day – and the higher population of Gasabo as estimated in EICV 5. Gasabo is likely to generate 459 tons per day compared to 207 in Kicukiro and 135 tons per day in Nyarugenge.

[22] See UNEP, *Global Waste Management Outlook,* 2015*. Page 55*

[23] Using the UNEP (2015) regression analysis as basis for estimating waste generation; See World Bank, *Bright Lights, Big Cities: Measuring National and Subnational Economic Growth in Africa from Outer Space, with an Application to Kenya and Rwanda*, Policy Research Working Paper: 7461, 2015, for estimates of Kigali GDP per capita and GDP (disaggregated by district)

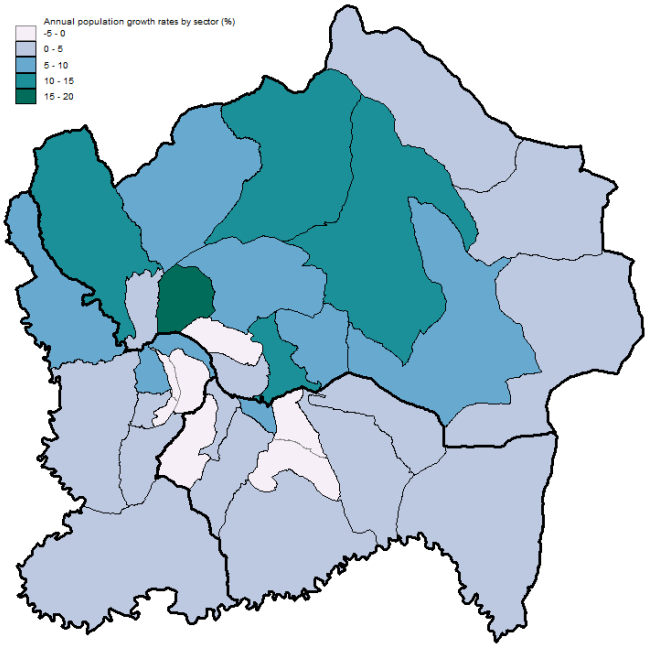
Figure 5: Spatial distribution of waste generated by district



Examining population growth across sectors in the country, we find that peri-urban Sectors are likely to see a much higher increase in waste generation in the future. To estimate sector population growth, we compare population estimates from the Census 2012 with population estimates for 2015 produced by the Centre for International Science Information at the Earth Institute in Columbia university and the Connectivity Lab at Facebook.[24] Comparisons of growth between 2012 and 2015 suggest that Gisozi, Bumbogo and Remera have annual growth rates between 11-17%, meaning that these areas are also likely to see increasing waste generation rates. A key takeaway is that much of the population growth is taking place in areas further away from the city centre, suggesting that new strategies around waste collection in peri-urban areas might be necessary. While these growth rates are not indicative of future growth, they do provide spatial disaggregation of waste generation across the city. Figure 6 highlights the areas with the fastest population growth rates.

[24] See http://www.ciesin.columbia.edu/data/hrsl/ for more information on the data, methodology and lab

Figure 6: Estimated annual population growth rate by sector, 2012-2015



An important distinction that needs to be highlighted is that waste generation does not equate to waste collection. The amount of waste that is collected is usually a fraction of what is generated. Hence, estimates from the Auditor General, based on an analysis conducted in 2013, indicates that the total waste collected in Kigali was equivalent to approximately 300 tons per day,[25] while REMA reports suggest that Kigali's Nduba dumpsite receives about 400 tons per day of solid, unsorted waste or 140,000 tons per year.[26] A more detailed discussion of waste collection is included in Section 6.1 below.

5.1 Waste composition

The composition of the waste generated in Kigali shows that organics dominate. Previous studies on the characteristics of Kigali's waste by the Rapid Planning and Kabera et al. indicate that organics are likely to make up between 66-70% of any waste that is generated. Overall, these

[25] Republic of Rwanda, Office of the Auditor General of State Finances, *Performance Audit Report on Management of Solid and Liquid (Sewage) Waste in the City of Kigali,* 2016, pp 4

[26] Rwanda Environment Management Authority*, National Implementation Plan for the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 2014 – 2021*, 2014, Pp 58 and REMA, *State of the Environment and Outlook Report 2017,* 2017, pp 55

estimates are higher than what is predicted by the UNEP's *Global Waste Management Outlook*, which indicates that organics would only account for approximately 53% of total waste in low-middle income countries – which corresponds to Kigali's GDP per capita. Table 4 highlights the waste characterization as per our study and various sources:[27]

Table 4: Waste composition in Kigali City

	%	UNEP waste characterization (lower income) (2015)[28]	Rapid Planning (2018)[29]	Kabera et. al (2017)	Sylvie Mucyo (2013)	REMA (2013)	SWM Strategic Plan[30] (2012)
Organic	Food, garden wood	53	75.3	70	74	77	70
Non-Organic	Paper and Cardboard	6	6.6	5	26	16.1	6
	Plastic	7	3.7	5		1.5	5
	Metal	2	1.6	1-3		1.9	3
	Glass	2	1.1			1.4	1
	Other (incl. textiles, rubber/ leather	30	11.7			2.4	15
	Total	**100**	**100**	**100**	**100**	**100**	**100**

The high proportion of organics indicates the importance of waste beneficiation strategies that target organic waste management. This would entail more extensive use of biological treatment processes such as composting or anaerobic digestion to create useful by-products, such as cooking gas, energy or compost. Moreover, separating organic waste would have a positive spin-off of reduced organic waste to landfill and consequently a reduction in products of biodegradation from landfilled waste. In this regard, Mucyo (2013) presents a comprehensive study on the potential for treatment of organic waste using biogas technology, identifying opportunities and barriers to a sustainable plant in Kigali.[31] However, all of these strategies would

[27] Kabera, T., Wilson, D., Nishimwe, H*., Benchmarking performance of solid waste management and recycling systems in East Africa*., Waste management Researcher, 2019., pp 62; see REMA (Rwanda Environment Management Authority). 2013. "Kilgali State of Environment and Outlook Report 2013 cited in World Bank *What a Waste*

[28] UNEP estimates come from a cross country comparison of waste characteristics of countries with low economic development

[29] See Presentation by Dr. Undine Giseke, TU Berlin, October 25, 2019. *Introduction to the Trans-sectoral Scenario Workshop Nyarugenge District, Kigali*

[30] Cited in Nishimwe pp 55

[31] See Sylvie Mucyo, *Analysis of Key Requirements for Effective Implementation of Biogas Technology for Municipal Solid Waste Management in Sub-Saharan Africa: A Case Study of Kigali City, Rwanda.,* Unpublished Dissertation in partial fulfillment of Doctor of Philosophy at Abertay University, Scotland, 2013

require an efficient separation of biodegradable waste, ideally at the household level, and a cost benefit analysis that objectively assesses the various options available for the collection and treatment of organic wastes would be required to determine the most beneficial route.

5.2 Future Waste flows

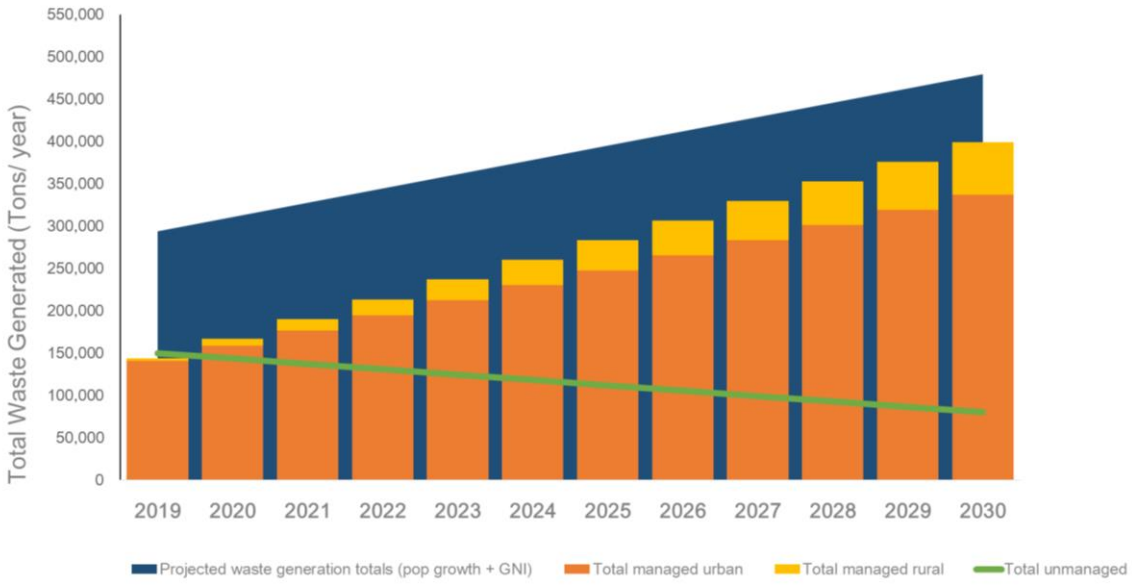
Future projections indicate a very quickly changing landscape for urban waste in Kigali partly due to changing income profile and higher rates of urban growth. According to the World Bank, Rwanda aspires to Middle Income Country status by 2035[32]. Achieving this level of economic growth will result in a commensurate increase in waste generation due to rising incomes. Assuming that Rwanda will reach middle income status by 2035, and applying the median GDP/capita in this category to the UNEP waste generation regression, we calculate a waste generation rate of 0.56 kg/capita/day. This represents a 14% increase in waste generation from current levels (0.49 kg/capita/day) due to economic growth alone. Accounting for population growth and changing economic profiles, it is possible that waste generation rates could increase by 63% over the next ten years, from approximately 800 tons being generated per day to approximately 1,300 tons per day by 2030.

In addition, our estimates based on Waste Flow Model projections is that the amount of waste to be managed will significantly increase if the future demand for collection services is met. Waste generation data only presents one part of the waste system picture. Modelling current and future waste generation, together with assumptions on current and future waste characteristics, provides the basis for developing waste management scenarios aimed at dealing with specific components of the waste stream. At present, all collected waste in the City of Kigali is disposed to landfill. Uncollected waste is assumed to be unmanaged and is likely either informally dumped or burnt at source. In the absence of strategies for dealing with organics or recyclable waste, for example, a waste flow model would merely project the current generation rate, waste to landfill and unmanaged waste. Assuming that the dominant formal management of waste in the medium term (next ten years) remains that of disposal, then improvements in the collection service over time will impact the ratio of managed to unmanaged waste. The results of the waste flow model that projects waste generation by management type and waste generation by component for the next ten years is presented in

[32] The World Bank In Rwanda. https://www.worldbank.org/en/country/rwanda/overview

Figure 7 below. The model is predicated on the assumption that economically related waste growth will be linear.[33]

Figure 7: Projected waste generation for the City of Kigali

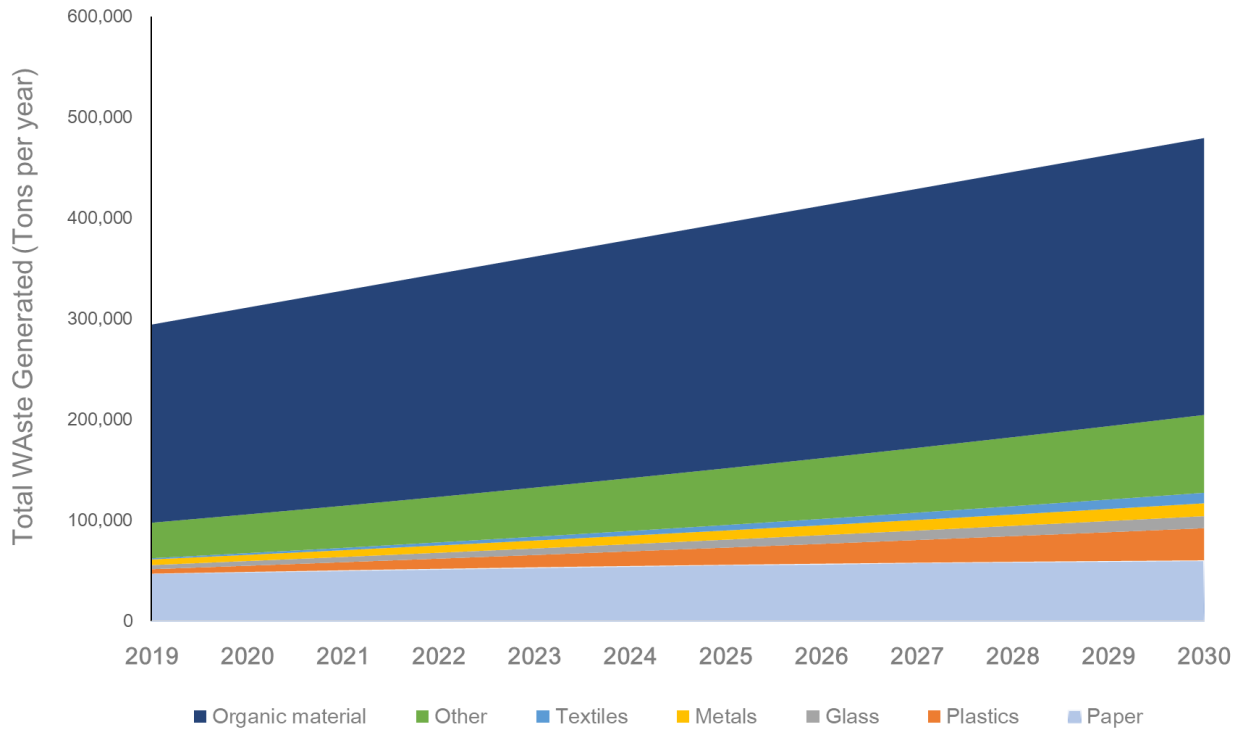


We estimate that the amount of organic waste will continue to be high. As the income levels within a waste system increase, the proportion of recyclable waste tends to increase while the proportion of organic waste tends to fall. The UNEP provides characterization data from 97 countries, categorized into the World Bank income bands (low, low-middle, high-middle, high), which we have used to predict changes in waste composition over time. Overall, organics can be expected to decline from the current levels – between 60-70% - to approximately 50% as Rwanda moves to lower-middle income status; as such while the amount of organic waste will continue to increase, we expect it will do so at a decreasing rate. Overall, our estimates suggest that the amount of organic waste generated per day will change from 480 tons per day to 710 per day in 2030[34] as illustrated in Figure 8.

[33] We use Population Growth Projections from IGC to make estimates of the amount of waste produced in the future. See Bower & Murray, *Housing Need in Kigali*, Policy Paper, International Growth Centre, 2019

[34] Changes in waste characteristics assumed to occur linearly over time

Figure 8: Projected waste generation by waste component




KUBWIMANA
LAKERS
FUSO
FIGHTER
RAA 756V

6 Waste collection

Presently waste collection in Kigali is largely outsourced. This is a common practice globally and across Africa, with collection being completed by private companies and cooperatives that collect waste and fees directly from households under 1-5 year contracts.[35] However, this was not the practice prior to 2001 when the Kigali municipality was the primary authority involved in collecting and managing household waste. After the establishment of RURA, waste collection was outsourced to private companies due to perceived efficiencies in their ability to undertake collection and disposal activities.

Our research from 2019 suggests that the number of firms operating in Kigali has decreased over time, with the total number of waste collection companies today equaling 11.[36] A report produced by REMA in 2013, on the other hand, indicates that 13 companies operated in Kigali City. Table 5 highlights the companies currently in operation and the year in which they were established.

Table 5: Waste Collection companies operating in Kigali

Waste collection Company	Operating in 2013	Operating in 2019	Household/ Commercial Waste
AGRUNI	Yes	Yes	Household
COPED	Yes	Yes	Household
Ubumwe Cleaning Company	Yes	Yes	Household
Inzira Nziza	Yes	Yes	Household
CESCO	Yes	No	Commercial
COCEN	Yes	Yes	Household
Coyagaying	Yes	No	N/A
Isuku Kinyinya	Yes	Yes	Household
Umurimo Mwiza	Yes	No	Commercial
Indatwa	Yes	Yes	Household
Baheza	Yes	Yes	Household
Real Protectors	No	Yes	Household
Road Environment Protection	Yes	No	N/A

Companies wanting to enter the waste collection services market in Kigali have to comply with guidelines set out by RURA. Category 1 licenses are issued by RURA if companies are able demonstrate that they comply with various criteria, including: (i) owning three trucks each carrying at least five tons capacity, (ii) demonstrating the ability to collect waste on a weekly basis, (iii) submitting a viable business plan, and (iv) paying RWF 100,000 in application fees. If a

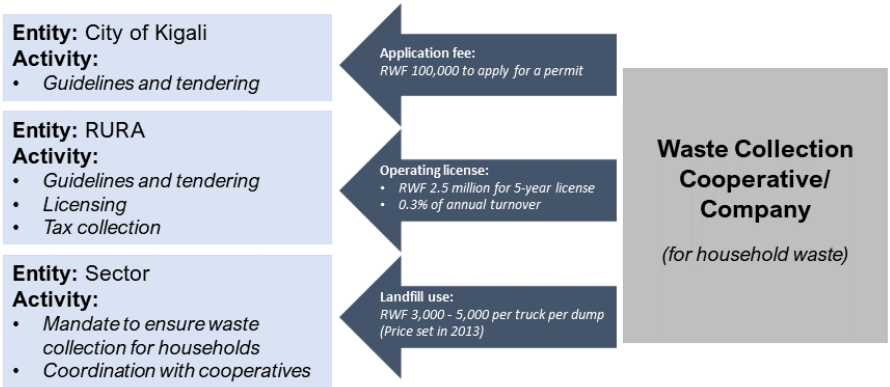
[35] The time-frame for collection appears to vary by sector, with some sectors only issuing 1 year contract and others issuing 3-5 year contracts. See below for a more detailed discussion
[36] Interview with Mr. John Mugabo, City of Kigali, March 18, 2019

company is selected they are required to pay a further RWF 2.5 million to RURA for a 5-year license, while also paying the authority 0.3% of quarterly turnover (a report is submitted every 3 months).[37]

Despite the regulations being applied at the national level, waste collection services are determined at the sector level. Overall, Sectors hold the mandate in the provision of solid waste management services to households in the city, with Sector Executive Secretaries determining whether a certain area has reached the adequate size to be viable for waste collection services. Interviews with Sector Executive Secretaries indicated that, when required, waste collections services are publicly tendered and companies are invited to bid. Companies advertise their working experience, waste collection capacity and equipment when vying for jobs, while also competing on the tariffs they charge households.[38] Executive secretaries sign contracts with waste collectors after a company is chosen, with sector hygiene officers responsible for overall monitoring and evaluation of waste collection activities. Districts, while officially being responsible for Hygiene and sanitation, play a limited role in solid waste collection service regulation.

Figure *9* highlights the overall institutional arrangement between various ministries and waste collection companies. Districts, while officially being responsible for Hygiene and sanitation, play a limited role in solid waste collection service regulation.[39]

Figure 9: Waste Collection guidelines



[37] RURA, Regulation No. 001/EWATSAN/RURA/2014 of 28/8/2014 Governing Solid Waste Management, pp 14; Interviews with various waste collection companies indicated that the 1% quarterly turnover was reduced to 0.3% of quarterly turnover after negotiations with RURA officials in 2016, See RURA BOARD DECISION N° 07/BD/LER/ RURA/2016

[38] Interview with NIboye Executive Secretary, May 23, 2019; Interview with Remera Executive Secretary, May 28, 2019

[39] See Pius Nishimwe, *Privatization of Solid Waste Collection Services as a tool to sustainable waste management in developing country cities. Lessons from the Case of Kigali, Rwanda Capital City*, 2016, Master's Thesis submitted in at UNESCO-IHE Institute for Water Education, pp 28

Interviews with companies and sector officials revealed that contracts between waste collection companies and Sectors vary. Companies often reported that contract lengths with Sectors can range between 1-5 years, depending on the Sector, although more recent renewals have been 1 year long. The short contracts signed with sector officials is often a source of grievances for waste collection companies that struggle to (i) borrow capital on the back of shorter contracts, and (ii) face extensive negotiations when it comes to the renewal of contracts with Sector officials. Further, regulations stipulated by RURA require large investments in high quality trucks and collection infrastructure that are not possible without companies resorting to external financing. As such, while shorter contracts with waste collection companies may be seen as the best way to ensure a competitively priced service, extending contract periods with Sectors is likely to be a more effective strategy as this would allow companies to invest in their fleets, realize a return on investment and consequently better comply with RURA regulations.

The number of household actually served by waste collection companies is lower than the number of households that should be served. Said otherwise, waste collection companies are not fulfilling their mandate of serving all households in the sectors in which they operate. According to Census 2012 estimates Agruni, Ubumwe Cleaning Company, and Baheza General ought to serve the largest number of households in the City, with the total number of serviced households all above 20,000. However, interviews with a select group of these companies indicate that estimated households serviced and the number of households that sign contracts with waste collection companies do not align. Interviews with RURA and the City of Kigali indicate that this could be a result of a number of discrepancies, most notably that (i) on many occasions, households living on the same compound group their waste together to be paid by one landlord; (ii) that waste collection company record keeping might be imperfect and (iii) that companies only service urban areas within different sectors.[40] Nevertheless, the difference between the estimated number of households that should be served, and the number actually served is in line with EICV 5 estimates of households with access to waste collection services. Table 6 illustrates the estimated number of households served based on census estimates and numbers obtained from waste collection companies (where applicable).

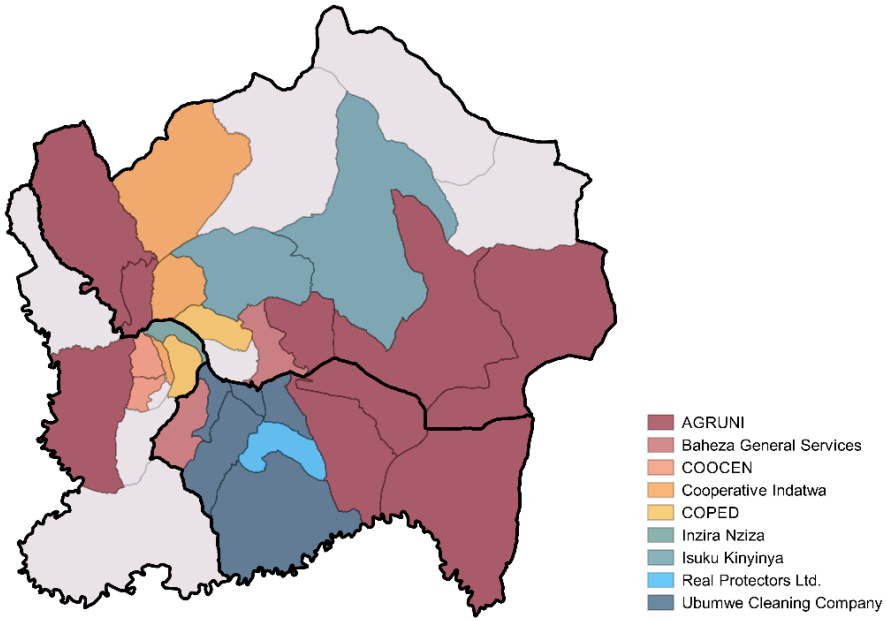
[40] Interview with RURA representative, May 29, 2019; Interview with City of Kigali representative, June 25, 2019; see Pius Nishimwe, *Privatization of Solid Waste Collection Services as a tool to sustainable waste management in developing country cities. Lessons from the Case of Kigali, Rwanda Capital City*, 2016, Masters Thesis submitted in at UNESCO-IHE Institute for Water Education, pp 37 for additional information on discrepancies between company figures and actual collection coverage

Table 6: Growth in the estimated number of households served, by company

Company	Estimated Households (2012)	Estimated Households – Urban (2012)	Estimated households served from interviews (2019)	% of households served
AGRUNI	92,600	69,710	36,087	51
Baheza General Services	22,560	22,560	10,240	45
Ubumwe Cleaning Company	33,919	29,100	14,440	49
Cooperative Indatwa	27,819	21,830		
COOCEN	18,020	18,020	11,160	61
Isuku Kinyinya	26,120	16,560		
COPED	14,650	14,650	4,000	27
Inzira Nziza	7,340	7,340		
Real Protectors	3,260	3,260		

Visualizing the areas that are administered by waste management companies in Kigali, we see that cooperatives and private companies operate in rural as well as urban parts of the province. AGRUNI, in particular, operates in sectors that extend outwards towards neighboring provinces, especially those in the east. The spatial distribution of the waste collection companies is highlighted in Figure 10. The sectors that are serviced by waste collection companies are similar to previous maps of areas where companies have operated, indicating limited increases in coverage over the past years.

Figure 10: Spatial distribution of the waste collection companies



Tariffs are progressive with households in lower ubudehe categories benefitting from lower service charges. Waste collection companies interviewed as part of this study – a finding that is confirmed by RURA authorities – noted that tariffs for households were set by RURA in 2012 using a 3-4 tier system that loosely corresponded to a household's *ubudehe* category, or level of poverty; households within each band are charged different rates based on the distance of that household's administrative Sector from the landfill.[41] Overall, the highest earning households pay RWF 5,000-11,200 per month; the middle income households pay between RWF 3,700-7,500 and the lowest income households pay between RWF 1,700-2,300 depending on the Sector in which they live. A certain number of households across different Sectors are designated as indigent by Sector level authorities and are excused from paying tariffs. Waste collection companies are obliged to serve low income households - regardless of their ability to pay - as a form of charity.

The quality of waste collection services is generally considered high. A study[42] conducted in 2016 indicated that waste collection companies generally respected collection frequency as compared to 3-4 years previously, with a two thirds of the six sectors considered in the study receiving a 'reliable' service. The service quality was influenced by the physical capacity (number

[41] See RURA Board decision meetings for Tariff bands (https://rura.rw/fileadmin/Documents/docs/board_decision_ibiciro_imyanda.pdf); The lowest two *ubudehe* categories are classified as one

[42] See Pius Nishimwe, *Privatization of Solid Waste Collection Services as a tool to sustainable waste management in developing country cities. Lessons from the Case of Kigali, Rwanda Capital City*, 2016, Masters Thesis submitted at UNESCO-IHE Institute for Water Education, pp 58

of trucks and condition) and organization and planning capacity in the collection companies. High service capacity levels generally correlated to a more reliable service, however poor planning resulted in certain companies being highly inefficient (measured as households served per number of vehicle trips) despite offering a regular service. As such, irregular service levels were not necessarily correlated to physical capacity and condition of vehicles but rather a combination of limited resources and lack of astute, formal route planning. Instances of companies borrowing trucks or using old vehicles were cited as limitations, especially given the proclivity of these vehicles to breakdowns.

Despite the reported good quality service, few mechanisms exist to ensure contractor accountability. Across many sectors, it was reported[43] that there were no regular checks on waste collection companies with regards to service quality, and companies were allowed to operate independently. While household complaints – either sent directly to companies or expressed during *umuganda* – there was little by way of clear channels with which to ensure that waste companies collect waste from all households in their jurisdiction in a timely manner.

6.1 Household waste collection rates

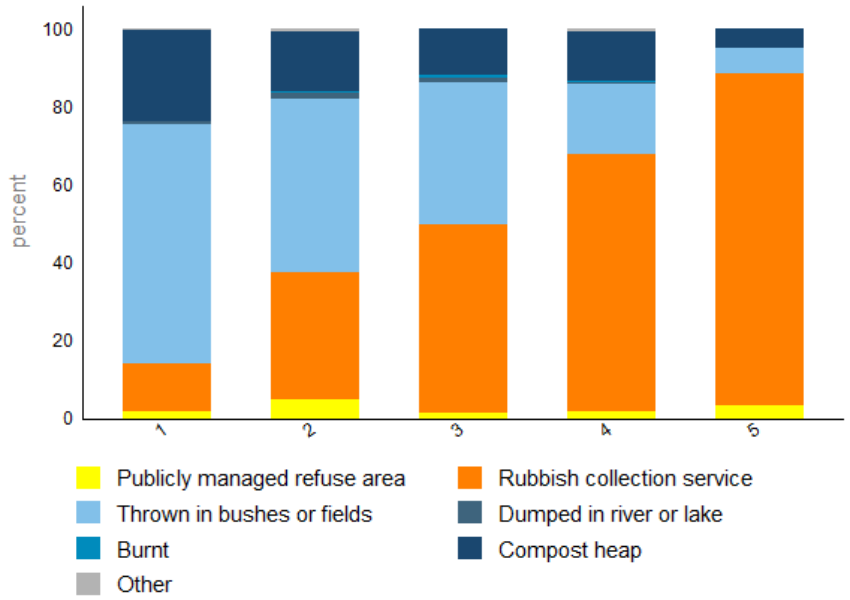
Estimates of waste management services are generally low despite previous research highlighting the contrary. Kabera et al put collection rates at 88% citywide using data from the Kigali Office of the Auditor General of State Financing.[44] However based on results from EICV5 we estimate that the proportion of households that report access to waste management services in Kigali is approximately 49%. As a point of comparison, these estimates are slightly higher than the average waste collection estimates in urban low-income countries (48%), and significantly higher than rates in Sub-Saharan Africa which are estimated at 44%.[45] They are comparable with other major cities in the region including Nairobi, Kenya (50%), although Kampala, Uganda has much higher collection rates (65%).[46]

Looking at Kigali province as a whole, access to waste management services varies by household consumption profiles. EICV5 indicates that access to rubbish collection services increases consistently across consumption quintiles in each of the three Kigali districts – coinciding with a reduction in the amount of waste that is disposed of in bushes or fields. Overall, we see a 63 percentage point increase in the proportion of households accessing waste

[43] Pius Nishimwe, *Privatization of Solid Waste Collection Services as a tool to sustainable waste management in developing country cities. Lessons from the Case of Kigali, Rwanda Capital City*, 2016, Masters Thesis submitted in at UNESCO-IHE Institute for Water Education, pp 28
[44] Office of the auditor general of State Finances, *performance audit report on management of solid and liquid (sewage) waste in city of Kigali from May,2012 to December 2015,* pp 64
[45] See What a Waste 2.0: pp 33
[46] See What a Waste 2.0; pp.90

management services between households in the bottom 20 percent – 2.2% of households access services in the bottom quintile, city-wide - and households in the highest 20 percent - 66% access waste management services in the highest 20 percent. The increase in the likelihood of accessing waste collection services is coupled with a decrease in the proportion of households relying on the disposal of waste in bushes or fields: approximately 85% of households in the bottom 20 percent in Kigali province report disposing of waste informally compared to only 20% in the highest consumption quintile (see Figure 11). The trends are similar across districts. While the Auditor General's report on waste management indicates that a high percentage of household coverage in sectors where solid wastes are collected - 97% in Nyarugenge, 88% in Gasabo and 84% in Kicukiro[47] - our estimates based on data from EICV 5 suggests that access to waste collection reach these levels only for households in the highest 20 percent: 82.8% of households in Nyarugenge, 89% in Gasabo and 92% in Kicukiro report access to either a Rubbish collection service or a publicly managed refuse area.

Figure 11: Access to Waste collection services by Household quintile across Kigali (EICV 5)

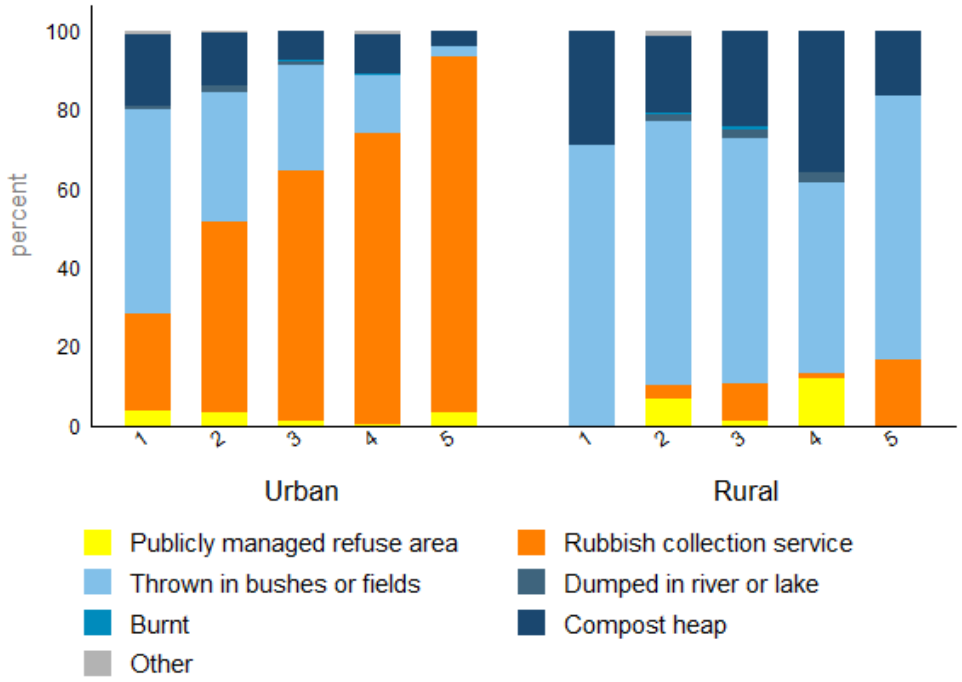


Access to household waste management services is bifurcated along urban and rural parts of the city. Kigali province – while also being subdivided into three separate districts - is divided into a rural and urban areas, with the average urban household reporting better access to municipal services compared to households located in rural areas. Along these lines, households in urban parts of Kigali are significantly more likely to access waste collection services compared

[47] Office of the auditor general of State Finances, *performance audit report on management of solid and liquid (sewage) waste in city of Kigali from May,2012 to December 2015,* pp 36

to rural households. The differences are stark: 67% of urban households reporting access to municipal waste collection services – either a publicly managed refuse area or a public collection service - compared to only 7% of rural households as per EICV5. The opposite pattern is recorded when comparing the proportion of rural households that report disposal of their waste in fields and bushes (66%) compared to households in urban areas (22%). Despite these variations, the City government does not intend extending services to rural households given the small amount of organic waste that they produce, accepting that these households will dispose of waste through other means. However, changing lifestyles and incomes in the future means that provisions for waste collection in rural areas ought to be an area of focus.

Figure 12: Access to Waste collection services across urban/rural areas of Kigali Province (EICV5)



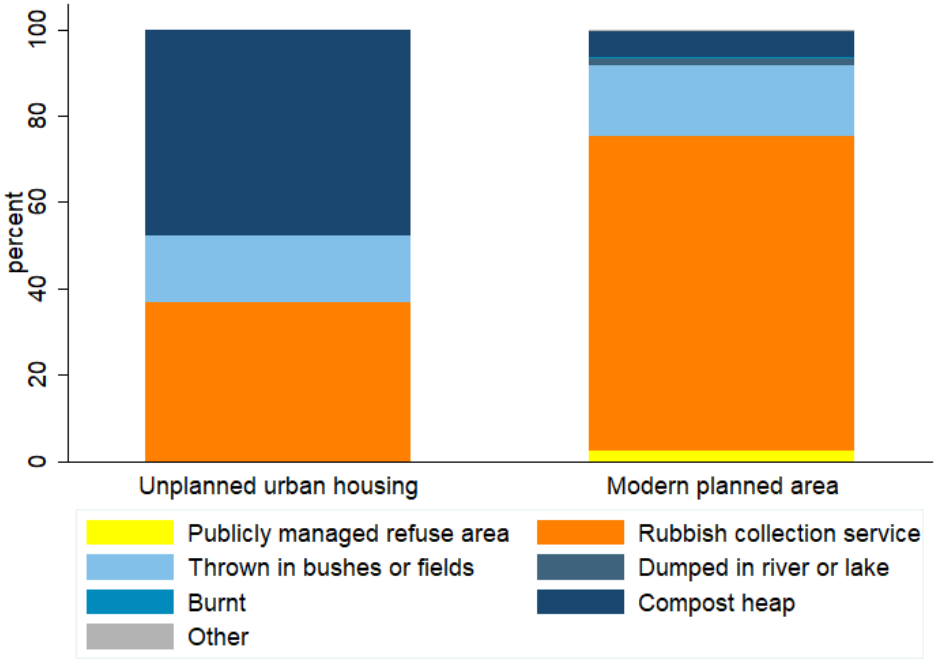
Access to waste collection services is a major predictor of access to other basic services. Read row-wise, Table 7 provides a co-consumption matrix of probabilities that a household has of accessing a particular service contingent on having another service. For example, 50.8% of households with electricity, 60% of households with a flush toilet or pit latrine and 84% of households with piped water report access to waste management services (see Column 4). Overall, access to waste collection services is much better than access to piped water, slightly worse than access to toilets, and much worse than access to electricity based on the likelihood of a service predicting access to other services: while access to waste services is predictive of access to toilets, toilets are not predictive of access to waste. Overall, access to piped water is likely to result in a household having access to all other basic services.

Table 7: Co-consumption matrix of access to services in Kigali (EICV5)

	Piped Water (home/ yard)	Electricity (grid/ off grid)	Toilet (flush/ VIP)	Waste collection services (waste pickup)
Piped Water (home/ yard)		99.9	99.3	83.8
Electricity (grid/ off grid)	35.9		82.2	50.8
Toilet (flush/ VIP)	42.5	98		59.7
Waste collection services (waste pickup)	58.2	98.2	96.8	

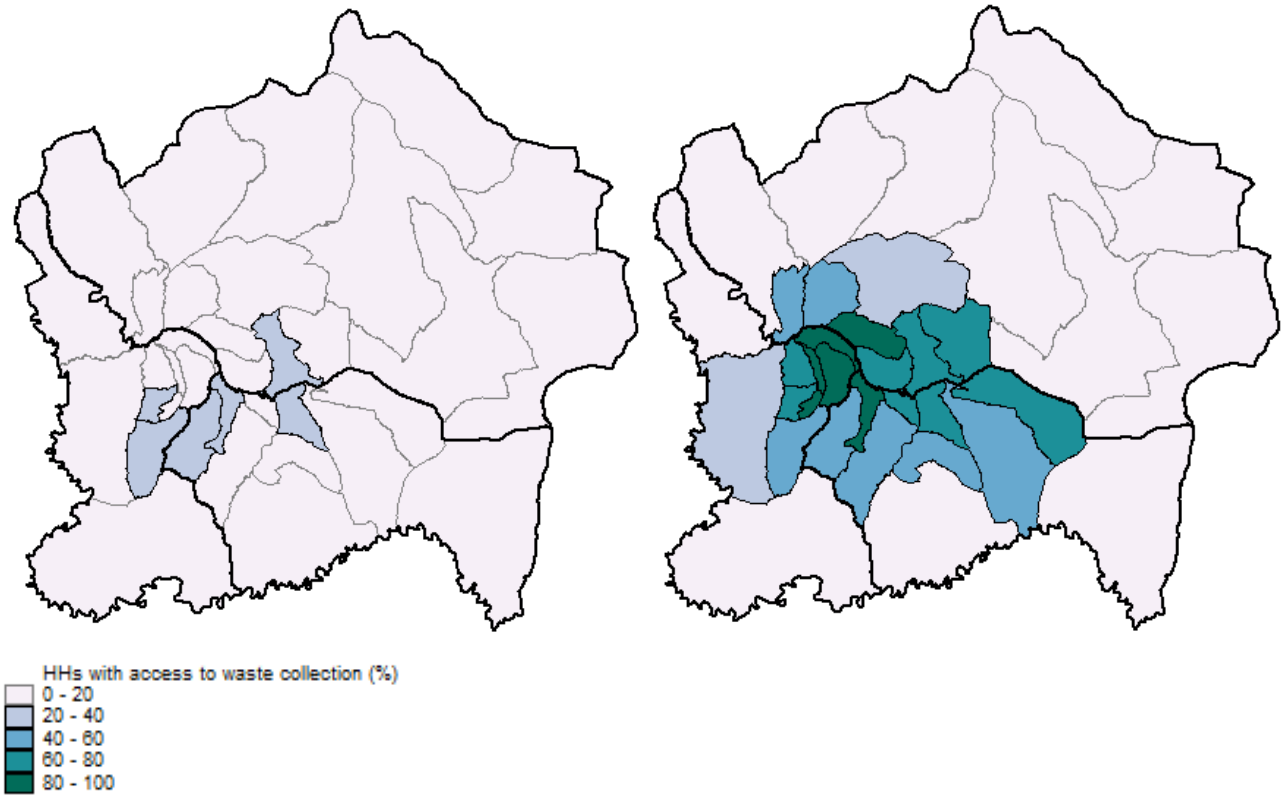
Waste collection by planned and unplanned settlements indicates two different patterns: one of door-to-door servicing and one of disposal via a compost heap. Only 37% of households living in unplanned urban housing have access to waste collection services – door-to-door services and common collection points - compared to 75% of households living in planned areas. Moreover, the majority of households living in unplanned settlements are likely to dispose of their waste in compost heaps (48%). These different methods of waste collection are likely a combination of two different factors: First, waste collection vehicles are likely to find it difficult to access households living in unplanned settlements due to poor quality, narrow or very steep roads. As such, they are likely to be unable to provide door-to-door collection services. Second, households living in unplanned areas are likely to produce less inorganic waste, meaning that they are able to dispose of their waste via composting.

Figure 13: Access to Waste Services by type of habitat (EICV5)



Nevertheless, comparing the census 2002 to the census 2012, we find that access to waste collection services has increased over time. Estimates from the Census data produced by NISR indicates that the proportion of households that have access to waste collection services increased by 34 percentage points – a major improvement over the span of 10 years. As highlighted in Figure 14, access has especially increased in areas closer to the city center compared to areas located further away. This is potentially explained by two factors: (i) household income levels amongst those households living closer to the city centre and (ii) the quality and availability of infrastructure services, especially all-weather roads. Regression analysis of data from 2018 suggests that, controlling for a household's consumption quintile and whether the household is living in an urban or rural part of Kigali, distance to access to all-weather roads is still a major determinant of access to waste management facilities, highlighting the potential for policy interventions along these lines. However, households living further away from all-weather roads are still more likely to benefit from access to waste services if they are in higher consumption quintiles indicating that this is still a major determinant of service access.[48]

Figure 14: Access to Waste collection services by sector (Census 2002, 2012)



[48] Republic of Rwanda, REMA, *State of Environment and Outlook Report 2013*, 2013, pp ix

However, analysis of household surveys and the Rwanda census indicates only marginal increases in access to waste management since 2012. In particular, the period between 2014 and 2018 has only seen a marginal increase in the proportion of households with access to waste management services – 3.3 percentage points – despite an increase in almost 63,000 households with access to waste collection services (see Table 8). The low levels of service expansion highlights the major challenge that population growth and migration play in delivering urban services to Kigali households.

Table 8: Access to Waste Management services 2002 - 2018

	2002 (Census)	2012 (Census)	2014 (EICV4)	2018 (EICV5)
% of households with access to waste collection services	10.3	44.7	46.5	48.9
% of households with access to waste collection services in Urban Kigali	11.9	57.8	62.5	64.8
No. of households with access to waste collection facilities in Kigali	17,765	128,132	137,280	200,352

Overall, despite increases in waste collection, Kigali city is falling short of targets. The National Sanitation Implementation Strategy of 2016 highlights the desire to properly dispose – i.e. collect from households - of 60% collection of waste by 2020 and 80% by 2030.[49] This means that there is currently a shortfall of 10% of households and also means that considerable steps need to be taken to increase access to waste collection to meet targets in 10 years' time. Given the extent of urban expansion – and the increase in population in peri-urban areas – it is likely that the City of Kigali will need to increase waste collection access in Kigali's periphery in the near future in order to achieve policy targets.

[49] Republic of Rwanda, Ministry of Infrastructure, *National Sanitation Policy Implementation Strategy*, 2016, pp 32

7 Waste disposal

Kigali's waste has historically – and currently – been dealt with through the disposal of waste in a single landfill. Waste in Kigali province was initially dumped on a waste site in Nyanza, located in Kicukiro district. The site was originally a quarry but started receiving waste from transition centres located across the city after it was first opened up in 1983. The landfill, which was closed in May 2012 after being in operation for 29 years was replaced by the Nduba landfill in Gasabo district. The Nduba landfill is still currently in operation and remains Kigali's only landfill.

The Nduba landfill can be characterized as an open-air dumping site. As per the State of Environment Outlook, 2018, the Nduba landfill receives approximately 35.8% of the overall waste generated in the city, a 10% difference compared to what is collected (see above) either suggesting that this waste is diverted to recyclers or illegally dumped to avoid landfill charges.[50] In addition to solid waste, liquid waste generated from human excrement is deposited at the Nduba landfill, although this is currently deposited in a separate area.[51] Landfill operators currently estimate that approximately 100 trucks – 80% of which are small trucks with an approximate size of 5 tons, and 20% of which are large trucks with an approximate size of 10 tons – make their way to the landfill each day, dumping an estimated 600 tons. This estimated disposed mass exceeds our estimated total generation estimates and that of the literature (see Section 5). This possibly points to inaccuracies in assumptions of waste density or under-utilized capacity in collection vehicles. Approximately 10 hectares of the total 43 hectare areas is currently being used.[52]

A number of environmental issues currently plague the Nduba landfills - similar to what was experienced in Nyanza. The Nyanza site, which was never designed to be a landfill, started encountering issues beginning in 2003 after closure of waste transit centers, the privatization of waste collection systems and the increasing volume of waste collection.[53]. These included spontaneous methane gas explosions as well as leachate flowing to nearby communities, unpleasant smells and the existence of vermin.[54] Despite its official closure, the Nyanza landfill still suffers from land-slides on the eastern part of the site, and apparent tension cracks in the landfill, which makes it susceptible to water penetration and instability, and a lack of access control in certain areas, which allow for scavengers to recover metals and other scrap materials.[55] The Nduba landfill, which replaced the Nyanza landfill, has also faced a number of growing management deficiencies as highlighted in the Auditor General's assessment of waste management in Kigali. These include:[56]

[50] https://www.newtimes.co.rw/news/new-report-raises-red-flag-over-lack-waste-treatment-system-cities
[51] Interview with Mr. John Mugabo, City of Kigal, March 19, 2019
[52] Interview with landfill managers, Nduba landfill, May 23, 2019
[53] See Report City of Kigali Landfills, Internal Report, pp 1, 2017
[54] See Report City of Kigali Landfills, Internal Report, pp 2, 2017
[55] See Report City of Kigali Landfills, Internal report, pp 3, 2017
[56] Republic of Rwanda, Office of the Auditor General of State Finances, *Performance Audit Report on Management of Solid and Liquid (Sewage) Waste in the City of Kigali,* 2016, pp 3-5

- Leachate with high polluting potential is not prevented from seeping into the ground and surface water
- Issues with vermin and flies, in addition to the loss of a wasted opportunity to recover valuable products as a result of solid waste is not being separated into separate biodegradable and non-biodegradable waste
- Spontaneous combustions due to buildup of landfill gas (comprising flammable methane) - due to the solid waste only being covered by soil once every two months rather than every working day
- Three of the four cells which were constructed are nearing full capacity.[57]

The Nduba landfill has been through a number of management changes over the past year. Until June 2018, the site was managed by a private company, New Life ltd, for a 25-year concession period, under the purview of the City of Kigali. However, stockpiled garbage and poor upkeep by the company led to their dismissal and replacement by the Rwanda Reserve force. The Reserve force made various changes at the site including constructing leachate diversion channels, relocating stockpiled waste and more frequently covering with laterite (gravel). As of January 2019, management of the landfill was transferred from the Reserve Force to be jointly managed by WASAC and the City of Kigali.[58]

While mismanagement at the Nduba landfill has been a major issue, environmental degradation at the dumpsite has largely been caused by the fact that the site was never designed as a sanitary landfill. As highlighted by the City's internal reports, several attempts were made to build a sanitary landfill, composting site and waste to energy site after the closure of the Nyanza landfill, but all of these efforts failed for various reasons. In 2013, a tender was launched seeking out interested investors in composting and waste management but failed due to issues regarding inadequate due diligence of the winning bid. Another attempt was sought in 2015, during which five companies – out of 14 – were shortlisted to bid on the project and a winner was chosen but was later disqualified for failing to undertake a feasibility study with which it would negotiate the feed in tariff for electricity and other investment requirements.[59] A serious consequence of these unsuccessful tenders was the continued operation of the temporary Nduba landfill, which was initially meant to operate for two years, but has been in use for over seven years, and for which no environmental impact assessment (EIA) was ever conducted.

Currently, the management of the landfill faces major financial shortfalls, both in terms of revenue recovery and the cost of managing the site. Costs of running the landfill are covered by the City of Kigali and WASAC.[60] On the revenue side, private collectors are required to pay

[57] Republic of Rwanda, Office of the Auditor General of State Finances, *Performance Audit Report on Management of Solid and Liquid (Sewage) Waste in the City of Kigali,* 2016, pp 13, pp 17
[58] This information was gathered after speaking to managers at the Nduba landfill, May 23, 2019
[59] See Kigali Landfill internal report, 2017, pp 6
[60] Interviews with landfill operators, Nduba, May 23, 2019

approximately RWF 1,000 per ton of waste deposited at the site; however, the lack of a weighbridge, or suitably inventive alternative means that trucks are charged per trip with smaller trucks being charged RWF 3,000 and larger trucks – regardless of tonnage – being charged RWF 5,000.[61] This likely creates a perverse incentive for collectors to aggregate waste into bigger trucks to reduce disposal fees. Landfill managers ensure that any truck passing by the landfill pay before they receive access to the premises.[62] However despite a high payment rate, interviews with officials at the City of Kigali indicate that management of the landfill costs approximately RWF 600 million annually, with only RWF 72-80 million being recouped, highlighting a very low recovery rate of between 12-13%. It should be noted that this deficit would be significantly higher if the external costs of poor management were internalized (through appropriate pollution control infrastructure and sanitary operations).

7.1 Waste Minimization and recovery

Overall, waste recycling rates are low in Kigali city. REMA's environmental outlook report indicates that only about 2% of waste is recycled.[63] More recent studies suggest that the recycling rate is closer to 10-12%.[64] Regardless, these are significantly below government targets which have sought to achieve a recycling rate amongst non-organic solid waste of 30% by 2019/2020 and 40% by 2029/30.[65]

A few companies exist to handle recycling, the majority of which center around paper and plastics. One paper treatment and recycling plant, Trust Industries, transforms paper waste into toilet paper. Several plastic recycling organizations exist, the majority of whom turn a combination of high density and low density plastics into furniture, household objects and industrial agriculture materials. At present, there is no domestic recycling facility for PET bottles, meaning that the majority of these bottles – estimated to be 100,000 bottles on a daily basis – are crushed and sold onto recyclers in Uganda, Kenya, Tanzania and, until recently, China.[66]

Almost all material that is recycled is collected separately from households; almost no recyclable material is obtained from the landfill. Recyclers of plastics tend to receive materials from small industries which are then separated, cleaned and combined with virgin materials to

[61] We base these estimates on the fact that waste collectors pay between RWF 3,000-5,000 for trucks carrying 3-5 tons. See Republic of Rwanda, Office of the Auditor General of State Finances, *Performance Audit Report on Management of Solid and Liquid (Sewage) Waste in the City of Kigali,* 2016, pp 16-17
[62] Interviews with landfill operators, Nduba, May 23, 2019; companies pay for access to the landfill in advance of having trucks arriving the site, and companies are warned in advance when credit is low
[63] REMA, State of the Environment and Outlook Report 2017, 2017, pp 55
[64] See Kebera et al., *Systems Analysis of Municipal Solid Waste Management and Recycling System in East Africa: Benchmarking performance in Kigali City, Rwanda.,* 2019, pp 1
[65] Republic of Rwanda, Ministry of Infrastructure, *National Sanitation Policy Implementation Strategy*, 2016, pp 32
[66] See REMA*, State of the Environment and Outlook Report 2017*, 2017, pp 55; Also see interview transcripts with recyclers, Jardin Muebles and Agroplast

create new products for the market. Similar trends are likely to exist for recyclers of paper materials. At the moment, only one company, Agruni, actively sorts waste at the landfill. Interviews with landfill operators highlighted that Agruni sends its own personnel to sort the waste at the landfill and is allowed to collect the waste without charge; they extract approximately one truck of recyclable waste per week, equivalent to approximately 20 tons a month.[67] Meanwhile, informal waste collectors or scavengers are actively discouraged as per various policy documents including REMA's *Practical guides on Solid Waste Management of Imidugudu Towns and Cities, 2010,* and landfill operators indicated that this practice is highly regulated as a result of tight security.

Various stakeholders highlighted that previous attempts by the city to enforce household waste separation failed due to the lack of any clear downstream sorting. Conversations with various stakeholders including some waste collectors and regulators, indicated that a targeted waste separation campaign was attempted in 2012. As part of this campaign, households were trained to separate waste and waste collection companies were asked to collect organic and inorganic waste separately.[68] However, the lack of any stringent guidelines at the landfill, where comingled recyclables were to be further separated into individual fractions, along with a lack of necessary infrastructure – such as internal roads – meant that waste collection companies struggled to offload their waste in a systematic manner, leading to the contamination of inorganic waste.[69] The initiative was abandoned after a few months.

KIIs with recycling companies highlight a number of barriers to recycling, including the high cost of inputs, the availability of inputs, and difficulties in selling recycled products due to cheap imports. One of the biggest costs a number of recyclers mentioned was electricity, which accounted for between 25-30% of costs; to be profitable, companies reported that electricity costs needed to be approximately 5% of total costs. Additionally, a major impediment to recycling is the lack of waste sorting/segregation at source, which forces companies to depend on smaller intermediaries and also deploy significant resources to sort and clean waste. On the revenue generation side, companies discussed the difficulties of selling their products at prices that were competitive compared to products that were imported from abroad.

A number of waste collection firms mentioned composting and briquette production as a viable means of waste beneficiation. COPED, which is one the largest waste collection firms in the city, uses windrows for aerobic composting. The company sells compost to customers at RWF 7,000 per cubic meter but the system is still small scale due to the need for COPED to perfect the technique. However, with the company currently stockpiling close to 100 tons of composted organics, it is unclear whether there is a viable market yet. Representatives from COPED described the possibility of the government distributing compost along with fertilizer as a way to create a more viable business while also dealing with organic waste in a constructive manner.

[67] Interview with landfill managers, Nduba landfill, May 24, 2019
[68] Interview with RURA representative, May 29, 2019
[69] Interview with COPED representative, May 15, 2019

Another waste collection company, COCEN, reported the production of Briquettes as a means of converting compost into a viable byproduct, although the cost of inputs – especially electricity – and the lack of demand for the product has prevented it from scaling.[70]

The government has, over the past two years, prioritized two special forms of waste remediation – e-waste recycling and hazardous waste treatment – and has enacted regulations regarding these initiatives. E-waste has generated the most attention recently, given Rwanda's ambitions to become an ICT and technology hub. Given current - annual growth in the generation of e-Waste in Rwanda is at about 5.95% - and anticipated growth in this sector, the government instituted an e-Waste policy in 2015 targeted at "resource recovery involving the collection and dismantling of electronics to recover valuable metals."[71] In 2017, Rwanda opened a USD 1.45 million electronics recycling facility in Bugesera .[72] With regards to hazardous waste, the government has constructed an incinerator with installed capacity of 100 kg per hour at the landfill site.[73] While reports note that a small portion of hazardous and infectious waste is burnt by the incinerator, interviews suggest that the incinerator is not currently in operation and that the majority of hazardous waste is disposed of in a pond and covered on a monthly basis.[74]

[70] Interview with COOCEN representative, May 21. 2019
[71] REMA, *State of the Environment and Outlook Report 2017*, 2017, pp 57
[72] REMA, *State of the Environment and Outlook Report 2017*, 2017, pp 45
[73] See Republic of Rwanda, Office of the Auditor General of State Finances, *Performance Audit Report on Management of Solid and Liquid (Sewage) Waste in the City of Kigali,* 2016, pp 2
[74] Interview with landfill managers, Nduba landfill, May 23, 2019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8 Waste System Finances

The City of Kigali faces major challenges in terms of financing the waste collection system. This is mostly driven by the high costs of delivering services and the limited revenues that are earned. On the cost side, the City is faced with staffing a team to deal with waste collectors, the landfill and any interventions involved in capacity building and hygiene related outreach. Given that waste collection services are delivered through private contractors and costs are recovered directly from the households receiving a service, SWM related expenditures are likely to exclude waste collection altogether, apart from the administrative burden placed on City officials to manage the contracts and monitor the services provided. On the revenue side, the City only receives revenue from tipping fees that waste collectors pay at the landfill.

The City has allocated 2.55% and 2.16% of its total operating budget in the 2018/19 and 2019/20 financial years, respectively, to solid waste management.[75] This budget is earmarked for public relations and awareness, landfill management and technical assistance. The budgets allocated for human resources ("staff costs") involved in waste management service implementation and delivery are reported at the aggregate level, which means that full waste service costs – including the costs of Hygiene officers at the sector level - cannot be calculated. Regardless, compared to international benchmarks, these allocations are likely smaller than what might be necessary to manage a sustainable system.

The budgeted amount for the landfill is insufficient to operate a sanitary landfill. The budget for landfill management in 2018/2019 is RWF 316 million, translating to a unit cost of RWF 2,484 per ton. At the prevailing exchange rate, this is approximately $2.70 per ton, which when benchmarked against international costs, is insufficient to cover basic activities involved in the operation of a sanitary landfill. For example, gate fees in South Africa typically range between $14 and $36 per ton. Moreover, the budgeted amount is also not in line with the actual costs incurred, which according to Kigali officials was nearer to RWF 600 million (see above). Not only is this budget insufficient to meet current operational costs, it is also unlikely to keep pace with waste growth and necessary improvements to landfill operations.

In addition, estimates indicate that the City recovers only 23.3% of budgeted landfill costs and 12.3% of actual costs incurred. This is based on the landfill gate fees levied on small (5 ton) and large (10 ton) vehicles at the landfill. Anecdotal reports suggest that 80% of the vehicles using the landfill are small and 20% are large. This equates to an average recovery of RWF 580 per ton, which is significantly lower than the real cost of disposal.

Planned future expenditures by the city on capital investment and upgrades as well as the extension of waste collection services is unclear. First, there are no short- or medium-term capital expenditure budgets for waste infrastructure. A commitment to improve waste

[75] City of Kigali, *ANNEX II-1: 2017-2020 DETAILED EXPENDITURE BY BUDGET AGENCY*, pp 51

management in the City will require investment in infrastructure, initially aimed at mitigating landfill pollution and ultimately at facilitating improved logistics and diversion of waste from landfill.[76] Second, despite the minimal involvement of the city in managing waste collection, a more sustainable financing of extended collection services to poor households ought to be explored. Currently the contractors provide a "free service" to households that cannot afford to pay, but the sustainability of such an approach is questionable. The extension of services to all urban households irrespective of affordability will need to be addressed through appropriate basic service provision policies. [77]

The current collection system is rife with non-payment. Companies interviewed as part of this study highlighted that all higher income households tended to pay for the service, while only between 50-60% of middle income households and 20% of lower income households paid for waste collection services. Official non-payment rates are reported by waste collection companies are highlighted in Table 9.

Table 9: Non-payment rates reported by waste collection companies

Company	Reported Non-payment rates (2019)
AGRUNI	41%
COOPED	40%
Ubumwe Cleaning Company	39%
COCEN	8%
Baheza	30%

Non-payment is likely driven by the fact that tariffs, despite being artificially low, might be too high for lower income households. As highlighted in Table 10, we estimate that current tariffs range between 3.2-7.5% of monthly consumption for households in the second and third *ubudehe* categories, and between 1.6-3.5% for those in the highest *ubudehe* category. These are significantly higher than standard affordability measures in low-income countries, which are usually at 1% as per UNEP guidelines.[78] Further willingness to pay studies conducted in 2016, indicate that 31% of households would prefer to pay tariffs lower than what is currently being charged.[79]

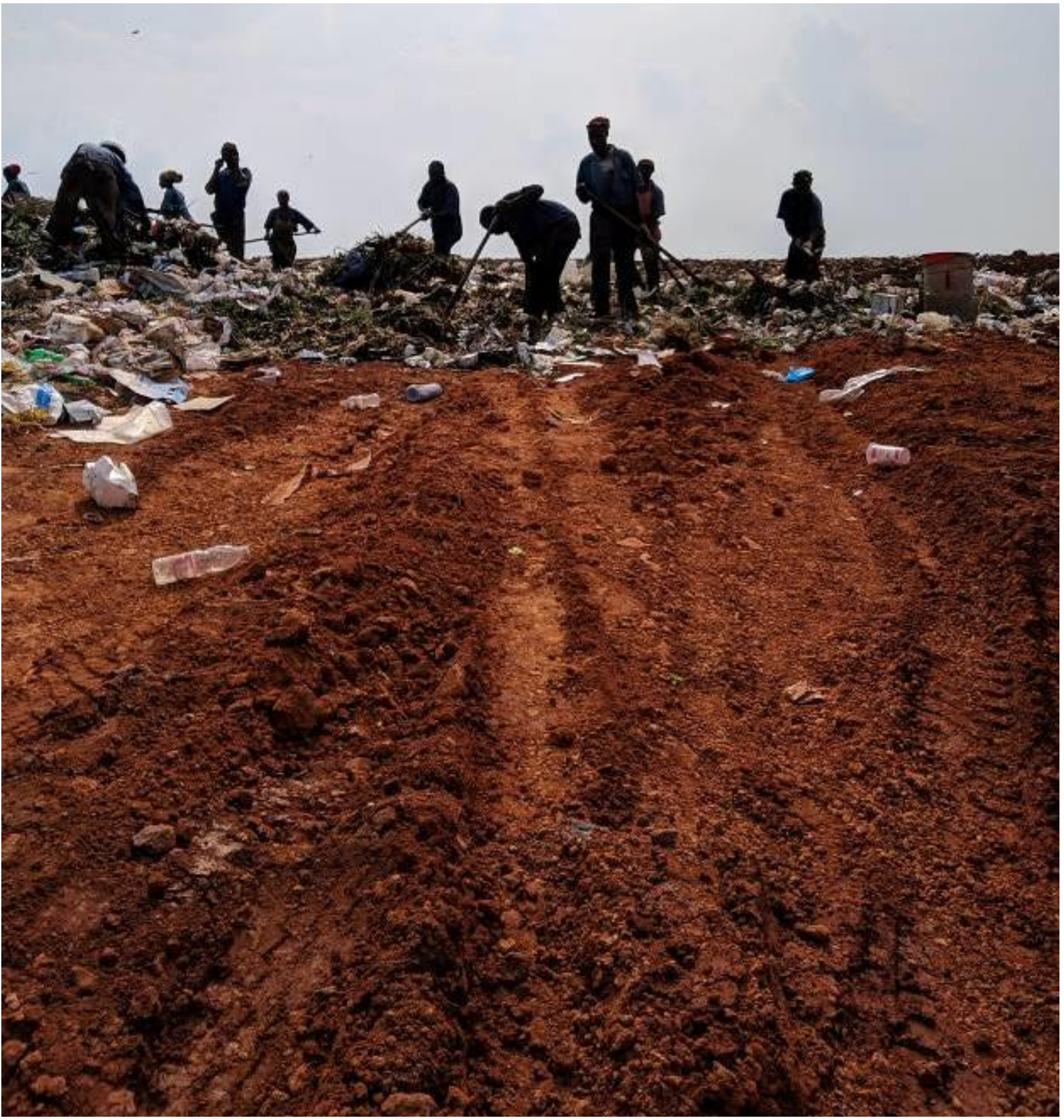
[76] The real cost of disposal is the actual costs plus negative externalities (i.e. the social cost)
[77] The full service cost includes collection, area cleansing, disposal and administration. Disposal costs include infrastructure costs, operational costs and provision for landfill closure and monitoring.
[78] See UNEP, *Global Waste Management Outlook*, 2015, pp 234
[79] See Nishimwe, P, *Privatization of solid waste collection services as tool to sustainable waste management in developing country cities. Lessons from the case of Kigali, Rwanda Capital City*, Masters Thesis UNESCO-IHE, 2016, pp iii

Table 10: Estimate of Household expenditure on Waste collection by *Ubudehe* cateogry

Ubudehe	Avg. Monthly Household consumption (RWF)	Monthly Tariff (RWF - low)	Low %	Monthly Tariff (RWF -high)	High %
4	321,438	5,100	1.6	11,200	3.5
3	99,865	3,400	3.4	7,500	7.5
2	54,150	1,700	3.2	2,300	4.5

Moving towards a full-cost accounting of the waste service ought to be a short-term goal for the City. While it is unlikely that the City will be able to raise sufficient revenue to meet the full waste service costs, it is a necessary start in moving towards cost-reflective tariffs. Full cost accounting would necessarily require a review of institutional arrangements and cost reporting and should therefore be considered in any waste-related organizational restructuring plans. Furthermore, setting tariffs for municipal services is complex and each service cannot be considered in isolation, but rather in accordance with a City-wide tariff and revenue generating policy. The goal of full cost recovery and encouraging private and community initiatives for financing and operating waste management operations is a stated aim of the National Sanitation Implementation Policy.[80]

[80] See Republic of Rwanda, MININFRA, *National Sanitation Policy Implementation Strategy*, 2016, pp 28



9 Recommendations and Policy considerations

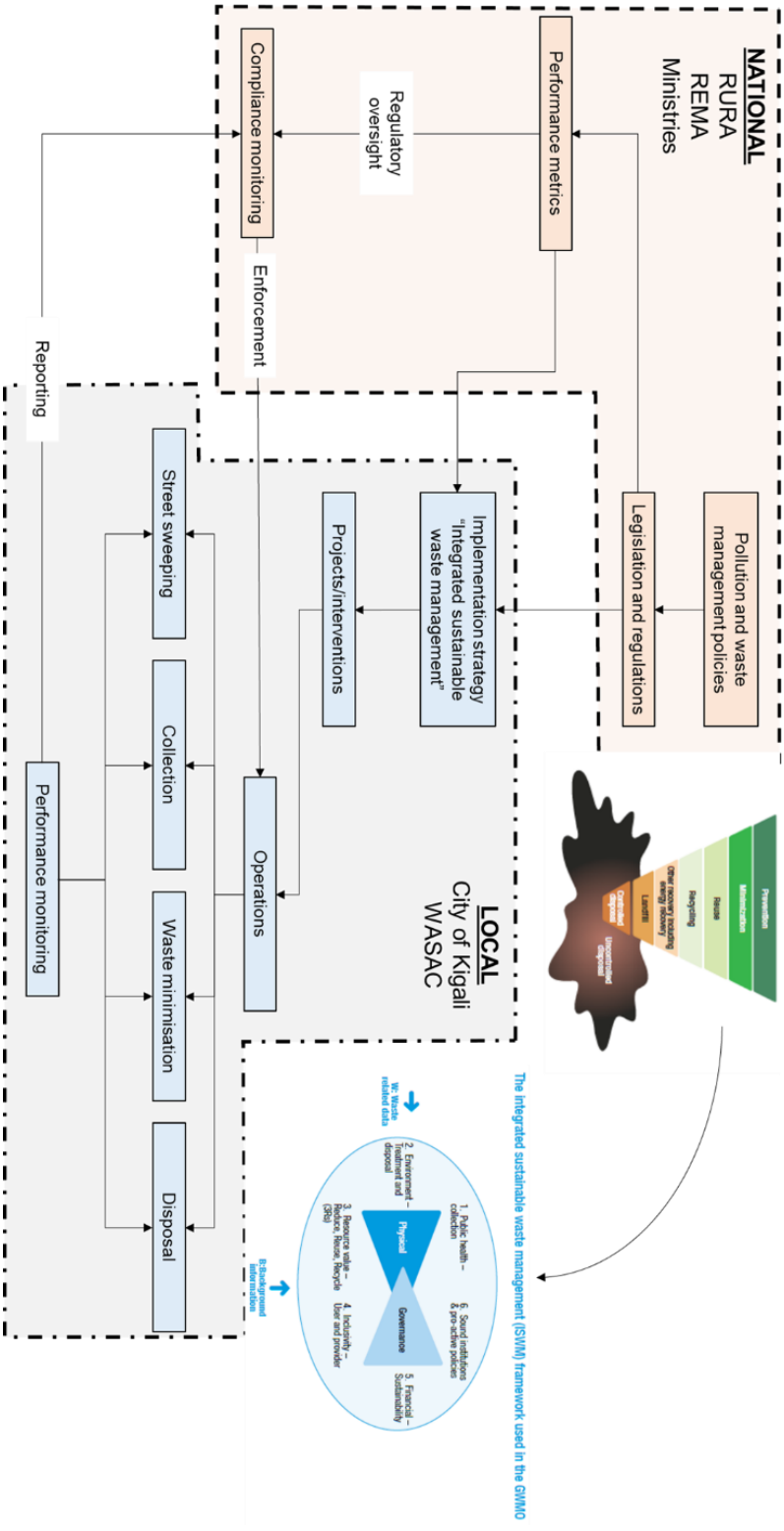
This report provides policy makers with a single reference point from which to better understand the waste system in Kigali. Further, our study provides a broad scope analysis that puts key issues in Kigali's waste management system – slowly growing waste collection rates, landfill management issues, the limited market for recycles - into context. It achieves this by combing through all the available literature on Waste management in Rwanda.

Interventions within the purview of the City of Kigali are in implementation of waste management services. This is because the City must respond to, and implement, policies and legislation from national and regional Departments as described in Section 4. By mapping the roles and responsibilities of the various government department and agencies, as shown in Figure 14, one can see where the City's current focus is and where it ought to focus improvement efforts in the short-to-medium term.

However, an essential requirement in planning for improved waste management in the City of Kigali is a waste strategy and implementation plan. These plans are usually referred to as integrated waste management plans (IWMPs) as they evaluate the whole system and recommend strategies and interventions that balance competing demands to ensure an optimal solution for waste management.

While an IWMP is arguably the highest priority for the City, the development and implementation of the plan is likely to take some time and is therefore a medium-term intervention. There are however clear immediate interventions needed to (i) understand the scale of the waste system and (ii) minimize pollution impacts. The proposed short and medium term interventions are elucidated in sections following.

Figure 15: Notional description of roles and responsibilities in the Rwanda waste system[81]



[81] Waste hierarchy and elements of ISWM diagrams from the Global Waste Management Outlook (UNEP, 2015), pp 30-31

9.1 Short term interventions

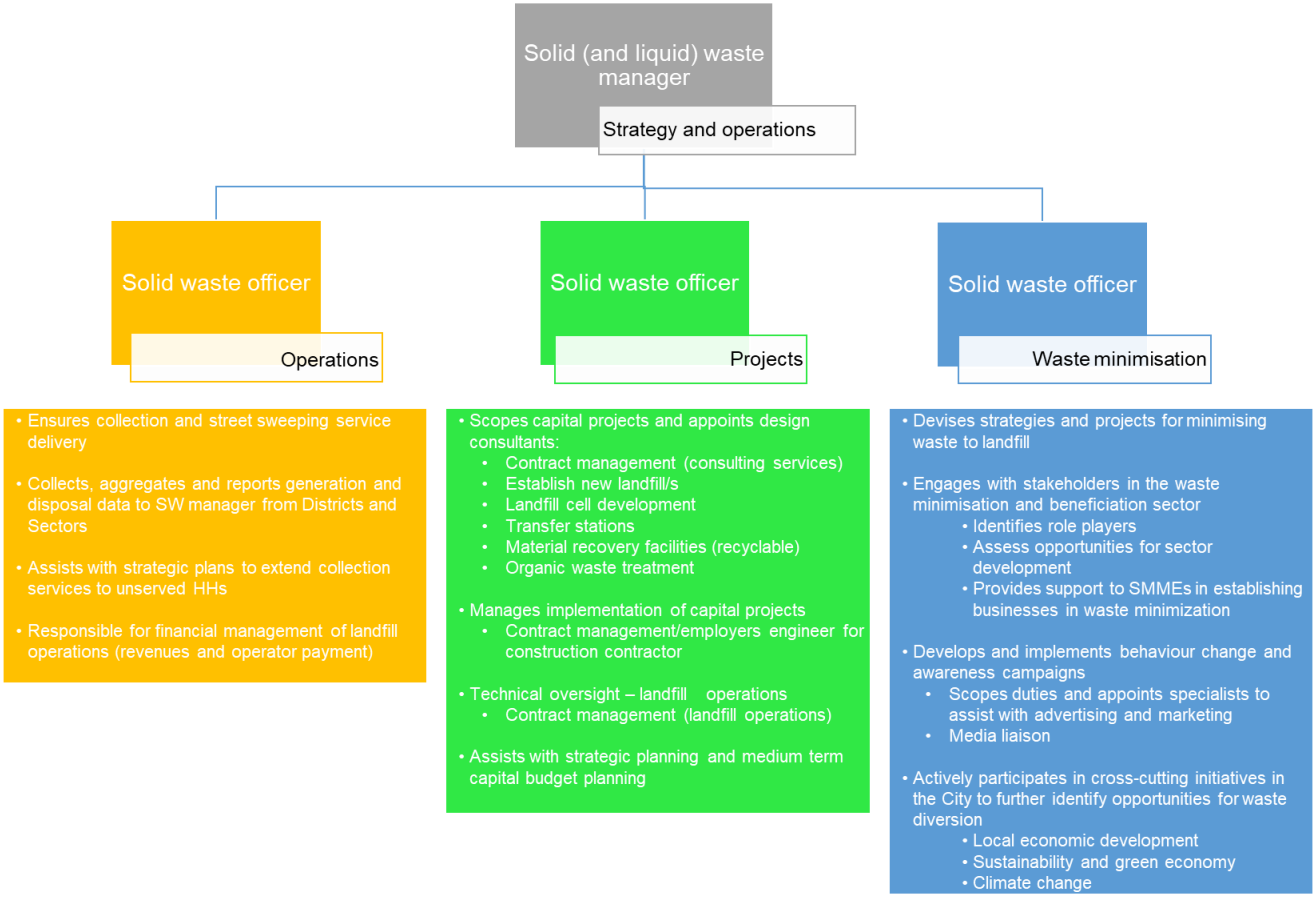
9.1.1 Recognize the importance of waste management and capacitate the department

One of the ways the City might seek to improve its capacity to deliver better solid waste management outcomes is by adding technical skills to a new SWM Department. This would entail developing an institutional structure that can deliver the proposed short and medium term interventions. While the detailed governance and institutional arrangements would be identified in the IWMP (see below), immediate improvements are advised in terms of the role of the solid waste department and the skills needed in the leadership team. A proposed high-level structure is presented in Figure 16, which includes functional responsibilities. This structure is premised on the solid and liquid waste management services being removed from "Public Health" and into a separate waste management department. Whether it should be in the Social Development Directorate or the City Engineer General Directorate is a matter for further discussion as waste management cuts across technical, social and economic development lines.

Such a structure would effectively allocate responsibility along three functional lines: operations, projects and waste minimization. The three individuals accountable for these service lines should be led by a senior manager with skills in strategy development, technical leadership and operations. Since the scope of this report does not extend to liquid waste management, it is assumed that the solid waste officers would focus solid waste only. The specific attributes and skills expected of these individuals should be carefully specified, with key performance areas clearly stated. As a starting point, the roles would need people with the following broad attributes:

- *Solid waste manager - Strategic and Operations:* Senior engineer or scientist experienced in strategy development, leadership and technical and operational experience in waste management.
- *Solid waste officer – Operations:* Experience in solid waste logistics, contract management, data administration with good communication skills.
- *Solid waste officer – Projects:* Engineer with contract management experience in delivering infrastructure projects, preferably in the solid waste sector.
- *Solid waste officer – Waste Minimization:* Likely to have experience the education, environmental science, sustainability/green economy or climate change sectors.

Figure 16: Proposed structure of Kigali's solid waste management department



9.1.2 Data collection and management

It is clear from our analysis of the current waste system that there are data discrepancies throughout the waste system, and this is because there is very little primary data available. This means that waste generation and composition data must be estimated from population demographics and data from outside Rwanda, which in itself has inherent inaccuracies. Without a reasonable understanding of generation, collection and disposal data, policies that set collection and diversion targets are meaningless as compliance can only be measured anecdotally. Planning for future projects based on data of unknown accuracy; data which forms the basis of technical design, is extremely risky and unlikely to attract investment.

The City needs to understand how much and what types of waste are being generated – the start of a Waste Information System. Waste generation and characterization data must be spatially linked to generation points, which would allow for correlation with other variables

(incomes, socio-cultural, seasonality etc.) to better understand both drivers for waste management as well as options for managing the waste.

In the short term, data quality can be improved through simple, low cost interventions such as:

- **Collecting data from waste collection companies including** (i) the current number of trucks and total tonnage of each truck; (ii) number of trips (per vehicle capacity) to landfill (which should then corroborate with disposal records); and (iii) the total number of households services per sector, will allow for quick estimates on total waste generated and waste generated by sector/ household.

- **Developing standard reporting templates and a central data store that Sector officials report into**

- **Installing a weighbridge at the landfill** to log all vehicles (by waste type, e.g. MSW, construction waste, garden waste etc.) is crucial to the long-term fiscal sustainability of the landfill as this would allow for trucks to be charged for the amount they actually dump rather than on a per trip basis. This should be linked to a database that has all collection vehicles info stored, as well as area served. In this way, generation data at sector level can be extracted, analyzed and used for planning.

- **Commissioning a topographical survey of the landfill**, which could be done by aerial survey (drone technology for example) using LIDAR[82] technology. This would provide a baseline profile of the landfill, over which subsequent topographical surveys can be laid. This would provide an estimate[83] of the volume of waste disposed over the period, which would correlate to the tonnage of waste disposed by applying a waste density factor.

[82] Light Detection and Ranging (LIDAR) – "Lidar data is an accurate and effective method for creating three-dimensional topographical aerial maps and highly accurate aerial surveys of both surface terrain elements and man-made structures" from https://oceanservice.noaa.gov/facts/lidar.html

[83] It would be an estimate since the baseline surface surveyed changes over time due to waste settlement effects.

Box 1: South Africa's Waste Information System (SAWIS)

The South African Waste Information System (SAWIS) was initiated through the National Waste Management Strategy Implementation (NWMSI) between 2004 and 2006. The project, which was funded by the Department of Environmental Affairs and Tourism (DEAT) and the Danish International Development Agency, was designed to produced waste data to assist with policymaking at the National, Provincial and Local level.

The key premise behind South Africa's Waste Information System was to assist government with the development of national policies and strategies on waste; assist with the identification of problem waste streams; develop capacity within government around; monitor the effectiveness of waste management policies and strategies; support regional planning; monitor the effectiveness of provincial waste management and waste minimization initiatives; support informed decision-making with respect to environmental impact assessment; support the generation of revenue at landfill sites through waste disposal services rendered; support the budgeting for waste management services and facilities; support the effective operation of waste management facilities, e.g. landfill sites.

DEAT adopted a phased approach to the development and implementation of the SAWIS, recognizing the resource challenges facing government and the waste sector. In Phase 1, the data that was to be collected was minimal and designed to only include urgently needed data from the few the fewest, most relevant role players in the waste generation, transport, disposal and recycling system. During Phases 2-4, the SAWIS will begin to collect data from additional waste management role-players, as shown below. The intention is that with time, waste data will be collected from both generators of waste and facilities receiving waste for reprocessing, treatment or disposal.

All waste data collected by the identified waste facilities is submitted directly into the SAWIS on a regular basis. However, the responsibility to submit data to the SAWIS lies with the waste facility. In order to successfully implement SAWIS, the government identified key constraints in human capital and technology, and identified roles and responsibilities (see below).

Overall, SAWIS highlighted how the collection of data for a national waste information system could, through a process of learning, change the way that waste is managed in the country, such that there was a noticeable improvement. Certain organizations, in particular private waste companies have been successful in collecting waste data, and through a process of learning, these organizations have utilized this waste data to inform and manage their operations.

Source: Republic of South Africa, Department of Environmental Affairs and Tourism, *Guideline on Implementing the South African Waste Information Management System*, 2006; Godfrey, Linda & Scott, Diane., *Improving waste management through a process of learning: the South African waste information system*., Waste Management and Research, 2010

9.1.3 Improve the management of the Nduba Landfill

The Nduba Landfill site is currently operating as an uncontrolled dump. Apart from the obvious aesthetic, vermin, fly and odor impacts, it is highly probable that the site is contaminating the surface and groundwater below and downstream of the site. While the longer term plan would be to close and rehabilitate the site, an alternative disposal solution is unlikely to be available in at least the next three to five years.

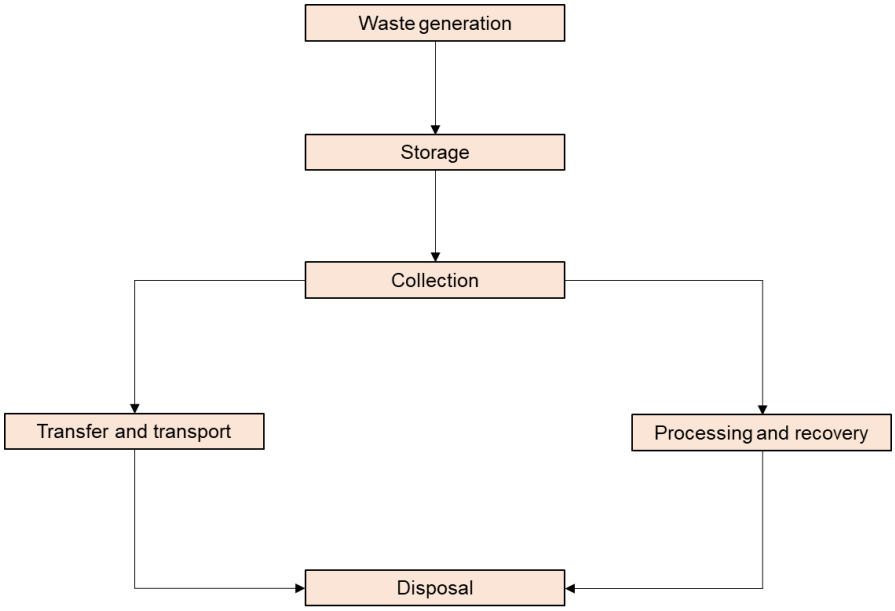
In the short term, it is critical that the City prepares a landfill management turnaround plan that address operational deficiencies, installs groundwater monitoring infrastructure, develops a monitoring plan and identifies new areas in which to developed sanitary landfill cells. A landfill management turnaround plan should include:

- **Appointing specialist design engineers** to prepare a short-term operational plan (where to dispose and for how long) and longer-term designs for new sanitary cells
- **Preparing a design to closure plan** by taking into account the remaining lifespan needed to locate and develop an alternative site
- **Implementing monitoring infrastructure around the site based on a geohydrological study**. Monitoring boreholes must then be installed upstream and downstream of the site to evaluate pollution impacts.
- **Developing and implementing an operational plan document that includes a detailed monitoring plan**
- **Developing engineering solutions to minimize pollution impacts**, for example leachate cut-off drains and pumping systems, leachate containment dams and contaminated storm water management systems

9.2 Medium term intervention – Integrated Waste Management Planning

An integrated waste management plan goes beyond short term quick fixes, but rather aims to develop optimal waste management strategies that consider all elements of a system and all waste types generated within the system. The boundaries of the system are usually defined by the physical extent of the area under the jurisdiction of the entity responsible, as well as the waste types to be managed. In the case of a local authority, the geographic boundaries typically define the scope of the plan. UNEP (2015) broadly separates integrated waste planning into the physical components and governance components necessary for a functional system. Another way to frame an IWMP is to consider how waste flows through a system, and then address each physical element while considering the stakeholders, institutional capacity and financial resources needed to give effect to implementation. Through this process, the gaps between the desired end-state and the current situation are highlighted, allowing for prioritization of interventions. The physical elements of the waste system are presented in Figure 17.

Figure 17: Physical elements of a waste management system



Based on our initial assessment of Kigali's waste system, interventions that could be considered in the first version of an IWMP are described in the subsections following.

9.2.1 Waste generation and minimization

Given that waste generation will continue to increase as a result of rising incomes, behavior change campaigns might serve to illustrate growing waste problem and encourage conscious consumption. While Kigali – and Rwanda – is still far away from having this be a major problem, efforts to reduce waste generation at the household level will pay a big role in preventing problems in the future. Additionally, waste minimization can be encouraged by introducing a more

stringent pay-as-you throw policy. While most waste collectors currently agree to collect two 25kg bins per month based on the tariffs they charge, these are not strictly enforced. Introducing different sized receptacles at different prices might be one way of more strictly creating the economic incentives to reduce waste generated.

One of the key initiatives that the city has repeatedly sought to institute is household separation of Inorganic and organic waste. Household waste separation reduces the amount of waste to be disposed by creating an alternative path for non-organic waste to be reused, and a means for organic waste to be transformed into a useful byproduct**.** While attempts were made to systematize the process in years past, a number of systemic changes – at the household level, with waste collection companies and at the landfill – are necessary to ensure that any such initiative can be put into practice. Examples from other developing countries, such as the Philippines, might be helpful for the City when implementing waste separation activities.

Box 2: Bayawan's Pre-Paid PAYT system

The City of Bayawan, Philippines, introduced a pre-paid PAYT system that requires households to purchase one sticker per bin bag (up to 25 litres) for the collection of in-organic waste; households or commercial establishments in the city centre that do not have space for composting are given bio-waste bags and stickers. The stickers are only sold at the City Hall or at authorised sales points in the public markets or district centres, and cost two pesos (around four euro cents) per sticker.

Each sticker composed of two portions, with each portion displaying a matching identification number. The collection crew checks if a sticker is connected correctly to the garbage bag placed for collection and takes off the other portion to be documented by the City Office. The system has been effective in reducing the amount of waste collected for disposal, although it is unclear whether this was due to reduced waste production or a higher share of recyclable materials given to recyclers.

Source: GIZ, *Economic Instruments in Solid Waste Management*, 2015

9.2.2 Collection and Logistics

While waste collection is currently one of the strongest elements of Kigali's waste management system, it is unclear whether the system is working as best as possible and whether it will continue to work well in the near future considering the predicted waste growth**.** Consideration must be given to incorporating mini aggregation stations to service impassable areas of the city.

For one, the fact that waste collection is completely outsourced raises the questions of whether private companies will actively seek out additional sectors in less-densely populated areas, where households are more likely to be poor. Given that the waste collection business is a function of the number of households and household income, it is unclear whether

areas located on the urban periphery will benefit organically from access to waste collection services unless the government actively intervenes.

Additionally, our research uncovered that the management of waste collection companies by Sector officials might be limiting their overall productively. Firstly, contracts that companies sign with sector level officials might not be the best way to organize waste collection system or ensure high service delivery given the lack of capacity at lower levels of government. Secondly, the length of contracts – which vary between one to five years – means that waste collection companies are unable to invest in fleet to improve their services; it also means that licenses do not correspond with contracts lengths, meaning that incentives between different government agencies are not fully aligned.

The City of Kigali ought to explore the possibility of further consolidating or re-centralizing waste management as a means of improving service delivery over the coming years. Moves to manage the waste collection system through the introduction of licensing and new regulations in 2012 consolidated the waste management sector by limiting the number of firms that could operate across sectors – leading to an improvement in service quality. Similar moves to consolidate the sector even further across the three Kigali districts might allow for efficiencies and economies of scale. Consolidation is also likely to lead to improved 'professionalization' of the service and greater compliance with RURA regulations.

9.2.3 Processing and recovery

Building on efforts to increase household waste separation, the city ought to explore creative ways of dealing with organic waste. Given high levels of food waste in Kigali and potential for offtakes in the agricultural sector, the city's focus might be best directed at this form of valorization. Additionally, finding creative ways of moving or using waste that is collected and composted to rural areas may have tremendous benefits for farmers who would not be able to afford or produce their own compost. Finally, decentralized and technologically simple aerobic treatment techniques (simple in-vessel composters with windrow maturation or vermiculture) could be considered if organics can be separated at source. More advanced technology also exists for extracting organics from mixed MSW, but the business case would need to be made.

Box 3: Decentralized Organic Waste Management by households in Burkina Faso

In Burkina Faso, households have traditionally managed waste through a practice called *tampouré*. *Tampouré* involves storing organic waste in front of homes during the dry season and spreading the waste in fields before the first rains. The waste serves as a layer of compost.

Today, just as Burkina Faso's cities are growing, so too is the demand for agricultural products in rural areas. To address the issue of waste generation in urban areas as well as the growing needs of rural farmers, the Ministry of Agriculture launched a Manure Pit Operation in 2001 inspired by the traditional practice of *tampouré*.

Under this system, the government encourages households to establish pits and compost on their own land and allocates funds each year to support household waste management. Between 2005 and 2012, the national government financed the construction of 15,000 manure pits in Burkina Faso's eastern region and currently, about 2 million tons of organic fertilizer is produced annually and used by farmers each year. A World Bank study in 2006 revealed that 40% of the total waste produced by households in secondary cities and peri-urban areas in Burkina Faso was directly processed onsite (Banna 2017). Burkina Faso's decentralized waste management system has significantly reduced the burden on the formal waste collection and disposal infrastructure.

Source: Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018. *What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050*. Urban Development;. Washington, DC: World Bank

An important area that needs to be addressed in terms of inorganic waste recovery is PET bottles. At the moment, PET bottles are ubiquitous but no recycling currently takes place due to restrictions placed by REMA. This is happening despite the desires of some recyclers to enter the market. While the government is committed to reducing its reliance on single-use plastic bottles, banning their use is not the only option available. A strategy to deal with PET bottle recycling might be another way of dealing with the ill-effects of these materials.

With regards to waste-to-energy, our analysis suggests that the City of Kigali is in the early stages of developing an effective waste management system and is therefore not suitable for an incineration type solution for the foreseeable future. While the collection system is well established, waste disposal takes place at an uncontrolled landfill. The waste generated by the City is rich in organics and will consequently have a high moisture content. It is therefore questionable whether the waste will meet the minimum heating value necessary to maintain combustion without pre-treatment or auxiliary fuel. The City is also in a state of flux, with rapid urbanization and expansion of the City making long term predictions of waste generation and waste composition risky. Added to the current technical and planning challenges is likely to be a

significant affordability gap – financing the capital and operational costs of a waste to energy incineration plant through tariff collections from residents will simply not be feasible.

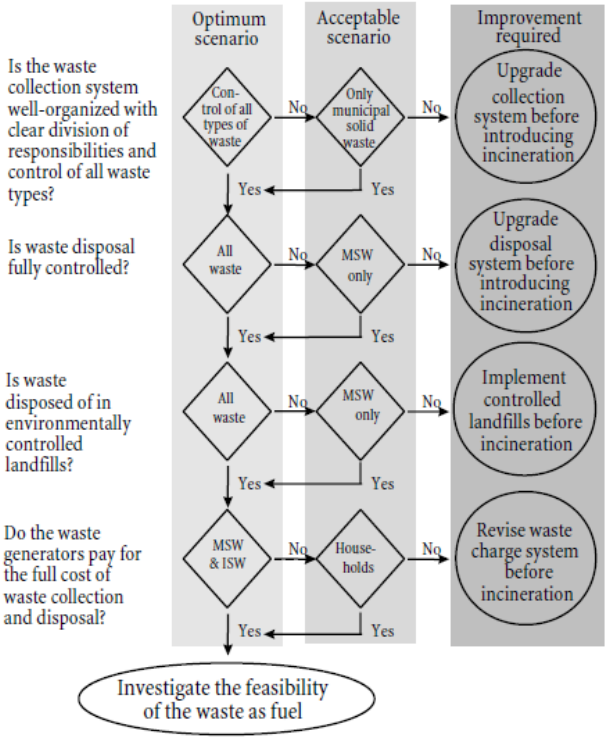
Box 4: Is "Waste-to-Energy" an option for Kigali?

Incineration (with or without energy recovery) is often seen as an attractive option for managing municipal solid waste. Incineration efficiently reduces waste volumes, and electricity generating plants can be sited near incinerators to ensure that energy can be recovered from the process.

Incineration is however one of the most expensive forms of waste management, requires advanced operational skills and a well-established regulatory regime to ensure that emissions are controlled and meet environmentally acceptable levels. Mass burn incinerators are not the panacea to dealing with municipal solid waste and can only exist within a functional waste management system. World Bank (2000) advises that MSW incineration is only applicable when the following criteria are met:

- A functional waste system that has been in place for a number of years
- Solid waste is disposed at well managed, sanitary landfill/s
- The supply of combustible waste is constant and no less than 50,000 tons per annum
- The waste has an average heating value of 7 MJ/kg
- The local authority is able to recover (additional) waste management costs from Kigali residents
- Skilled staff can be recruited
- There is long term certainty and stability within the City of Kigali to allow for a 15-year planning horizon

The diagram below (World Bank, 2000) can be used as an initial screening of the existing waste system to determine whether it is worthwhile further pursuing waste as a fuel:



Source: World Bank, *Municipal Solid Waste Incineration: A Decision Maker's Guide*, 2000

9.2.4 Disposal

Further to immediate actions to improve conditions at the landfill (see above), work needs to start to find a new site. A new site is likely to be more remote than the current and will increase system costs due to higher transportation costs – the earlier sites are identified, and associated costs are estimated, the longer the timeframe available to set the correct tariffs. We recommend that bidders meet a minimum technical and environmental compliance, and that the financial offer *matches the required resources* needed to operate the site according to specification to avoid non-compliance during operation.

9.2.5 Governance

Integrated Waste Management Policy and institutional structure

Developing a (i) clearer waste management policy as well as a (ii) responsive institutional structure to the deal with the growing waste problem is critical to ensure the sustainability of the current system. First, with regard to policies, current waste management arrangements in Kigali are spread across a variety of different ministries and institutions, all of which follow waste management regulations that only form a small portion of their overall mandate. While the system is currently working, fragmented, unfocused and potentially incoherent waste management legislation can have serious consequences for the effective management of waste; so too the lack of government enforcement of existing legislation. Second, while the PPP type system currently in place for waste collection is successful, questions about whether this capacity can be increased – especially in peri-urban areas of the city – is important to address; further, given the poor management of the landfill, questions about whether the City ought to continue undertaking certain activities in-house ought to explored. Key to any changes to governance structure and policy, however, is a carefully considered plan.

Box 5: Integrated Pollution and Waste Management for South Africa

In the late 1990s, insufficient resources to implement and monitor existing legislation, meant that South Africa was seeing unacceptably high levels of pollution and waste. In response, as part of an effort to consolidate the waste management functions of the Department of Water Affairs and Forestry, the Department of Minerals and Energy, the Department of Health, and the Department of Agriculture, the Department of Environmental Affairs and Tourism drafted a policy white paper on *Integrated Pollution and Waste Management* to ensure the country was in line with national objectives, while also focusing on preventing pollution and waste and avoiding environment degradation. The legislation was also aimed at tackling the current fragmentation, duplication and lack of co-ordination across government agencies. The policy resulted in a review of all existing legislation and the preparation of a single piece of legislation dealing with all waste and pollution matters.

Source: Republic of South Africa, Department of Environmental Affairs and Tourism, *Integrated Pollution and Waste Management for South Africa*, 2000

Finances

A key finding of the current waste collection system is that all the costs of providing the service are not fully accounted. While waste management is a basic service and ought to be subsidized, full cost accounting is critical to ensure that all system costs are known and internalized so that correct tariffs can ultimately be set. Additionally, a full-cost accounting system would allow the city to revise tariffs and taxes for high income households to cross-subsidize the poor more efficiently in addition to potential cross-subsidization from other municipal services.

In the case of Kigali, the positive impact of full cost accounting would mostly involve waste disposal, given that waste collection is largely privatized. Taxes and tariffs around waste disposal should be based on actual waste disposed and should ultimately be set so that there is full cost recovery. Underpriced disposal not only leads to external costs (pollution), but sends incorrect economic incentives that encourage disposal over other options. Tariff increases need to be accompanied by awareness campaigns around producer pays principles and waste minimization imperatives. Finally, if significant increases are forecast, these need to be phased in over time and strategies to fund shortfalls in the interim be sought.

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